

PART 400

RIGHT-OF-WAY AND TRAFFIC CONTROL

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TRAFFIC CONTROL

401.1 DESCRIPTION:

Traffic control shall consist of traffic control devices and flagmen or pilot cars. All traffic control devices, the application of traffic control measures, and traffic regulation in these specifications are to supplement and are not intended to delete any of the provisions of the Contracting Agency's Traffic Barricade Manual, the Uniform Manual on Traffic Control Devices or any agency's Supplements to these Uniform Standard Specifications.

Municipality	Supplements
PH:	<p>DESCRIPTION: Traffic control shall consist of traffic control devices and flagmen or pilot cars. All traffic control devices, the application of traffic control measures, and traffic regulation in these City of Phoenix supplements are to supplement and are not intended to delete any of the provisions of the Contracting Agency's Traffic Barricade Manual, the Uniform Manual on Traffic Control Devices or any agency's Supplements to these Uniform Standard Specifications.</p>

401.2 TRAFFIC CONTROL DEVICES:

Traffic control devices shall consist of providing, erecting, and maintaining necessary and adequate devices for the protection of the work, the workmen and the traveling public as approved by the Engineer.

(A) Temporary traffic control devices shall be used to guide traffic through construction areas. They include traffic cones to channelize traffic, portable barricades for warning, vertical panel channelizing devices to divert traffic, and lighting devices between the hours of sunset and sunrise.

(B) Advance warning devices shall be used to alert the motorist of an obstruction in the roadway. They include diamond-shaped signs, flags, and flasher type high level warning devices mounted 8 feet above the roadway.

Municipality	Supplements
GI	<p>4.2 TRAFFIC CONTROL DEVICES</p> <p>4.21 Traffic Signs: All new developments shall provide the necessary funding for required traffic control signs, street name signs and sign posts on all streets and intersections. The City will install these signs and posts at the developer's expense upon payment of all applicable charges. These charges will be billed by the City Traffic Engineer as a separate item, apart from applicable fees for other portions of the development. Construction bonds will not be released and streets will not be opened to traffic until these charges have been paid and the signs have been installed.</p> <p>4.22 Traffic Signals:</p> <p>A. Signal pole bases, signal conduit with pull boxes, interconnect conduit and vehicle loop detectors shall be provided at all major arterial, arterial and collector street intersections as shown in Details G-403 and G-404 (also, refer to the C.O.G. Traffic Signal Standards Manual).</p> <p>B. Signal interconnect conduit and pull boxes shall be provided between existing and/or future traffic signals on major arterial, arterial and collector streets.</p> <p>C. The cost of providing traffic signal poles and related signal equipment, along with installing new traffic signals, or modifying and relocating existing traffic signals shall be at the sole expense of the developer. The City does not loan signal equipment to developments for any reason. Deviation from these standards shall be approved by the Transportation Director.</p> <p>D. All traffic loops shall be installed prior to the placing of the final lift of asphalt concrete pavement.</p> <p>4.23 Barricades:</p> <p>A. All new developments shall provide for barricades at all dead ends and incomplete streets per</p>

	<p><u>Detail G-460</u>, except when waived by the Transportation Director.</p> <p>B. New barricades shall be constructed per MAG Detail 130-B.</p> <p>C. If an existing barricade is removed, it shall be delivered by the contractor to the City Traffic Sign Shop at 6210 West Myrtle Avenue.</p> <p>D. Barricades installed with phased construction may be relocated within the same development.</p> <p>E. Barricades shall be set one foot inside the subdivision being developed. The pavement should stop short of the barricade.</p> <p>4.24 Street and Lane Closure Permits: A street/lane closure permit is required from the City before any work can be done within the street right of way. It is the responsibility of the developer's contractor to request the permit at least 24 hours in advance for a lane closure and 48 hours in advance for a street closure. The City may also require that a traffic control plan be submitted a minimum of 72 hours prior to the issuance of a permit. All construction zone signing shall be installed and maintained per the Phoenix Barricade Manual and the Federal Manual of Uniform Traffic Control Devices, at the developer's expense.</p> <p>4.25 Pavement Markings: All new developments are responsible for the cost, design and installation of pavement markings on the City streets adjacent to the development project. This includes the removal of all existing pavements markings that are in conflict with the pavement markings.</p>
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Municipality	Supplements
MC	<p>: 401.2.1</p> <p>All traffic control devices and their application shall conform to the Manual on Uniform Traffic Control Devices (MUTCD) handbook and current revisions (United States Department of Transportation, Federal Highway Administration), the special provisions and any field modifications made by the Engineer.</p> <p>All traffic control devices shall meet the guidelines of NCHRP 350.</p> <p>Traffic cones shall only be used during daylight hours and shall be a minimum of 711 mm (28") high. Daylight hours are defined as ½ hour after sunrise to ½ hour before sunset. All traffic cones shall have retroreflective bands installed as per MUTCD guidelines.</p>

401.2.2

It shall be the responsibility of the Contractor to provide, erect, maintain, remove and/or relocate all temporary and existing traffic control devices and signal indications necessary to properly mark and control the construction area(s) for the safe and efficient movement of all roadway users.

The Contractor shall provide additional devices as determined by the Engineer, to safely control traffic.

The Engineer reserves the right to make contact with the traffic control subcontractor at any time to request any materials or services deemed necessary for the safety of the public or workers. The cost of these materials or services shall be part of the cost of Traffic Control.

The Contractor shall install temporary traffic control warning signs and devices prior to the start of any work in accordance with the approved Traffic Control Plan (TCP).

All advanced warning construction signs shall be mounted on channels driven into the ground. Each mile and half-mile point of the project shall be signed with construction and speed limit signs, mounted on channels driven into the ground and placed at locations where the need for relocation during construction is minimized.

All temporary traffic control devices shall be ballasted with sandbags or other approved ballast. The amount of sandbags used shall be enough to provide adequate safety for the traveling public.

The Contractor shall mount signs on wind resistant, spring-type bases when conditions warrant or as requested by the Engineer.

The Contractor shall place flags above all signs.

The Contractor shall use warning lights to mark traffic control devices at night.

The Contractor shall mount Type B high-intensity flashing warning lights on all stop signs within the work zone.

The Contractor shall use an arrow board for all stationary or moving lane closures.

The Contractor is responsible for all costs incurred in replacing all lost or damaged traffic control devices and traffic control warning signs.

Portable concrete barrier (PCB) installations shall be in accordance with Chapter 9 of the AASHTO Roadside Design Guide. The PCB shall use F-shape faces. Each section shall be properly connected to the adjacent section to provide barrier continuity to resist movement, snagging, and/or instability of impacting vehicle. PCB panels and connections shall meet NCHRP 350 Test Level 3.

401.2.3

The Contractor shall notify the Engineer prior to the removal of any permanent traffic control devices. The Contractor shall remove (without damage) all permanent signs including signposts that are no longer applicable and store them in the Contractor’s on-site construction yard. The Engineer will notify the County to collect the signing and/or traffic control devices.

Pavement markings used as an integral part of the traffic control plan shall be kept distinct and visible during their use. Temporary pavement markings shall match and meet the markings in place at both ends of their usage.

Municipality	Supplements
PH:	<p>FLAGGERS AND PILOT CARS:</p> <p>Flagging of traffic or pilot cars shall consist of providing sufficient flaggers (with proper signing), uniformed off-duty law enforcement officers or pilot cars to expedite the safe passage of traffic. Off-duty law enforcement officers shall be used when flagging two or more traffic lanes in each direction</p>

401.3 FLAGMEN OR PILOT CARS:

Flagmen or pilot cars shall consist of providing sufficient flagmen, uniformed off-duty law enforcement officers or pilot cars to expedite the safe passage of traffic.

Municipality	Supplements
PH:	<p>Traffic Control Devices: The Contractor shall provide and maintain all necessary traffic controls to protect and guide traffic for all work in the construction area.</p> <p>Traffic control devices shall consist of providing, erecting, and maintaining necessary and adequate devices for the protection of the work, the workmen and the traveling public.</p> <p>(A) Temporary traffic control devices shall be used to guide traffic through construction areas. They include, but are not limited to, traffic cones to channelize traffic, portable barricades for warning, vertical panel channelizing devices to divert traffic, and lighting devices between the hours of sunset and sunrise.</p> <p>(B) Advance warning devices shall be used to alert the motorist of an obstruction in the roadway. They include diamond-shaped signs, flags, and flasher-type high level warning</p>

	<p>devices mounted 8 feet above the roadway.</p> <p>(C) The Contractor shall in all cases notify the Engineer at the same time as other required notices in this section are made. Notification shall be through the Engineer when so required.</p>
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401.4 TRAFFIC CONTROL MEASURES:

The application of all traffic control measures shall be based primarily upon the conditions existing at the time that such measures are deemed necessary. Prior to the start of any work that would interrupt the normal flow of traffic, sufficient and adequate devices and measures shall be provided and erected as directed by the Engineer. These devices shall be immediately removed when no longer needed.

Municipality	Supplements
PH:	<p>401.4.1 Traffic Control Plan Construction shall not commence without an approved Traffic Control Plan (TCP). At the time of the pre-construction meeting, the Contractor shall submit preliminary traffic control plans for each phase of the work for review. Plans shall be of an appropriate size and legible, plans found to be deficient by the Engineer shall be returned. The Contractor shall design the traffic control plan using the posted speed limit existing prior to work starting as the design speed. The TCP shall show all striping, signing, barricading and distances for all devices for all movements of roadway users during each phase of construction. The signing shall show both existing and temporary construction signs, identify conflicting signs to be covered/removed or relocated, and identify other features that may conflict with the placement of temporary signage. The TCP shall also show the duration with the start and end date of each phase. The County will within 10 working days review the plan and notify the Contractor of approval or note changes needed.</p> <p>401.4.2 Traffic Control Technician The Contractor shall appoint a Traffic Control Technician (other than the superintendent/foreman or barricade subcontractor), who has been properly trained and certified in the application of work zone traffic control, to maintain all necessary traffic control devices. At the beginning and end of each workday, and periodically throughout the day, the Traffic Control Technician shall inspect the construction work site. The Traffic Control Technician shall ensure that all construction signs and barricades are standing upright in accordance with the approved traffic control plan, free of dirt and debris and visible to intended traffic. At the end of the workday all non-essential traffic control devices will be removed. The Contractor shall immediately correct deficiencies noted by the engineer. The Contractor shall provide an after-hours pager and telephone number for the Traffic Control Technician at the pre-construction meeting.</p> <p>401.4.3 Intersection Restriction Off-duty uniformed police officers are required at all major intersections when restrictions are present, and may be required at other locations as requested by the Engineer. Any work performed in the right of way within 300 feet of an intersection shall be considered as restricting the intersection.</p> <p>401.4.4 Traffic Control Devices The Contractor shall provide and maintain all necessary traffic control devices until acceptance of the project by the County.</p> <p>401.4.5 Flaggers All flaggers shall be properly trained and certified by a recognized source, such as the American Traffic Safety Services Association (ATSSA) and shall carry with them at all times proof that training and certification requirements have been completed within the last two years. International Municipal Signal Association (IMSA) and shall carry proof of training with them at all times.</p>

	<p>401.4.6 FAILURE TO PROVIDE ADEQUATE TRAFFIC CONTROL MEASURES If the Contractor fails to provide adequate traffic control measures, the Engineer may have the work accomplished by other sources. The cost of having this work accomplished by other sources will be computed in accordance with Section 109.5. The total cost will be deducted from monies due or to become due to the Contractor.</p>
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Municipality	Supplements
PH:	<p>TRAFFIC CONTROL MEASURES:</p> <p>The application of all traffic control measures shall be based primarily upon the conditions existing at the time that such measures are deemed necessary. Prior to the start of any work that would interrupt the normal flow of traffic, sufficient and adequate devices and measures shall be provided and erected required for compliance with the stipulations. The Engineer reserves the right to require additional traffic control measures in any specific instance. These devices shall be immediately removed when no longer needed</p>

401.5 GENERAL TRAFFIC REGULATIONS:

A traffic lane shall be a minimum of 10 feet of clear street width with a safe motor vehicle operating speed of at least 25 miles per hour.

An intersection shall be all of the area within the right of way intersection streets plus 300 feet beyond the edge of the intersected right of way on all legs of the intersection.

A minimum of two traffic lanes, one for each direction, shall be maintained open to traffic at all times on all major streets.

(A) On Bond Issue and Budget Projects: All existing traffic lanes on major streets shall be maintained open to traffic at signalized intersections between the hours of 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. weekdays unless otherwise specified in the special provisions.

Municipality	Supplements
SC:	<ul style="list-style-type: none"> ▪ SC: 401.5 (A) ON BOND ISSUE AND BUDGET PROJECTS: <i>Delete in its entirety.</i>

(B) On Improvement District Projects: All existing traffic lanes on major streets shall be maintained open to traffic between the hours of 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. weekdays. All work that enters or crosses a major street must be done at times other than 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. unless otherwise specified in the special provisions.

Local access shall be maintained to all properties on the project at all possible times. When local access cannot be maintained, the Contractor must notify the affected property owner at least 24 hours in advance and restore access as soon as possible.

A traffic lane shall not be considered as satisfactorily open to traffic unless it is paved with hot mix or cold mix asphalt paving if surrounded by or adjacent to existing pavement. Where pavement did not previously exist or where all of the existing pavement has been removed, a traffic lane shall not be considered as satisfactorily open to traffic unless it is graded reasonably smooth and maintained dust free as directed by the Engineer.

Arrangements for partial or complete street closure permits shall be handled through the Engineer on local projects or the Arizona Highway Department, Resident Engineer on Federal Aid Projects, to the Contracting Agency's Traffic Engineering Department. An advance notice of 48 hours for major streets and 24 hours for local streets and alleys is required from the Contractor.

The Contractor shall provide and maintain all necessary traffic controls to protect and guide traffic for all work in the construction area.

The Contractor shall maintain all existing STOP, YIELD, and street name signs erect, clean, and in full view of the intended traffic at all times. If these signs interfere with construction, the Contractor shall temporarily relocate the signs away from construction but still in full view of the intended traffic.

The Traffic Engineering Department will reset all STOP, YIELD, and street name signs to permanent locations.

Existing traffic signs other than STOP, YIELD, and street name signs shall be maintained by the Contractor until such time as construction renders them obsolete. At that time the Contractor shall remove signs and posts without damage and deliver them as directed by the Engineer. The Traffic Engineering Department will reinstall all traffic signs.

Subject to the approval of the Traffic Engineer, the Contractor shall furnish and install the 25 MPH Construction Zone Speed Limit Signs. The Contractor shall maintain the signs erect, clean and in full view of the intended traffic at all times. Should the signs interfere with construction, the Contractor shall relocate the signs as necessary.

At any time project construction shall require the closure or disruption of traffic in any roadway, alley, or refuse collection easement such that normal refuse collection will be interfered with, the Contractor shall prior to causing such closure or disruption, make arrangements with the Contracting Agency's Sanitation Department in order that refuse collection service can be maintained.

Special traffic regulation will be listed in the special provisions.

Municipality	Supplements
MC	<p>401.5 GENERAL TRAFFIC REGULATIONS: The Sheriff's Department shall be provided with the name and phone number of the person responsible for 24-hour maintenance of all traffic control devices.</p> <p>401.5.1 Road Closure and Road Restrictions A road closure for the convenience of the Contractor is not authorized. Traffic restrictions are not permitted on major or collector streets during peak traffic hours of 6:00 a.m. to 8:30 a.m. and 4:00 p.m. to 7:00 p.m.</p> <p>401.5.2 Minimum Lane Requirements At signalized intersections, during peak hours, four lanes shall be open on roads with five or more lanes, and three lanes shall be open on roads with four or less lanes with a center lane. During off-peak traffic hours, the minimum number of lanes shall be two lanes (one in each direction) on streets with four lanes or less, and three lanes on streets with five or more lanes.</p> <p>401.5.3 Temporary Lane Diversions For construction or trenching that requires movement of traffic from the normal travel lanes, temporary lane diversions may be used only during daylight hours and the normal traffic lanes shall be restored prior to the end of daylight hours. Traffic plates and temporary pavement shall be used to restore traffic lanes. The Engineer, under unusual conditions, may authorize exceptions.</p> <p>401.5.4 Regulatory Speed Limit Signs An appropriate regulatory speed limit sign shall be used where traffic is maintained on temporary detour roads, diversions, or on traffic lanes that are severely restricted.</p> <p>401.5.5 Access to Adjacent Property Access to all adjacent properties shall be maintained whenever possible. When access cannot be maintained, Contractor shall notify the adjacent residents at least 48 hours in advance of the access closure. In no case shall the access be closed for more than four hours. Access to fire stations, hospitals, sheriff stations and schools shall be maintained at all times.</p>

	<p>401.5.6 Signal Equipment Repair If existing signal equipment is damaged the Contractor shall notify the County Signals Supervisor at (602) 506-8660, in order to facilitate the prompt restoration of the traffic signal operation. All costs associated with the repair of damaged traffic signals, caused by Contractor construction activity, shall be borne by Contractor.</p> <p>401.5.7 Portable Concrete Barriers / Steel Plating Open excavations and trenches within 10 feet of an active traffic lane shall be protected at night and during non-working days from vehicle traffic by steel plating or the use of portable concrete barriers. Open excavations as may occur with reinforced concrete box culvert construction and other work shall require portable concrete barriers to separate vehicle traffic from the work site. The Contractor shall use Portable Concrete Barrier when construction hazards warrant, or as requested by the Engineer. Impact attenuation devices shall be provided by the Contractor commensurate with concrete barrier requirements.</p> <p>401.5.8 Supplemental Safety Markings Rope, flagging, fencing and woven plastic tape may be used between barricades and channeling devices to provide additional safety.</p>
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Municipality	Supplements
PH:	<ul style="list-style-type: none"> ▪ PH: GENERAL TRAFFIC REGULATION: Requests for partial or complete street closure permits shall be directed to the Construction Traffic Control Specialist through the Engineer or the Permit Inspector on permit work. An advance notice of 48 hours for major streets and 24 hours for local streets and alleys is required from the Contractor. <p>A traffic lane shall be a minimum of 10 feet of clear width with a safe motor vehicle operating speed of at least 25 miles per hour. An intersection shall be all of the area within the right-of-way of intersecting streets plus 300 feet beyond the edge of the intersected right-of-way on all legs of the intersection.</p> <p>The following are minimum traffic control requirements for all traffic restrictions, unless otherwise provided for in the "Special Traffic Regulations" listed in the special provisions or permit, approved by the Construction Traffic Control Specialist, or during emergency conditions:</p> <ul style="list-style-type: none"> (A) During the PEAK TRAFFIC HOURS of 7:00 a.m. to 8:30 a.m. and 4:00 p.m. to 6:00 p.m., weekdays, TRAFFIC RESTRICTIONS ARE NOT PERMITTED on Major or Collector streets. Streets with reversible lanes shall not be restricted between 6:00 a.m. and 9:00 a.m. and between 4:00 p.m. and 6:00 p.m. weekdays. (B) During OFF PEAK TRAFFIC hours, when one traffic lane is restricted at multiple lane signalized intersections with left-turn channels, the left-turn channels with special channelization shall be used to provide a minimum of four through traffic lanes (two lanes for each direction). (C) Except as provided for in items A and B above, <u>a minimum of two traffic lanes</u> (one for each direction) shall be maintained open to traffic on all Major and Collector streets at all times. A minimum of two traffic lanes in the same direction shall be maintained open to traffic on "one way" streets at all times. (D) A traffic lane shall not be considered as satisfactorily open to traffic unless it is paved with hot mix or cold mix asphalt. (E) The Contractor, utility or other agency, shall provide a uniformed off-duty police officer

during OFF PEAK traffic hours to assist with traffic control at multiple lane signalized intersections whenever traffic in any one direction is restricted. This requirement may be waived by the Engineer when conditions, in his opinion, do not require it.

- (F) Local streets may be closed except for local access, when construction or maintenance requires.
- (G) Local access shall be maintained to all properties on all streets (Major, Collector and Local) at all possible times. When local access cannot be maintained, the Contractor, utility or other agency shall notify the affected property owner, resident, or tenant, a minimum of 24 hours in advance and restore access as soon as possible. Unless specifically authorized by the Engineer, access to businesses will not be closed during business hours.
- (H) All Contractors doing work in the right-of-way shall promptly remove traffic control devices when the closure or lane restrictions are no longer in effect. When no construction work is being done, a temporary construction control sign shall be turned so that it is not readable by drivers. Signs may be temporarily stored behind the sidewalk for short periods of time.

EXISTING TRAFFIC CONTROL DEVICES:

During construction and maintenance operations it is important that all existing traffic control devices be kept compatible with the traffic restrictions imposed. This includes existing signs, parking meters, traffic signals and pavement markings. Some devices will remain applicable to traffic and must be maintained. Other devices must be covered, relocated or removed. Requirements for each group of devices are detailed in this section.

(A) Traffic Signs:

The Contractor, utility or other agency shall maintain all existing STOP, YIELD and street name signs, verifying they are erect, clean and in full view of the intended traffic at all times. If these signs interfere with construction, the Contractor, utility or other agency shall temporarily relocate the signs to permit construction, but the devices must be kept in full view of the intended traffic. Portable signs shall be used to supplement the relocated permanent signs.

Other signs still applicable shall also be maintained erect, clean and in full view of the intended traffic by the Contractor, utility or other agency at all times. Existing signs, not applicable, shall be removed by the Contractor, utility or other agency without damage, and salvaged on the adjacent property lines. The Streets Transportation Department shall be notified of all removals.

(B) Traffic Signals:

The Contractor, utility or other agency shall maintain all existing traffic signal equipment except vehicle detector sensing devices, fully operational in the existing locations and in full view of the intended traffic at all times unless otherwise specified in the Contracting Agency's Traffic Barricade Manual or in the Project or Permit Plans or specifications.

The Contractor, utility or other agency shall notify the Contracting Agency's Electrical Facilities Section 48 hours prior to the start of construction in the vicinity of signalized intersections. The electrical Facilities Section will, upon request, provide the approximate locations of all underground traffic signal equipment (conduits, junction boxes, vehicle detector sensing devices, etc.). The exact location of this underground equipment shall be determined by the Contractor, utility or other agency prior to any excavating operations.

The Contractor, utility or other agency shall exercise care to prevent damage to all existing traffic signal equipment. Should damage occur, The Electrical Facilities Section will make the necessary temporary repairs to immediately restore traffic signal operation.

Responsibility for permanent repair or replacement of damaged equipment shall be as follows:

The cost for the permanent repair or replacement shall be at the Contractor's, utilities', or other agency's expense, when the approximate location of the damaged equipment has been made known to them. They will also be charged by the Electrical Facilities Section for any temporary repair. Permanent repairs or replacements must be made by a qualified electrical Contractor to the satisfaction of the Electrical Facilities Section.

All permanent repairs or replacement shall be at the Contracting Agency's expense, when the approximate location of the damaged equipment has not been made known to the Contractor, utility or other agency; provided they have complied with the notification requirements of this section and requested underground locations.

When the existing traffic signal equipment cannot be maintained as provided for in the Manual or in the Project or Permit Plans or specifications, the Contractor, utility or other agency shall, at their expense, have a qualified electrical Contractor relocate said equipment to a temporary location and/or provide additional temporary equipment, such that all functions and indications of the existing signal equipment, except vehicle detector sensing devices, are maintained and in full view of the intended traffic at all times. The location and type of all temporary signal equipment shall be approved by the Streets Transportation Dept. All signal equipment relocations and/or installations of temporary signal equipment shall be coordinated by the Contractor, utility or other agency with the Electrical Facilities Section. 24 hours advance notice is required.

When temporary equipment or new equipment is installed to replace existing equipment, the temporary or new equipment shall be fully operational before the existing equipment is removed.

The Contractor, utility or other agency shall restore all signal control equipment to the original locations or new locations, if so specified, as soon as possible after all work in the immediate area is completed.

(C) Pavement Markings:

Existing pavement markings that conflict with the vehicle path indicated by barricades and channelization and cause driver confusion shall be removed or obliterated by the Contractor, utility or other agency as directed by the Streets Transportation Dept.

Generally, pavement marking removal or obliteration is only required on long term construction projects such as detours for bridge construction or similar fixed location projects. However, removal or obliteration of existing pavement markings may be required at any location when visual inspection and/or accident history shows driver confusion caused by existing pavement markings.

Proper pavement marking removal or obliteration leaves a minimum of pavement scars and completely removes or covers existing markings. Slurry Seal (MAG Specification, Section 332) may be used to obliterate existing markings. When used, Slurry Seal shall be applied in strips at least 24 inches wide over existing markings. Markings that become exposed shall be recovered with Slurry Seal. Painting over existing markings with black paint or asphalt material is not satisfactory except in emergency conditions awaiting more permanent removal to follow immediately.

(D) Parking Meters:

The Contractor, utility or other agency shall maintain all metered parking spaces open for parking at all possible times. When parking meters must be hooded or removed, the Contractor, utility or other agency shall notify the Streets Transportation Dept. 24 hour advance notice is required.

All parking meter post removals, relocations or installations shall be done by the Contractor, utility or other agency as provided for in the plans, or as directed by the Parking Meter Supervisor.

	<p>The Streets Transportation Dept will provide the parking meter posts.</p> <p>401.7 HOLIDAY SEASON TRAFFIC:</p> <p>During the holiday season from mid November through the 1st of January, it is imperative that construction and maintenance activities which interfere with traffic flow be reduced to the lowest possible level.</p> <p>On all major streets, adjacent to, or serving as primary access to large regional shopping centers work that restricts traffic should be minimized. In addition, work within the entire Central Phoenix area should be curtailed (Maricopa Freeway to Bethany Home Road, 27th Avenue to 32nd Street).</p> <p>Careful planning of work schedules to avoid operations that restrict traffic flow can do much to benefit the traveling public and decrease traffic accidents.</p> <p>401.8 FAILURE TO PROVIDE ADEQUATE MAINTENANCE OF TRAFFIC:</p> <p>If the Contractor fails to provide adequate maintenance of traffic, the Contracting Agency will have the work accomplished by other sources. The cost of having this work accomplished by other sources will be computed in accordance with the City of Phoenix Supplement to Section 109. The total cost will be deducted from monies due to the Contractor.</p>
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Municipality	Supplements
SC	<p>401.5 (B) ON IMPROVEMENT DISTRICT PROJECTS: <i>Delete the subsection designation "(B) On Improvement District Projects" and delete the first paragraph which reads: "All existing traffic lanes on major streets ... unless otherwise specified in the special provisions."</i></p> <p><i>Delete the seventh paragraph which reads: "The Traffic Engineering Department will reset all STOP, YIELD, and street name signs to permanent locations."</i></p> <p><i>Combine the remaining paragraphs of 401.5(B) into the main body of 401.5 and add the following paragraphs:</i></p> <p>No work requiring the closure of arterial or collector traffic lanes shall be done between the hours of 7:00 A.M. to 9:00 A.M. and 4:00 P.M. to 6:00 P.M.. The roadway must be completely unobstructed during these hours. At other times, a minimum of one lane of traffic for each direction of travel shall remain open. All signs must be turned or removed from driver's sight when work is not being accomplished within the roadway. Any exceptions to this must be approved in advance, in writing, by the COS Transportation General Manager or his Designee.</p> <p>Traffic control shall conform to the latest City of Phoenix Traffic Barricade Manual and/or as directed by the COS Traffic Engineering Division, COS Inspection Services, or MUTCD Manual.</p> <p>A barricading plan shall be submitted to COS Inspection Services a minimum of 72 hours prior to any proposed partial or complete street closure. Work shall not commence on the portion of the project requiring street barricading until approval has been obtained in writing from both COS Inspection Services and Traffic Engineering Division.</p> <p>Arrow panels are required during all barricade setups on roadways with posted speeds of 35mph or greater.</p> <p>Uniformed off-duty police officers require a minimum 72 hours notice prior to commencement of their service</p>

401.6 MEASUREMENT:

No measurement will be made for traffic control devices.

Flagmen, uniformed off-duty law enforcement officers or pilot cars, with driver, will be measured by the hour for each individual, including vehicle and equipment, required to perform traffic control. When an officer is used less than 3 hours, a minimum of 3 hours will be charged. Anything over 3 hours will be measured by the hour.

Municipality	Supplements
MC	<ul style="list-style-type: none"> ▪ MEASUREMENT: Section 401.6 is replaced with the following: Measurement for Traffic Control shall be made on a Lump Sum basis. This lump sum measurement shall include all materials, equipment and labor necessary to facilitate traffic control per the contract documents. Items of Traffic Control include but are not limited to the obliteration of existing and temporary pavement markings, pilot cars, flagmen, barricades, sign panels, sign stands, warning lights, and related temporary pavements. No direct measurement of individual traffic control elements or devices will be made. All traffic control devices, unless otherwise noted, shall be considered as included in the lump sum measurement for the Traffic Control bid item. No direct measurement for temporary pavements will be made. All sawcutting, grading, aggregate base course materials, asphaltic concrete pavement, labor, and equipment shall be considered as included in the lump sum measurement for the Traffic Control bid item. No direct measurement for removal of temporary pavements will be made. All sawcutting, and removal of aggregate base course materials and asphaltic concrete pavement shall be considered as included in the lump sum measurement for the Traffic Control bid item. Uniformed Off-duty Law Enforcement Officers including vehicle and equipment will be measured by the hour for each hour required to perform traffic control duties. When an officer is used less than 3 hours, a minimum of 3 hours will be charged. Time over 3 hours will be measured by the hour. When included as a separate pay item within the bidding schedule, Portable Concrete Barrier shall be measured by the foot. Otherwise, portable concrete barrier shall not be measured and shall be considered a traffic control device.

Municipality	Supplements
PH:	<p>MEASUREMENT: No measurement will be made for traffic control devices.</p> <p>When a pay item is included in the Contract Documents, flagmen, off-duty law enforcement officers or pilot cars, with driver, will be measured by the hour for each individual, including vehicle and equipment, required to perform traffic control. Minimum payment shall be three hours on any separate call out</p>

401.7 PAYMENT:

Payment will be made at the contract bid price in the proposal for uniformed, off-duty law enforcement officer. If the officer is utilized in excess of 8 hours in any calendar day or in excess of 40 hours in any calendar work week, payment shall be at the rate of 1 1/2 times the contract bid price for all hours worked in excess in either of the above time periods.

Municipality	Supplements
MC	<p>PAYMENT:</p> <p>Section 401.7 is replaced with the following:</p> <p>Payment for Traffic Control other than Uniformed Off-duty Law Enforcement Officers shall be made at the lump sum bid price in equal payments distributed over the entire duration of the project. Payment for Traffic Control shall be full compensation for all labor, pilot cars, flagmen, materials, traffic control devices, and miscellaneous incidental items necessary to complete the work.</p> <p>Payment for Uniformed Off-Duty Officer will be based on approved time sheets or invoices not to exceed the amount shown on the Bidding Schedule. For all actual hours Contractor provided a Uniformed Off-Duty Law Enforcement Officer for traffic control purposes at the request and with the approval of the County. Expenses, eligible for reimbursement, are labor costs, supported by approved time sheets or invoices and documented expenses such as taxes or bond cost charges to Contractor in connection with the Uniformed Off-Duty Law Enforcement Officer assignment. No additional mark-up for profit and/or fee for Contractor will be eligible for reimbursement.</p> <p>Separate payment for Portable Concrete Barrier will only be made when Portable Concrete Barrier is included as a separate pay item within the bidding schedule. Payment will be full compensation for the furnishing, transportation, installation, adjustment, maintenance, and removal of the temporary barrier system.</p>

Municipality	Supplements
PH:	<p>PAYMENT:</p> <p>Payment will be made at the contract bid price in the proposal for uniformed off-duty law enforcement officer. If the officer is utilized in excess of 8 hours in any calendar day or in excess of 40 hours in any calendar work week, payment shall be at the rate of 1-1/2 times the contract bid price for all hours worked in excess in either of the above time periods.</p> <p>Off-duty police officers required by the permit or used but not required by the Contract shall be paid at their regular rate of pay established by their primary employer. This is a non-pay item.</p>

Municipality	Supplements
TE	<p>: 401</p> <p>Add the following to Section 401.</p> <p>On City Budget Projects:</p> <p>When the contractor is to provide law enforcement officers for traffic control, City of Tempe officers shall be used when available. City police officers will remain on the City payroll. The contractor will be responsible for contacting the Tempe Police Department at 350-8296 at least two days (48 working hours) in advance to determine availability of police officers. (In reference to the above, see City of Tempe Traffic Barricade Manual, latest edition.)</p> <p>Change the phrase "off-duty law enforcement officers" to "law enforcement officers" wherever it appears in Section 401.</p>

Municipality	Supplements
GI	<p style="text-align: center;">The following section has been added:</p> <p style="text-align: center;">PAVEMENT MARKING</p> <p>402.1 GENERAL NOTES</p> <p>Pavement Marking Plans</p> <p>A. The general Contractor or the Sub-Contractor installing pavement markings within the Town’s right-of-way are required to obtain a striping permit prior to any installation. Permits applications can be obtained from the Development Services Department located at 90 E. Civic Center Dr, Gilbert, AZ. 85296, or by calling (480)503-6700.</p> <p>B. All pavement markings shall conform to the Arizona Department of Transportation Standard Drawings and Specifications unless otherwise specified in the 2003 Edition of the Manual on Uniform Traffic Control Devices handbook, or as noted on the plans.</p> <p>C. The Contractor shall spot mark the entire project before applying any markings. When the spotting is complete the Contractor shall contact the Traffic Engineering Section at (480) 503-6186 to make arrangements for inspection prior to applying any paint (2 business days advance notice is required). The permanent marking plans may be modified as directed by the Engineer. The Contractor shall refer any questions concerning pavement markings to the Town of Gilbert Traffic Engineering Section.</p> <p>D. Any pavement markings applied prior to field inspection by the Town of Gilbert’s Traffic Engineering Section shall be removed and re-striped at the Contractor’s expense.</p> <p>E. All striping will be applied initially in paint (to include all items specified to be applied in thermoplastic). The Contractor will be required to re-stripe the entire project 30 to 45 days after initial striping. At this time all symbols, transverse markings, and holding bars will be re-striped in Thermoplastic paint, and the remainder of the project in paint.</p> <p>F. Raised pavement markers shall be installed on the new pavement. They shall be installed per ADOT Standard Detail 4-M-2.02 and 4-M-2.03.1. They shall be non-adhesive with an abrasive resistant surface. They shall be secured to the pavement with a hot, flexible marker adhesive. All markers shall be installed so that the reflective face of each marker is facing the direction of traffic and is perpendicular to the direction of traffic flow.</p> <p>G. Where raised pavement markers are placed along solid striping, the nearest edge of each marker shall be offset no less than 4 inches and no more than 6 inches from the nearest edge of the striping.</p> <p>H. Turn lane arrows shall be installed per ADOT Standard Detail 4-M-1.16 with the exception of the word marking “ONLY” which shall not be used.</p> <p>I. The dimensions shown to the pavement marking stripes are to the center of the stripe, or in the case of a double stripe, to the center of the 2 lines.</p> <p>J. All permanent pavement lines parallel to the flow of traffic shall be installed at a minimum thickness of 15 mills and shall be placed in accordance with the Arizona Department of Transportation</p> <p>K. All striping shall be a minimum width of 4 inches except where noted on the plans, or as noted below:</p>

	<p>1. All edgelines shall be 6”</p> <p>2. All holding bars shall be 8”</p> <p>3. All crosswalk lines shall be 12”</p> <p>4. All STOP bars shall be 18”</p> <p>L. The pavement marking dimensions on any given set of plans may be schematic and not to scale, therefore the Contractor shall follow all standard details that are noted on the plans when installing pavement markings.</p> <p>M. When striping obliteration is necessary, it shall be accomplished by water blasting (other methods may be allowed with prior approval of the Town Traffic Engineer). If obliteration causes shadowing, or in the opinion of the Engineer will cause confusion on the part of the driver, the Contractor shall seal the area with slurry per M.A.G. Specifications 713 and 715, Type I. Applying paint over striping does not constitute stripe obliteration. Striping obliteration may go beyond the project limits so that the new striping will match permanent existing pavement markings.</p> <p>N. Median ends shall be marked in accordance with the MCDOT Striping Manual Details 4-17 and 4-18.</p> <p>K. If necessary for smooth traffic flow, the Contractor may be required to add additional asphalt to accommodate traffic. The Contractor or Developer will be required to complete this at their expense.</p> <p>P. Should field conditions change due to construction on adjacent pieces of roadway, the Contractor shall be responsible for notifying the Town of Gilbert Traffic Engineer at 480-503-6186 and will be required to submit for review an updated striping and signing plan 21 days prior to paving. The Contractor may be required to re-stripe, stripe, and design striping for adjacent portions of roadway that are affected by their construction. Any changes, additions, or deletions will be accomplished by the Contractor at their expense.</p> <p>Q. All signing and pavement markings shall be installed within 5 days of completion of the final lift of asphalt or as required by the Engineer.</p>
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Municipality	Supplements
SC	<p style="text-align: center;">SECTION 402 PAVEMENT MARKINGS AND SIGNING</p> <p>402.1 GENERAL:</p> <p>The work under this item will provide the final striping and marking of all pavements and the installation of traffic control signs as described herein in accordance with COS Standard Details and as shown on the plans.</p> <p>Any striping other than the replacement of pre-existing striping shall be done in accordance with a plan prepared by a registered Engineer and approved by the COS Traffic Engineering Division.</p> <p>All construction shall conform to Arizona Department of Transportation standard drawings and specifications unless otherwise specified in COS Standard Details, the "Manual On Uniform Traffic Control Devices", latest edition, or as otherwise specified in the contract documents.</p> <p>402.2 PAVEMENT MARKINGS:</p> <p>Permanent lane striping shall be <u>90 mil. extruded thermoplastic material</u>, conforming to all requirements of ADOT Standard Specifications Section 704, latest edition. Crosswalks and stop lines shall be 90 mil extruded hot thermoplastic material conforming to ADOT Standard</p>

Specifications Section 704.

The actual width of the stripe shall be:

<u>Plan Width</u>	<u>Actual Width</u>
4 inches	4 to 4.5 inches
6 inches	6 to 6.5 inches
8 inches	8 to 9 inches
over 8 inches	+/- 1 inch

Pavement symbols, arrows and legends shall be preformed markings, Type I (Permanent) pavement tape conforming to all requirements of ADOT Standard Specifications Section 705, latest edition, unless noted otherwise on the plans. Tape shall meet or exceed the specifications of 3M 380-IES series and shall in addition meet or exceed applicable ADOT Specifications.

Painting shall be provided on all median noses and at temporary pavement marking locations where indicated on the plans and standard details. Reflectorized paint materials shall be white or yellow as noted and shall meet ADOT Standard Specifications Section 708. Glass beads shall be applied to all painted surfaces.

Raised pavement markers shall conform to requirements of ADOT Standard Specifications Section 706, latest edition.

Obliteration of any existing pavement markings required for new work shall be accomplished per COS Supplemental Specification Subsection 350.2.

402.2.1 Measurement And Payment: Pavement striping and markings shall be measured and paid as described in the ADOT specifications. Striping will be in linear feet of equivalent four (4) inch wide stripes, excluding lengths of skips. Pavement markings and markers will be measured each, as designated in the bid schedule. Costs for temporary markings and signs are not included in this item but will be included in the bid price for traffic control.

402.3 SIGNING:

All traffic signs shown on the plans to be installed after the roadway improvements are completed shall be mounted on square tubular sign posts as specified herein when existing street light pole cannot be used, due to spacing or lack thereof.

Sign mounting heights and offset from edge of roadway shall per the MUTCD Manual. Sign blanks shall be 0.080 gauge anodized aluminum. Unless noted otherwise herein, sign faces shall be ASTM Type II retroreflective sheeting, sometimes referred to as "super engineering grade". Background and legends shall both meet Federal Highway Administration Standards.

All existing signs shall be inventoried prior to roadway work. Signs which are not reused shall remain the property of the City and will be carefully removed and delivered to the COS Sign Shop at 9191 E. San Salvador Drive. The Contractor shall remove any existing concrete bases using care not to damage the post. Any signs that will be used at project completion shall be stored safely and protected against damage at the Contractor's job site and shall be leveled, squared and set in ground per COS anchoring specifications and per MUTCD height and offset specifications.

402.3.1 Steel Square Tubular Sign Post Assembly: The sign post assembly shall consist of the post (1-3/4 inch x 1-3/4 inch square tubing, length per sign type according to MUTCD), sleeve (2-1/4 inch x 2-1/4 inch x 12 inches long square tubing) and anchor (2 inch x 2 inch x 36 inches long square tubing).

(A) Material: Tubing shall be roll formed of 12 gauge steel or of a gauge sufficient to supply a

minimum yield strength of 40,000 psi. Tubing shall conform to the Standard Specifications for Cold-Rolled Carbon Steel sheets, commercial quality, ASTM A-570, Grade 33 for plain finish, and ASTM A-446, Grade A for galvanized finish.

(B) Finish:

(1) Galvanized: All steel tubing shall be given a hot dipped zinc (galvanized) coating conforming to ASTM A-525, G-90. All exterior, interior, and corner weld surfaces shall be thoroughly coated.

(2) Painted: Galvanized tubing shall be cleaned and phosphated prior to application of a powder coat finish. The tubing shall be coated with polyester powder bake/fused or electrodeposited to the galvanized surface. The color is Perma-Green per Federal Standard 595-A, color number 14109 (dark limit V).

(C) Shape: A cross section of the post shall be a square tube carefully rolled to size. Tubing shall be corner welded by high intensity resistance welding, in such a manner that neither the weld nor flash shall interfere with telescoping properties.

(D) Holes or Knockouts: Hole or knockout diameter shall be 7/16-inch plus or minus 1/64-inch on 1 inch centers, on all 4 sides of the post for its entire length. Holes or knockouts shall be on the center line of each side in true alignment and placed opposite and adjacent to each other. Tolerance on hole or knockout spacing is plus or minus 1/8-inch in 4 feet. The sleeve and post tubing shall have the first two sets of knock outs pre-punched on one end.

(E) Telescoping Properties: The finished post, sleeve and anchor shall be straight and have a smooth uniform finish. It shall be possible to telescope the post with each consecutive larger and smaller size of square tube, freely and for not less than 10 feet of their length without the necessity of matching any particular face to any other face. All ends shall be free from burrs and shall be cut square.

(F) Anchor/Sleeve Installation: The Contractor shall install the anchor/sleeve by driving with a pneumatic hammer or by encasing in concrete.

(1) Pneumatic Hammer: The sign anchor and sleeve may be installed with a pneumatic hammer. The Contractor shall exercise extreme care to prevent deformation of the anchor tubing during installation. The sign post must be able to slide freely in and out of the anchor once it is in place.

(2) Concrete Encased: The sign anchor and sleeve may be wrapped with #30 tar paper and concentrically placed in an 8 inch diameter by 42 inch deep concrete encasement. The anchor tubing shall extend 35 inches into the concrete encasement. The sign post must be able to slide freely in and out of the anchor once it is in place.

402.3.2 Advance Street Name Signs:

(A) Material:

(1) Background shall be green, Type III sheeting per ASTM standard specifications, sometimes referred to as "high-intensity".

(2) Legend shall be silver, Type III sheeting per ASTM standard specifications, sometimes referred to as "high intensity".

(3) The sign width shall be a standard 18 inches. The sign length shall be variable and sized according to legend. The minimum length shall be 42 inches and maximum length shall be 72 inches.

(4) All vinyl sheeting shall carry a 10-year guarantee not to lose more than 20 percent of initial reflectivity by the end of a 10-year period.

(B) Sign Fabrication:

(1) All letters and numerals shall be Series "C". The first letter in each name shall be 8-inch upper case. All other letters shall be 6-inch lower case. In the event that a street name length will not fit on the maximum 72-inch blank, the letters shall be changed to Series "B". The street designation such as, Road, Street, etc., shall be abbreviated and may be down sized to a minimum of 4 inches. These adjustments are to be made only when the street name is of such length that it will not fit on a 72-inch blank.

(2) All street names shall be properly centered on a sign blank.

(C) Sign Installation:

(1) Sign installations shall be made in a high quality manner. All signs shall be level within 2 degrees. Sign poles shall be perpendicular to level plus or minus 2 degrees. Signs shall be installed at a height of 4 feet to the bottom of the sign.

(2) All signs shall be secured to each pole with no less than 2 each, 3/8-inch steel drive rivets.

(3) Signs over 60 inches in length will require 3 sign posts, equally spaced and centered on the sign.

(4) All signs must be clean and free of any contaminant upon completion of installation.

(5) The Engineer shall designate all sign locations, away from tress and other vegetation that may obstruct visibility.

402.3.3 Street Name Signs:

(A) Materials:

(1) Sign sheeting shall be ASTM Type II (super engineer grade) per ASTM Standard Specifications. Background color shall be green, legend color shall be white.

(2) Sign blanks shall be 9 inch-extruded aluminum blank, 0.091 gauge.

(3) Aluminum shall be chemically treated to meet ASTM B449 specification for corrosion resistance.

(B) Sign Fabrication:

(1) Letters for street name shall be upper case, 4-inch Series "C", Helvetica, medium stroke.

(2) Letters for block number, street direction and street designation (ST., RD., PL.) shall be upper case, 2-inch, Series "C", Helvetica, medium stroke.

(3) Letters and numbers for numerical streets shall be 4-inch (ie. ^E 5 TH₇₂₀₀AVE).

402.3.4 Metro Street Signs

(A) General:

(1) Workmanship: All items shall be new; the material and workmanship shall be of the best quality for the purpose.

(2) Drawings: All signs shall be made in accordance with the COS Standard Details. All sign layouts shall be the Contractor's responsibility and shall be subject to the COS's Traffic Engineering Division's approval.

(3) Warranty: Any sign delivered under this contract which does not conform to these specifications shall be replaced by the Contractor at no cost to the Engineer.

(B) Materials and Fabrication:

(1) Powder Coating: Aluminum frame and telescoping bracket shall be covered with opaque electrostatically applied TGIC POLYESTER POWDER COATING.

(a) Thickness: The thickness of the TGIC Powder Coating fused to the aluminum frame and telescoping bracket shall be .002-inch minimum. Thickness shall be determined in accordance with ASTM Designation D-1400, or other methods of equivalent or greater accuracy. The referee method, in case of dispute, shall be photomicrography.

(b) Color: Color shall be white TGIC Powder Coating on the mounting bracket and frame.

(2) 3M Diamond Grade Reflective Sheeting, ASTM Proposed Type IX (prismatic lens sheeting):

(a) Color shall be white legends on green background.

(b) The application and screening procedures must be in accordance with the sheeting manufacturer's specifications. May be applied or screen printed.

(3) Base Metal:

(a) Description: The base metal substrate shall be new sheet aluminum alloy 3003-H14 or 5052-H32.

The thickness of the aluminum shall be .125-inch. The material shall be subject to inspection prior to degreasing and chromate conversion coating operations. Alloy and temper designations shall be verified by mill test certifications.

(b) Shearing: All sign panel edges shall be shear-trimmed or roll-slit to produce neat edges and rounded corners. Sign panel edges shall be straight within 1/32-inch from the straight plane. Edge delamination or incomplete coverage of the base metal substrate up to and coincident with the cut edge of the sign panel shall be sufficient basis for rejection of the entire sign panel.

(c) Pretreatment: All treatment tanks and/or spray applied systems must be performed on the Contractor's premises, to ensure proper adhesion of powder or reflective sheeting materials. All treatment tanks or spray applied systems shall be charged with fresh chemicals at least once a year. If pretreatment is performed by immersion methods, the tanks must be sufficient size to accommodate the complete panel. Titration equipment shall be available for the inspectors to check the solutions' strengths. The cleaned and coated base metal shall be handled only by a mechanical device or by operators wearing clean cotton or rubber gloves. After cleaning and coating operations, the panels shall be protected at all times from contact or exposure to grease, oils, dust or other contaminants.

The front and back surfaces of the aluminum base metal shall be cleaned, deoxidized, and coated with a light, tightly adherent chromate conversion coating free of any powdery residue. The base metal pretreatment process shall be in conformance with Section 5, "Recommended Processing Methods" of ASTM Designation B-449. The coating weight shall be (30-100 mg/sq.ft.) a class 1 coating.

(4) Sign Message:

(a) The following letters/border sizes shall be used:

- (1) Street legend 10-inch uppercase Series "D" or "C";
- (2) Suffix and block number legend 4-inch uppercase Series "D" or "C";
- (3) Arrow size 8-3/4 inches x 4-inches;
- (4) One-inch border.

(b) The number of characters helps determine the length of each sign.

(5) Sign Frame & Panel Construction:

(a) Frames: The frame shall be aluminum channel extrusion, 1/25-inch x 1.25-inch x .125-inch wall thickness. Alloy 6063-T5. All joints of the aluminum channel shall be miter cut to form a 45-degree angle at each corner. The frame shall be welded with an inert gas shielded-arc welding process using 4043 electrode filler wire in accordance with good shop practice. The width of the filler wire shall be equal to the wall thickness of the channel being welded.

The top of the frame will have two 2-inch x 2-inch x .250-inch wall thickness channel members welded and fastened to the frame with stainless steel bolt, washer, ny-lock nuts and cotter pins. The adjustable swing assembly will be attached to these members as shown on the drawing.

(b) Assembly: A sign panel shall be fastened to both sides of the channel frame to make a double-faced unit. Each sign panel must be a continuous sheet, with no vertical or horizontal splices to make up one panel.

The sign panels shall be affixed to the frame with 3/16-inch diameter blind pop rivets, alloy 5052, or a type approved by the COS Traffic Engineering Division. They must be aluminum approved. The exposed face of the rivet shall be of similar shade and compatible with the face color of the finished sign. The rivets shall be placed through the face of the sign with the wall of the channel placed against the back of the sign panel. Rivets shall be placed no closer than 1/2-inch from the edge of the sign panel and a maximum of 8 inches apart from one another. All rivets must penetrate the web of the channel frame for proper grip strength between sign panel and frame.

The swing hinge is attached to the 2-inch x 2-inch channel member with a 1/4-inch stainless steel bolt and bronze bushing, and then secured with a ny-lock nut. Total assembly with fasteners per spec drawing.

(c) Mounting Assemblies: The top of the sign frame shall have two free swinging mounting brackets. They shall be of all aluminum, bronze, and stainless steel parts. The 5-inch long stainless steel bolt allows for fine adjustments. Dampening springs shall be used. Each of the swing brackets shall be adjusted vertically for leveling the sign to either a straight or curved mast arm. The bracket assembly shall permit the sign unit to swing perpendicular to the support hardware.

The hardware used to attach the sign and swing assembly to the mast arm will be "L-brackets" and "Y-brackets".

The "L-bracket" shall be a two-piece telescoping design to adjust from 17 inches to 21 inches in 1-inch increments without additional adapters required. The tubing shall be 6063-T6 aluminum extrusion. The outside tube shall be 1.5 inches x 1.25 inches x .150 inch wall with one wall .375 inch thick and threaded for two 3/8-inch stainless steel holding bolts with external tooth lock

washers. The inside tube shall fit firm within each other to slide smoothly. Safety Tabs must be located on the ends of each tube. These tabs will not allow the tubes to completely separate from each other during shipping and installation procedures. When installing the telescoping L-bracket, the outside tube should be extended first, then the inside tube.

The "Y-bracket" shall be a one-piece solid 6063-T6 extrusion construction. There shall be four slots in the brackets to accommodate two 3/4-inch wide stainless steel straps side by side. The strapping shall be a minimum of .020-inch thick. The L-bracket shall attach to the Y-bracket with a 1/2-inch stainless steel bolt, lock washer and ny-lock nut.

When installation of the sign to the mast arm is complete, the sign should swing freely 90 degrees in both directions when moved by the installer without any binding or hindrance felt. The sign will then move freely under normal weather conditions.

(d) Finish: The finished sign shall be flat within a ratio of 0.040-inch per linear foot when measured across the plane of each from opposite corners or at any location on the panel. All finished signs shall have a smooth flat surface without defects or objectionable marks of any kind on either the front or the back faces. All letters and designs shall be clearly cut and sharply defined.

The appearance of the sign face shall be uniform throughout and shall be free of wrinkles, gel, hard spots, streaks, extrusion marks, air bubbles or blemishes that may impair the serviceability, detract from the general appearance or color-matching of the sign when viewed from a distance of twenty-five (25) feet.

The finished sign shall be clean and free from all burrs, sharp edges, loose rivets and aluminum marks.

Signs with any defects or damage that affect their appearance and serviceability will not be acceptable. All metal parts shall be fabricated in a uniform and quality workmanlike manner with all sign surfaces and edges free of defects. No repairs shall be made to the face sheet without the approval of the entities' inspectors.

(C) Packaging: Packaging must be in accordance with the sheeting manufacturer's specifications. All signs shall be packaged in such a manner to insure delivery in perfect condition and shall be suitable protected for proper shipment and storage.

For approved equals and further details, please call the COS Field Services Signs & Markings Department at (480)312-5623 or (480)312-5646.

402.3.5 Measurement and Payment: All signing (except metro street signing) will be measured as the total square footage of reflective signing material and linear footage of square tubular steel sign post material. Sign anchor/sleeves will be measured each.

Metro street signing will be measured as a complete assembly, including all mounting hardware, for each sign installed as described herein.

Payment for signing will be at the unit costs as indicated in the bid schedule and will be considered full compensation for the work as described herein and as shown on the plans.

Municipality	Supplements
SC	<p><i>Add the following section:</i></p> <p style="text-align: center;">SECTION 403 TRAFFIC SIGNALIZATION</p> <p>403.1 DESCRIPTION:</p> <p>This specification describes the general requirements for traffic signal equipment to be installed within, or supplied to, the City of Scottsdale.</p> <p>403.2 GENERAL REQUIREMENTS:</p> <p>(A) All traffic signals and lighting equipment shall conform to the following documents, where applicable, in addition to meeting the requirements of this specification:</p> <ul style="list-style-type: none"> <li>-Arizona Department of Transportation, Standard Specifications for Road and Bridge Construction: Latest revision <li>-Arizona Department of Transportation, Traffic Signals and Lighting, Standard Drawings: Latest revision <li>-California Department of Transportation, Traffic Signal Control Equipment Specifications: Latest revision <li>-International Municipal Signal Association (IMSA), Wire and Cable Specifications: Latest revision <li>-National Electrical Manufacturers Association, Traffic Control Systems, Standards Publications: Latest revision <li>-U.S.D.O.T. / F.H.W.A., Manual on Uniform Traffic Control Devices: Latest revision <li>-American Association of State Highway and Transportation Officials, Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals: Latest revision <li>-U.S.D.O.T. / F.H.W.A., Type 170 Traffic Signal Controller System - Hardware Specification: 1978 <ul style="list-style-type: none"> <li>- COS Design Standards and Policies Manual, Latest edition. <li>- COS Traffic Signal Special Requirements Manual, Latest edition. <li>- COS Traffic Engineering Division Qualified Products List, Latest version. <p>(B) All traffic signal poles with pedestrian push button assemblies shall be wheel chair accessible. A four (4) foot wide concrete access ramp and landing per A.D.A. requirements shall be provided to poles which are not placed immediately adjacent to sidewalks. Pedestrian push button assemblies shall be mounted no higher than 42” above the adjacent sidewalk or ramp elevation. All pedestrian push buttons shall be A.D.A. compliant.</p> <p>(C) Personnel Requirement and Notification: All traffic signal construction must be staffed with two or more IMSA Level II Traffic Signal Technicians during all wiring and/or turn on phases of construction or one ISMA Level II Technician and one ISMA Level I Technician at the discretion of the COS Traffic Signal Supervisor. Prior to the start of construction, written proof of technician certification must be delivered to the COS Traffic Signal Supervisor along with company name, contact name, phone number, job location and estimated start date. The COS Traffic Signal Section can be reached by phone at (480)312-5635, by FAX at (480)312-5539, or by mail at 9191 E. San Salvador, Scottsdale, AZ 85258.</p>

(D) Inspection Request Notification: In addition to normal inspection request procedures, the Contractor must FAX an inspection request to the COS Traffic Signal Supervisor at least 3 working days prior to the completion of each of the following inspection points:

- 1) Pre-Construction Conference
- 2) Concrete pour
- 3) Backfill of conduit runs
- 4) Pole run and/or underground wire pulls
- 5) Cabinet installation and wiring
- 6) Signal turn-on

FAXed inspection request shall contain all information stated in section 403.2(C) except proof of technician certification. Information shall be FAXed using COS Inspection Request Form which can be found at the COS Internet website below.

COS Traffic Signal Special Requirements Manual, Latest Edition can be obtained from the COS Signal *Supervisor or can be found on the COS Internet website at <http://www.scottsdaleaz.gov/Design/TrafficSignalSpecs/>. This manual should be reviewed prior to beginning any signal construction and will help signal contractors to avoid rework.

(E) PEDESTRIAN SIGNALS

a. Contractors building signals in high pedestrian areas of Scottsdale shall install audio crosswalk devices into pedestrian units. Audible indications shall be “Cuckoo” for North-South 800 Hz & 1200 Hz repeating approximately every 1.5 seconds and “Chirp” for East-West 2000 Hz which repeats approximately every one-second. Devices shall be wired to the “WALK” indication.

b. Pedestrian signals shall be “LED”, 9-inches in height, have bottom hinges, and consist of the international “man/hand” symbol.

(F) ELECTRIC SERVICE CABINETS

a. All electrical service cabinets must meet APS and SRP requirements and must include Photocell Eye, Luminaire contactor and Auto/Test switch. All cabinets shall have detachable base and match existing COS cabinets.

b. The electric service cabinet shall be “MEYERS” model MEUGL-W/TB or approved equivalent. The service address shall be permanently attached to the electric service cabinet. Electric service shall include photocell eye, luminaire contactor, and auto/test switch.

(G) CONTROLLER CABINET AND CONTROLLER UNIT

*a. The controller unit shall be model 170ATC/HC11 and shall be compliance with Oregon Department of Transportation Standard Specification for Microcomputer Traffic Signal Controller dated July 20 2000 – 170ATC and HC-11 Version. The HC11 CPU board shall meet the specification requirements in subparagraph b. The controller cabinet shall be model 330, with a 12” extender *that has a removable front panel with a minimum size of 8in. x 8 in.*

b. SPECIFICATION FOR MODEL HC-11 CPU BOARD. This specification complies with the requirements in the TRAFFIC SIGNAL CONTROL SPECIFICATION, Dated January 1989 and the November 19, 1993 TSCES addendum #8 – Specification for the Model 170E enhanced Controller Unit and associated Model 412C and Model 172 Modules, with the exception that the 170 Controller/Unit and details related to the Model 170E/ Model 412C Module are superseded by the following HC-11 CPU Specification. When conflicts arise between the specifications this HC-11 specification shall take precedence.

SPECIFICATION FOR MODEL HC-11 CPU BOARD

- i. The purpose of this specification is to define a replacement CPU board for the 6800 based CPU board in the standard 170 E controller.
- ii. The HC-11 based CPU Module shall operate a 68HC11F1 MPU to replace the existing 6800 MPU installed in the existing 170E CPU board. The MPU shall operate with a crystal frequency of 8MHz. The MPU chip shall be socket mounted in an AMP PLCC socket #821574-1 series HPT or equal.
- iii. The 6850 communication IC's shall be used and shall operate with a crystal frequency of 6.144 MHz. There shall be four (4) chips (6850) with programmable jumpers to select 5 different communication baud rates per chip (1200, 2400, 4800, 9600, and 19200) for a total of 20 jumpers. There shall be no IRQ inhibits provided therefore all ACIA's shall be active. Programs should be written to initialize the four communications chips upon startup. An IRQ status register shall be provided as defined in the 170 E CALTRANS spec.
- iv. The EPROM and RAM shall be resident on the CPU board, and shall be socket mounted. The EPROM socket shall be a 32 pin ZIF force device. The RAM socket shall be a 28 pin Augat 828 series or equal.
 - 1. Ram will be continuous from locations \$0000 to \$6FFF. RAM shall be a ZERO power device exclusively, and be a Dallas 1230 or equal.
 - 2. When an optional RTC clock is required, the RAM shall be a DALLAS 1644 or equal. (Clock address shall be in the I/O map at location \$7FF8 to \$7FFF.)
 - 3. A jumper select shall be provided to switch locations \$6000 to \$6FFF from Internal to External for access to the remote Dual Port location. The status of the jumper position shall be read on the IRQ register - bit five (5).
 - a. When an enhanced Program Module is used with this system, it will only have access to addresses 6000/6FFF for dual-port.
 - 4. The Prom chip shall be either a 32K X 8 or a 128K x 8 device, and be jumper selectable.
 - 5. When using a 128K EPROM, a bank switch shall be enabled within the EPROM memory system. This bank switch shall function by moving to the upper 64K segment of the EPROM. The bank switch jumper controls address line A16. The bank shall be activated by a write to location \$7002 (directly connected to Port G on HC-11 MPU), which will cause memory to go to the upper 64K of the 128K EPROM. This will enable an extra 32K of EPROM memory via bank switching. The status of A16 will be read on the IRQ status register - bit six (6).
- v. Feature and location switches shall be provided on the front portion of the CPU board. Each switch shall be an eight-position front reading dip switch. These switches shall be decoded as follows:
 - 1. Features switch shall be addressed at \$700A – Port E
 - 2. Location switches shall be addressed at \$7000 – Port A
- vi. A header shall be provided near the front of the module for the SPI and serial interface pins.
- vii. There shall be one LED indicator located on the front of the CPU board, that shall be controlled via a software output of Port G bit 3.
- viii. The +12VDC, +5VDC and +/-12 VDC voltages input to the CPU board shall have transorb protection.

ix. The system address organization of the HC-11 Module shall consist of two addressing configurations. The decoder shall be furnished in address 1.

1. The two addressing configurations shall be selectable by use of a three- post jumper. The following input line state conditions shall cause the Decoder to provide the associated address configuration. The jumper shall be labeled "INT" and "EXT".

CONFIGURATION	LINE	FUNCTION
1	INT	Address 6000-6FFF shall reside on the internal RAM
2	EXT	Address 6000-6FFF shall reside on the external Program Module

HC11 BASED 170 MEMORY MAP

Configuration 1

LOCATION	BLOCK SIZE	FUNCTION	NOTES
0000-5FFF	24K	170 RAM	CPU BOARD RAM
6000-6FFF	4K	RAM	INT JUMPER POSITION (* See Note below)
7000-73FF	1K	CONFIG REG + RAM	INITIATE IMMEDIATELY ON START UP
7400-75FF	512 BYTES	I/O	EXTERNAL I/O FUNCTIONS
7600-7FFF	2K	RAM	CPU BOARD RAM
8000-FFFF	32K	EPROM	CPU BOARD PROM MEMORY

DETAILED BLOCK ALLOCATION

LOCATION	BLOCK SIZE	FUNCTION	NOTES
700A	1 BYTE	SWITCH	FEATURE SWITCH/HC11 PORT E
7000	1 BYTE	SWITCH	LOCATION SWITCH/HCLL PORT A
7002	1 BYTE	BANK SELECT	PROM BANK SWITCH SELECT HC11 PORT G - BIT 1
7002	1 BYTE	STATUS INDICATOR	HC11 PORT G - BIT 3 1=ON
7000-705F	96 BYTES	CONFIG.	68HC11 CONFIG REGISTERS

		REG.	
7060-73FF	1K (-96)	RAM	68HC11 RAM
7400	1 BYTE	DTA MINUTES	I/O DTA READ MINUTES
740F	1 BYTE	DTA SECONDS	I/O DTA READ SECONDS
7401-740A	10 BYTES	I/O	I/O READ AND WRITE
7410-7417	8 BYTES	ACIA	SERIAL PORTS 1-4
7500-7507	8 BYTES	DPR	DUAL PORT SEMAPHORES
75FF	1 BYTE	IRQ/STAT	60 HZ. RESET AND IRQ STATUS
7600-7FF7	2K	RAM	CPU BOARD RAM
7FF8-7FFF	8 BYTES	RESERVED	RESERVED CLOCK/CALENDAR OPERATION

NOTE: EXT JUMPER POSITION is CONFIGURATION #2 – Configuration #2 Redirects addresses 6000-6FFF to the Prom Module Slot.

(H) CABINET FOUNDATIONS

- a. If foundations are removed, they shall be removed to at least 12 inches below grade or as directed by the COS inspector.
- b. The electrical service cabinet shall project 12 to 18 inches above the adjacent ultimate ground elevation. The controller cabinet shall project above grade and have 12” base extender mounted. The cabinet foundations shall extend 32 to 36 inches below the adjacent ultimate ground elevation. Both foundations shall have a “technician pad” which shall be the width of the foundation extending 24” from base and be 4” above grade.
- c. Both cabinet and foundations shall have 4” above grade “tech pads” installed in front.

(I) SIGNAL HEADS

- a. All indications shall be “LED” type lamps. All pedestrian indications shall also be “LED” type lamps. LEDs shall approved by Traffic Signals Manager, Norm Akin (480) 312-5634.
- b. follows: watts
- c. Signal heads shall be reinforced polycarbonate with ribbed or fiberglass reinforcement and lenses must be glass.
- d. Heads and mounting brackets shall be black.

(J) CONDUIT & CONDUCTORS

- a. Galvanized conduit shall be used for exposed, aboveground runs through the first sweep below grade.
- a. Warning tape shall be placed in all trenches 12 inches below final grade.
- b. Expansion joints shall be used every 50 feet.
- c. Schedule 40 PVC shall be used except for service runs above ground.

d. All cables must be taped and color-coded as shown in the tables below. Detector and pre-emption wires should be taped the same as the signal wires. Spares shall be taped brown. Telecommunication cable shall be taped orange.

If there are only 4 phases, use the first cable colors with no tape around the cables. If 8 phases are used, use the first and second cable colors but tape the second cables white. Each individual conductor in the cables gets taped regardless of whether 4 or 8 phases are used.

First Cable Colors

PHASE	RED INDICATION	YELLOW INDICATION	GREEN INDICATION
1	Solid Red	Solid Orange	Solid Green
2	Black Traced Red	Black Traced Orange	Black Traced Green
3	White traced Red	White Traced Blue	White Traced Green
4	Green Traced Red	Red Traced Orange	Red Traced Blue
PHASE	DON'T WALK		WALK
2 Pedestrian	Solid Black		Solid Blue
4 Pedestrian	White Traced Black		Black Traced Blue
2 Push Button	Red Traced White		
4 Push Button	Red Traced Black		
Push Button Neutral	Solid White		
Spare	Black Traced White		

Second Cable Colors—Place a WHITE piece of tape around each CABLE

PHASE	RED INDICATION	YELLOW INDICATION	GREEN INDICATION
5	Solid Red	Solid Orange	Solid Green
6	Black Traced Red	Black Traced Orange	Black Traced Green
7	White traced Red	White Traced Blue	White Traced Green

8	Green Traced Red	Red Traced Orange	Red Traced Blue
PHASE	DON'T WALK		WALK
6 Pedestrian	Solid Black		Solid Blue
8 Pedestrian	White Traced Black		Black Traced Blue
6 Push Button	Red Traced White		
8 Push Button	Red Traced Black		
Push Button Neutral	Solid White		
Spare	Black Traced White		

Tape Colors—Place the appropriate color tape around each *PHASE SET*

NB	SB	EB	WB
Red	Yellow	Green	Blue
NBLT	SBLT	EBLT	WBLT
Red + White	Yellow + White	Green + White	Blue + White
NBRT	SBRT	EBRT	WBRT
Red + Black	Yellow + Black	Green + Black	Blue + Black

(K) PULL BOXES

- a. All pull boxes shall be marked “TRAFFIC SIGNAL” on the lid. Pull box lids shall be fiber composite type.
- b. Only pull boxes ADOT #5 and ADOT #7 shall be used.
- c. Concrete pull boxes with steel covers shall be used in all dirt areas and in sidewalks. Placement of pull boxes in sidewalks shall be avoided whenever possible.

(L) LIGHTING

- a. Luminaire wire connections shall only be made in pull boxes and not brought into the signal controller cabinet.
- b. Intersection lighting shall be 120 volt, 250 watt, two door, 90-degree cutoff with filter. Luminaires shall include one photocell for each luminaire.

(M) UPS – Some intersections will be equipped with an uninterruptible power supply (UPS) as directed by COS Traffic Engineering or Traffic Operations. At locations with a UPS, all indications including yellow pedestrian indications shall be “LED” type. UPS foundation shall meet same requirements as cabinet foundations.

403.3 MATERIALS:

403.3.1 Traffic Signal Structures:

(A) General: A traffic signal structure is defined as a complete pole and mast arm assembly attached to a concrete foundation for the purpose of supporting traffic signals, street lights, and signs. The traffic signal structure shall as a minimum consist of the following parts:

- pole shaft
- signal mast arm
- luminary mast arm (if required)
- foundation anchor bolts plus hardware
- mast arm pole connecting hardware
- top cap hardware
- pole hardware
- concrete foundation and steel reinforcing (if required)
- protective coating

(B) Qualified Products List (QPL)

- (1) A City of Scottsdale Qualified Products List has been established for traffic signal structures.
 - (2) Contractors are not required to submit documentation on qualified products for review by the City.
 - (3) All Contractors bidding traffic signal structures which are not on the City QPL are required to submit the following documentation for City review:
 - (a) Traffic signal structure drawings.
 - (b) Traffic signal structure specifications.
 - (c) Traffic signal structure load calculations (based on the maximum City loading) and a letter signed and stamped by a Professional Engineer registered in the state of Arizona stating that the signal structure will safely support the maximum loading as described by the City.
 - (d) Documentation of all deviations from ADOT specifications.
 - (e) Recommended foundation designs and specifications for all traffic signal structures, except the ADOT / Scottsdale standardized traffic signal structures.
- (C) Traffic Signal Structures ADOT/Scottsdale - The base specification and warranty requirements for the ADOT /Scottsdale traffic signal structure shall be:
- Arizona Department of Transportation, Standard Specification for Road and Bridge Construction: Latest Revision.
 - Arizona Department of Transportation, Traffic Signals and Lighting, Standard Drawings: Latest Revision.

MONUMENTS

405.1 DESCRIPTION:

This work shall consist of furnishing and installing portland cement concrete right-of-way monuments and survey monuments at the locations shown on the plans or directed by the Engineer and as specified.

Monuments shall conform to the standard details or details shown on the plan.

405.2 MATERIALS:

The concrete portion of monuments shall be constructed in accordance with the provisions in Sections 725 and 505.

Concrete shall be Class B.

Brass caps for survey monuments will be furnished by the Contractor unless otherwise specified in the special provisions.

405.3 CONSTRUCTION:

In constructing precast monuments, the forms shall not be removed until after the concrete has hardened. Monuments that are warped will be rejected. The exposed surface of the finished monuments shall be uniform, of even texture, and shall be free from holes, cracks and chipped edges. The precast monuments shall not be transported to the work site until the concrete has cured.

Cast in place monuments shall be cast in drilled holes without the use of forms.

Brass caps shall be placed in survey monuments before the concrete block has acquired its initial set and shall be firmly bedded in the concrete. The concrete block shall be so located that, the reference point will fall within a 1 inch circle in the center of the brass cap.

405.4 INSTALLATION:

Right-of-way monuments shall be set firmly and vertically in the ground to a depth of at least 3 feet.

The tops of survey monument covers shall be set flush with the pavement surface.

Survey monuments shall be set in position after the first course of asphalt concrete.

Municipality	Supplements
PH:	: Subsection 405 – Chains will be required between the frame and cover on all survey monuments as shown in M.A.G. Detail 120-1

405.5 PAYMENT:

Payment for monuments will be made on the basis of the prices bid and shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in constructing the monuments, complete in place, including asphalt seal and necessary excavation and backfill, as shown on the plans or as directed by the Engineer.

PRECAST SAFETY CURBS

410.1 DESCRIPTION:

This work shall consist of furnishing and installing precast safety curbs as shown on standard details or as detailed on the plans, or as directed by the Engineer.

410.2 MATERIALS:

Portland cement concrete shall be Class A, conforming to the applicable requirements of Section 725.

Steel reinforcing shall conform to the requirements of Section 727. The dimensions of the precast curb shall be as indicated on the plans and standard details.

Dowels shall conform to ASTM A-615 plain, intermediate grade, 1/2 inch round by 24 inches.

Mastic may be either a fiberized mastic cement or an epoxy cement. The Contractor shall submit to the Engineer, the type of mastic and manufacturer's recommended procedures for use, within 10 days after the date of award of contract which will enable the Engineer to determine that the proposed material is acceptable.

410.3 CONSTRUCTION METHOD:

Back of safety curbs shall be set at the property line unless otherwise shown on the plans. Curbs shall be kept a minimum distance of 5 feet from driveways.

Precast safety curb installed on natural earth or gravel surfaces shall be secured in place with a minimum of 2 steel dowels through each curb. A minimum 12 inches diameter by 12 inches deep Class B concrete cylinder or approved equal shall be poured in place around each dowel.

Precast safety curb installed on portland cement concrete or asphalt concrete surfaces shall be bedded in a continuous layer of mastic cement under its complete base area and secured with a minimum of 2 steel dowels driven through the safety curb.

Dowels shall extend into the sub-surface and/or concrete cylinder a minimum of 18 inches. When installed, the top of each dowel shall be flush with the top of the safety curb.

The Engineer will verify locations of all safety curbs in the field at time of construction.

410.4 MEASUREMENT:

Measurement will be the number of safety curbs furnished and installed, complete in place.

410.5 PAYMENT:

Payment will be made at the unit price bid each in the proposal for the following:

- (A) Safety curbs installed on natural earth or gravel.
- (B) Safety curbs installed on portland cement concrete.
- (C) Safety curbs installed on asphalt concrete.

FLEXIBLE METAL GUARDRAIL

415.1 DESCRIPTION:

This work shall consist of constructing metal beam guard railing, at the location and in accordance with the details shown on the plans, and as specified in the special provisions.

Municipality	Supplements
MC	415.1 DESCRIPTION: The work under this section shall consist of furnishing all materials, constructing new guardrail, and delineating guardrail sections at the locations shown on the project plans in accordance with the standard details or the details shown on the project plans, and as per the requirements of these specifications.

415.2 MATERIALS AND CONSTRUCTION:

Materials and construction for the railings shall conform to the following requirements:

The rail elements, terminal sections, bolts, nuts and other fittings shall conform to the specifications of AASHTO M-180, except as modified in this specification. The edges and center of the rail element shall contact each post or block. Rail element joints shall be lapped not less than 12 1/2 inches and bolted. The rail metal shall be open hearth, electric furnace, or basic oxygen steel and, in addition to conforming to the requirements of AASHTO M-180, shall withstand a cold bend, without cracking of 180 degrees around a mandrel of a diameter equal to 2 1/2 times the thickness of the plate.

The ends of each length of railing shall be fitted with terminal sections.

Workmanship shall be equivalent to good commercial practice and all edges, bolt holes and surfaces shall be free of torn metal, burrs, sharp edges and protrusions.

Three certified copies of mill test reports of each heat from which the rail element is formed shall be furnished to the Engineer.

Bolts shall have shoulders of such shape as will prevent the bolts from turning.

The rail element shall have full bearing at joints. When the radius of curvature is 150 feet or less, the rail element shall be shaped in the shop.

Unless otherwise specified the rail elements, terminal sections, bolts, nuts, and other fittings shall be galvanized in accordance with Section 771.

Posts, including blocks, shall be construction grade, Douglas Fir, free of heart center.

The posts and blocks shall be pressure treated after fabrication with oil borne pentachlorophenol, or copperraphthenate, as provided in Section 779.

The posts shall be firmly placed in the ground. The space around posts shall be backfilled with selected earth, free of rock, placed in layers approximately 4 inches thick and each layer shall be moistened and thoroughly compacted.

Posts shall be placed at equal intervals, as shown on the plans, except that the end posts may be spaced closer to adjacent posts if directed by the Engineer.

The bolted connection of the rail element to the post shall withstand a 5,000 pound pull at right angles to the line of the railing. The metal work shall be fabricated in the shop, and no punching, cutting or welding will be permitted in the field. Rail elements shall be lapped so that the exposed ends will not face approaching traffic. Terminal sections shall be installed

in accordance with the manufacturer's recommendations.

Surplus excavated material remaining after the guard railing has been constructed shall be disposed of.

Railing parts furnished under these specifications shall be interchangeable with similar parts regardless of source.

415.3 PAINTING:

All metal surfaces of the guard rails shall have a zinc chromate prime coat and two coats of white enamel. The exposed portions of the wood posts shall have a wood primer and two coats of finish paint. Materials and application shall be as specified in Sections 790 and 530. Colors shall be as directed by the Engineer.

415.4 MEASUREMENT:

The railing will be measured by the linear foot from end to end along the face of the railing including terminal sections.

415.5 PAYMENT:

Payment for furnishing materials and installing guard rails complete, in place, including excavation and backfill for posts and painting will be made on the basis of the price bid per linear foot, unless an alternate basis of payment is specified in the proposal.

Municipality	Supplements
MC	<p>CONSTRUCTION REQUIREMENTS</p> <p>The construction of the various types of guardrail shall include the assembly and erection of all component parts complete at the locations shown on the project plans or as requested by the Engineer. All Materials shall be new except as provided for under the project plans.</p> <p>Terminal sections shall be installed in accordance with the manufacturer’s recommendations.</p> <p>Workmanship shall be equivalent to good commercial practice and all edges, bolt holes and surfaces shall be free of torn metal, burrs, sharp edges and protrusions.</p> <p>The various types of guardrail shall be constructed with wood posts and wood blocks, except where other post materials to be used are noted on the plans.</p> <p>The bolted connection of the rail element to the post shall withstand a 5,000 lb. pull at right angles to the line of the railing. All metal work shall be fabricated in the shop. No punching, drilling, cutting or welding shall be done in the field, except as provided for by project plans. All metal cut in the field shall be cleaned and the galvanizing repaired in accordance with Section 771.</p> <p>Where field cutting or boring of wood posts and blocks is permitted, the affected areas shall be thoroughly swabbed with at least two passes of the same type of wood preservative as initially used.</p> <p>Where Wood posts with rectangular sections are used, the posts shall be set so that the longest dimension is perpendicular to the rail.</p> <p>All bolts shall extend beyond the nuts a minimum of two threads, except that all bolts adjacent to pedestrian traffic shall be cut off flush to the nut.</p> <p>Bolts extending more than 2” beyond the nut shall be cut off to less than ½” beyond the nut.</p> <p>Unless otherwise shown on the plans, bolts shall be torqued as follows:</p>

Diameter of Bolt	Torque, Foot/Pounds
5/8"	45-50
3/4"	70-75
7/8" and larger	120-125

All bolts, other than those specified to be torqued, shall be securely tightened.

When guardrail is being constructed under traffic, the work shall be conducted so as to constitute the least hazard to the public. All guardrail work shall be performed in the direction of traffic flow when feasible.

Any section of guardrail that is removed for modification shall be replaced within five calendar days, unless otherwise directed by the Engineer, of the date the guardrail is removed, unless otherwise directed by the Engineer. At the end of each day, incomplete guardrail sections having an exposed end toward oncoming traffic, shall have a standard flared terminal buffer end section (MAG Standard Detail 135-4,3 Standard Flared Terminal Detail No. 5 Buffer End Section) bolted securely in place together with approved overnight traffic control devices in place.

Municipality	Supplements
PH:	<p>415.5 PAYMENT:</p> <p>Payment for accepted quantities of each type of guardrail will be made at the unit price bid. Payment shall be full compensation for furnishing materials and installing guardrails, complete in place including excavation, backfill, and disposal of surplus material.</p> <p>Payment for Bolted Guardrail Anchors will be at the contract unit price bid, and shall be full compensation for the work, complete in place, including steel brackets, hardware, excavation, backfill, removing and replacing surfacing, cutting and fitting steel beam posts or timber posts, drilling anchor bolt holes in steel posts, timber posts, and box culverts, and disposal of surplus materials.</p> <p>Payment for Additional Steel W-beam will be at the contract unit price bid.</p> <p>Payment for guardrail transitions will be at the contract unit price bid.</p>

415.3.2 DELINEATION:

The maximum spacing between reflector tabs shall not exceed six posts. The slotted part of the tab shall be installed under the mounting bolt head so that the Reflectorized surface of the tab faces oncoming traffic. The exposed ends of the slotted part of the tab shall be bent up against and then over the top of the bolt head. The color of the reflective portion of the barrier markers shall conform to the color of the adjacent edge line. Silver-faced reflector tabs shall be installed on the right hand side of all roadways, and yellow-faced tabs shall be installed on the left-hand side of one-way, or median divided roadways.

All guardrail delineation shall be installed in accordance with the manufacturer's recommendations and as specified herein.

415.3.3 ROADWAY GUARDRAIL:

Wood posts shall either be driven, or placed in manually or mechanically dug holes; however, driven posts will not be permitted at locations where damage to the curb, gutter, sidewalk, buried items, shoulders or pavement might occur. The Engineer will be the sole judge as to whether driving of posts will be allowed. Driving of posts shall be accomplished in a

manner that will prevent battering, burring, or distortion of the post. Any post which is damaged to the extent it is unfit for use in the finished work, as determined by the Engineer, shall be removed and replaced at no additional cost to the County.

The posts shall be firmly placed in the ground. The space around the posts shall be backfilled with selected earth, free of rock, placed in layers approximately 4" thick and each layer shall be moistened and thoroughly compacted to the density of the surrounding material.

Where pavement is disturbed in the construction of guardrail, the damaged surfacing shall be repaired as approved by the Engineer. Where the top surface of a culvert is at an elevation, which would interfere with full depth post placement, the post shall be placed and anchored in accordance with the requirements of 415.3.3 415.3.4 Bolted Guardrail Anchors, (MCDOT Standard Detail No. 3010).

Wood blocks shall be toe nailed to the wood post with one 16 penny galvanized nail on each side of the top of the block. Wood blocks shall be set so that the top of the block is no more than 1/2" above or below the top of the post, unless otherwise shown on the project plans.

Rail elements shall be spliced at 25 foot intervals or less. Rail elements shall be spliced at posts unless otherwise shown on the project plans. Rail elements at joints shall have full bearing. When the radius of curvature is 150 foot or less, the rail elements shall be shop curved.

The Contractor shall dispose of surplus excavated material remaining after the guardrail has been constructed.

415.3.4 BOLTED GUARDRAIL ANCHORS:

Where the elevation of the top surface of a box culvert or other similar installation prevents the placement of a post of the specified length, the posts shall be shortened and anchored in accordance with MCDOT Standard Detail 3010 at the locations shown on the plans.

415.3.5 NESTED GUARDRAIL:

This work shall consist of furnishing and constructing nested guardrail, Type 1, 2, or 3, as shown in MCDOT Standard Detail 3008 including all materials, in accordance with the requirements of the project plans.

Nested guardrail consists of additional steel W-beam sections attached as an appurtenance to guardrail.

415.3.6 GUARDRAIL TO STRUCTURE TRANSITIONS:

Guardrail transitions shall be constructed in accordance with the details shown on the project plans, at the locations shown on the plans.

415.4 METHOD OF MEASUREMENT:

The limits of measurement for roadway guardrail shall be as detailed in MCDOT Standard Detail 3016 and as shown on the project plans. Guardrail, of the type shown on the project plans, will be measured by the linear foot along the face of the rail element from center to center of end posts, exclusive of guardrail terminals, guardrail end terminal assemblies, and guardrail transitions and anchor assemblies.

Delineation is considered an incidental item to the part of installation of guardrail and hence will not be measured as a separate item.

The accepted quantities of bolted guardrail anchors, will be measured by the unit each, complete in place, including steel brackets, hardware, excavation, backfill, removing and replacing surfacing, cutting and fitting steel beam posts or timber posts, drilling anchor bolt holes in steel posts, timber posts, and box culverts, and disposal of surplus materials.

Nested guardrail, Type 1, 2, or 3, installed as an appurtenance to new guardrail, shall be measured by the linear foot of additional steel W-beam, installed using guardrail hardware, complete in place and accepted, as shown on the plans.

Guardrail transitions will be measured by the unit each, complete and accepted as shown on the project plans.

Municipality	Supplements
MC	<p>Part 400 add the following new Section:</p> <p style="text-align: center;">MC: SECTION 416</p> <p style="text-align: center;">MC: GUARDRAIL END TREATMENTS</p> <p>416.1 DESCRIPTION:</p> <p>The work under this section shall consist of furnishing all materials and constructing new guardrail extruded terminal sections, and guardrail anchor sections at the locations shown on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.</p> <p>This work shall also include all the work and materials to delineate guardrail end treatments, including all necessary components and markings, installed new.</p> <p>416.2 MATERIALS:</p> <p>End treatment materials shall conform to Section 415.2 Materials. Adhesive materials for applying reflective sheeting to guardrail terminals shall be in accordance with the sheeting manufacturer's recommendations.</p> <p>All guardrail extruded terminal sections and guardrail transition sections shall be compliant to NCHRP 350 Test Level 3, published by the Federal Highway Administration. End terminals shall be type ET-2000PLUS as supplied by Trinity Industries, 2525 Stemmons Freeway, Dallas Texas, 75207.</p> <p>416.3 CONSTRUCTION REQUIREMENTS:</p> <p>The construction of the various types of guardrail end treatments shall include the assembly and erection of all component parts complete at the locations shown on the project plans or as requested by the Engineer. All Materials shall be new except as provided for under the Contract Plans.</p> <p>Workmanship shall be equivalent to good commercial practice and all edges; bolt holes and surfaces shall be free of torn metal, burrs, sharp edges and protrusions.</p> <p>416.3.1 GUARDRAIL EXTRUDER TERMINALS:</p> <p>Guardrail Extruder Terminal shall be installed at the locations shown on the project plans as per the manufacturer's specifications.</p> <p>Further information regarding assembly and installation of the ET-2000PLUS Energy Absorbing Safety Guardrail End Treatment may be obtained from Trinity Industries, Inc 1-80088-644818-7976. The manufacturer will provide in-field assistance for first time contractors for this item.</p> <p>Damaged end treatments shall be repaired or replaced immediately.</p> <p>The approach surface in front of all Guardrail Extruder Terminals shall be leveled and paved as shown on the project plans and MCDOT Standard Detail 3004, 3005, or 3006. Asphalt concrete paving shall be a minimum of 3" in depth, and comply with Section 321. The approach surface slope shall not exceed 1:10.</p> <p>416.3.2 DELINEATION:</p> <p>The configuration of reflective sheeting object markers on the approach and departure sides of the ET-2000PLUS shall conform to manufacturer's recommendations. At a minimum, delineation for the ET – 2000PLUS will have a Prismatic Barrier Marker on Post Numbers 2, 4, 6, 8 and the normal reflector tab spacing will begin with post number 10.</p>

416.3.3 GUARDRAIL ANCHOR ASSEMBLY:

Installation of guardrail anchor assembly shall be as per MCDOT Standard Detail 3007.

Foundation tubes shall be installed with an approved driving head. The tubes shall not be driven with the wood post in place. If approved by the Engineer, foundation tubes may also be installed in drilled holes. When foundation tubes are placed in drilled holes, the space around and under the tubes shall be backfilled with selected earth, free of rock, placed in layers approximately 4” thick and each layer shall be moistened and thoroughly compacted to the density of the surrounding soil.

The foundation tube shall not protrude more than 4” above the ground as measured along a 5-foot cord.

416.4 METHOD OF MEASUREMENT

416.4.1 GUARDRAIL EXTRUDER TERMINALS:

Measurement for furnishing materials and installing the ET-2000PLUS terminal section will be per each, complete in place, including 37.5 feet or 50 feet of guardrail, guardrail extruder, offset strut, anchor assembly, steel tubes, posts, hardware and delineation as required, excavation, backfill, and disposal of surplus material.

Delineation is considered incidental to part of the installation of guardrail end terminals and will not be measured.

416.4.2 GUARDRAIL ANCHOR ASSEMBLIES:

The accepted quantities of guardrail anchor assemblies will be measured by the unit each, complete in place, including excavation, backfill, and disposal of surplus material.

416.5 BASIS OF PAYMENT:

416.5.1 GUARDRAIL EXTRUDER TERMINALS:

Payment for furnishing materials and installing the ET-2000PLUS terminal section will be per for each unit of the designated length, complete in place, including 50 feet of guardrail, guardrail extruder, offset strut, anchor assembly, steel tubes, posts, hardware and delineation as required, excavation, backfill, and disposal of surplus material.

416.5.2 GUARDRAIL ANCHOR ASSEMBLY:

The accepted quantities of guardrail anchor assemblies, measured as provided above, will be paid for at the contract unit price each, complete in place.

CHAIN LINK FENCES

420.1 DESCRIPTION:

This work shall consist of constructing chain link fences at the locations and in accordance with the details shown on the plans, and as provided in these specifications and the special provisions. When installation procedures are not covered within these specifications, standard details, special provisions, plans or other documents, installation will comply with ASTM F-567.

420.2 MATERIALS:

Chain link fence material shall conform to the requirements of Section 772. Portland cement concrete shall conform to the requirements of Section 725.

420.3 CONSTRUCTION METHODS:

420.3.1 Fence Construction: Before any fence is installed, the Contractor shall submit to the Engineer for approval, shop drawings showing the details of all fittings and gates proposed to be furnished.

Posts shall be spaced at not more than 10 foot intervals, measured from center to center of posts, and shall be placed in a vertical position.

Changes in line or grade where the angle of deflection is 30 degrees or more shall be considered as corner and slope points, respectively, and corner or slope posts shall be installed at these points.

All posts shall be set in Class C concrete footings, which footings shall be crowned at the top to shed water. Footings for line posts for 72 inch fabric or less shall not be less than 30 inches deep and 8 inches in diameter, and footings for line posts for fabric more than 72 inches shall be shown on plans. All other footings, unless otherwise indicated on the plans or in the special provisions, shall be not less than 36 inches deep and 12 inches in diameter.

End, corner, slope and gate posts shall be braced to the midpoint of the nearest line post or posts with horizontal braces used as compression members and the said line posts trussed from the brace back to the bottom of the end, corner, slope or gate post with 3/8 inch steel truss rods with turnbuckles used as tension members.

Unless otherwise specified all fence shall be installed with a top rail and a bottom tension wire and the post tops shall be secured to the post by bolts or rivets. When top rail is omitted, a top and bottom tension wire shall be used.

The fabric shall be placed on the outward facing side of the posts and shall be installed so that the top edge projects above the top rail of the fence to form a knuckled or barbed projection. The fabric shall be stretched taut and securely fastened to the posts, the top rail, and the bottom tension wire. The tension wire shall be installed on a straight grade between posts by excavating the high points of ground and in no case will filling of depression be permitted. Unless otherwise specified the bottom of the fence shall be on a line approximately 2 inches above the ground surface.

The fabric shall be fastened to end, corner, slope and gate posts with 3/16 inch \square 3/8 inch high carbon steel tension bars and not less than 12 gage \square 1 inch steel tension bar bands spaced at 16 inch intervals; and to line posts, top rail and tension wire with 11 gage or heavier tie wires or metal bands. Tie wires or metal bands shall be placed on line posts at intervals of approximately 16 inches, and on top rail and tension wire at intervals of approximately 18 inches.

Barbed wire shall be installed on the fence only when specifically required by the plans or special provisions. When required, it shall be installed on extension arms of a type specified under Section 772.

420.3.2 Construction of Gates: The widths of any gates to be installed will be indicated on the plans or in the special provisions. Gates in which the width of the leaf is greater than 6 feet shall be constructed with an internal horizontal or vertical stiffener of the same diameter as the frame; the frame shall be trussed with a 3/8 inch adjustable tension rod. Gates in which the width of the leaf is 6 feet or less will not require a stiffener and will require only 1 truss rod.

The corners of gate frames shall be fastened together and reinforced with a fitting designed for the purpose or by welding. All welds shall be ground smooth.

Chain link fence fabric shall be attached to the gate frame by the use of tension bars and tie wires as specified for fence construction, and suitable tension connectors spaced at approximately 16 inch intervals.

The swing gates shall be hung by at least 2 steel or malleable iron hinges, so designed as to securely clamp to the gate post and permit the gate to be swung back against the fence.

Semi-cantilever gates shall be provided with a combination steel or malleable iron catch and locking attachment of approved design, and shall be subject to approval of the Contracting Agency. Stops to hold gates open and a center rest with catch shall be provided on all double drive gates and on all other gates where required.

420.3.3 Repair of Damaged Coating: Welds made after galvanizing shall be ground smooth, then wire brushed to remove loose or burned zinc coating, after which the cleaned areas shall be repaired to the satisfaction of the Engineer in accordance with Section 771. Repairs to abraded or otherwise damaged zinc coating shall be made in a similar manner.

420.4 MEASUREMENT:

Chain link fence shall be measured on the fence line along the bottom strain wire from center to center of end posts, deducting the widths of gates and openings.

420.5 PAYMENTS:

The price bid and paid per linear foot for chain link fence shall include full compensation for furnishing all labor, materials, tools, and equipment, and doing all the work involved in constructing the fence complete in place as specified on the plans, and in the special provisions, except for furnishing and installing gates.

Gates will be paid for at the unit price bid for each size of gate required by the plans or special provisions, which price shall include full compensation for furnishing the gates, together with all necessary gate posts, fittings and hardware, and doing all the work involved in installing the gates complete in place as specified. If double gates are required, each double gate will be paid for at the unit price bid and such unit price shall include furnishing and installing both leaves.

Full compensation for clearing the line of the fence and disposing of the resulting material, excavating high points in the existing ground between posts, excavating and furnishing and placing concrete footings, connecting new fences to structures and existing fences, and any other related work shall be considered as included in the price bid per linear foot of fence and no additional allowance will be made therefore.

PARKWAY GRADING

424.1 DESCRIPTION:

This grading shall include all work necessary to bring the surface of the parkway, between the back of curbs and sidewalks and/or the parkway between sidewalks and the right-of-way line, to the grade and cross-section shown on the plans or as directed by the Engineer. It shall also include median islands between divided roadways.

Municipality	Supplements
GI	<p>Description</p> <p>This grading shall include all work necessary to bring the surface of the parkway, between the back of curbs and sidewalks and/or between sidewalks and the right-of-way line, to the grade and crosssection shown on the plans or as directed by the Town Engineer. It shall also include median islands between divided roadways.</p>

424.2 ROUGH GRADING:

(A) Fill material shall contain no rocks over 3 inches in diameter, broken concrete, or debris of any nature.

G. Backfill behind curbs and along the edges of the sidewalk shall be made immediately upon the completion of those items.

Municipality	Supplements
GI	<p>Rough Grading</p> <p>Fill material shall contain no rocks over three (3) inches in diameter, broken concrete, or debris of any nature. Backfill behind curbs and along the edges of the sidewalk shall be placed immediately upon the completion of those items.</p>

Municipality	Supplements
PH:	<p>ROUGH GRADING: is modified to add:</p> <p>The parkway area shall be graded at a variable slope from 1 inch below the back of sidewalk to meet the existing surface at the right-of-way line in accordance with the typical section shown on the plans. Material displaced in the grading of parkways shall not be allowed to be placed on base and surfacing material already in place on the roadway. No measurement or direct payment will be made for this work</p>

424.3 FINE GRADING:

(A) The finished surface shall be free from stone and all debris and be true to grade and cross-sections after compaction to not less than 80% of maximum density, as determined by test methods specified in Section 301.

G. Where existing parkways are planted in grass, flowers, or shrubs and the level is somewhat above the top of the curb, or sidewalk, the parkway shall be graded back on a 4:1 slope from the edge of curb or sidewalk, with the least possible damage to the planted area.

Municipality	Supplements
GI	<p>Fine Grading</p> <p>The finished surface should be free of stone and all debris and be true to grade and cross section after compaction to a minimum of eight-five (85) percent of maximum density</p>

Municipality	Supplements
PH:	<p>FINE GRADING: delete paragraph (B) in its entirety and substitute the following: Where existing parkways are planted in grass, flowers or shrubs, and the level is somewhat above the top of the curb or sidewalk, the parkway shall be graded as per City of Phoenix Landscape Standards and Guideline Detail "Water Retention on Turf Installation" with the least possible damage to the planted area.</p>

424.4 PAYMENT:

Unless otherwise provided in the special provisions or proposal, no payment will be made for parkway grading as such; the cost thereof shall be included in the price bid for construction or installation of the items to which such grading is incidental or appurtenant.

TOPSOILS

425.1 DESCRIPTION:

This work shall consist of furnishing and hauling topsoil from an approved source and placing the topsoil as shown on the plans, in accordance with this specification and special provisions.

425.2 MATERIALS:

Topsoil shall conform to the requirements of Section 795.

425.3 CONSTRUCTION METHODS:

Prior to the excavation of topsoil, all grass, weeds, brush, stumps, loose rocks and other objectionable material shall be removed from the surface of the area from which the topsoil is to be removed.

The topsoil source shall be excavated in such a manner that all material excavated will be of the same composition and structure throughout.

Topsoil shall be spread over the areas and to the depths as specified, and shall be water settled.

After the topsoil has been spread, stumps, roots and other objectionable matter shall be removed from the surface of the area and disposed of in a manner satisfactory to the Engineer.

425.4 MEASUREMENT:

Unless otherwise specified, topsoil shall be measured by the cubic yard in place and loose after watering and settling.

425.5 PAYMENT:

The quantities measured as provided above, will be paid for at the contract price per cubic yard for furnishing and placing topsoil, which price shall be full compensation for the item complete, as described and specified.

Municipality	Supplements
PH:	<ul style="list-style-type: none"> ▪ PH: Add this section <p style="text-align: center;">SECTION 429</p> <p style="text-align: center;">TRAILS</p> <p>429.1 DEFINITION OF TERMS</p> <ul style="list-style-type: none"> a. Multi-Use Trail: The City of Phoenix Trails Master Plan shows the planned locations for the citywide trail network. The Multi-Use Trail (MUT) needs to be constructed within a 30 foot public trail easement and is a Barrier Free Trail. This easement is exclusive from the PUE, trail and Landscaping. The MUT can occur in gentle topography or hilly locations where use is anticipated to be relatively heavy. Grades are generally easy to negotiate with a maximum sustained longitudinal slope of 5% (20:1) and a maximum cross slope of 2%. Tread width shall be a minimum of 10 feet with 2 foot shoulders, allowing pedestrian, bicycle and equestrian use along with the occasional maintenance vehicle. The MUT tread surface shall be compacted stabilized decomposed granite. All Multi-Use Trails shall meet or exceed the Americans with Disabilities Act (ADA) requirements. b. Shared-Use Path: The Shared-Use Path (SUP) is a non-equestrian pathway providing recreation and educational experiences. The path will generally occur in areas with easy to moderate topography up to 5% (20:1) slope for short distances. Tread width of 10 feet

will allow side by side travel and the cross slope shall not exceed 2%. The tread conditions shall be concrete. All Shared-Use Paths shall meet or exceed the Americans with Disabilities Act (ADA) requirements.

- c. Private Trails: The Trails Master Plan does not regulate the locations of Private Trails (PT). Construction and maintenance of PT is the responsibility of the private development. Construction of PT should follow the MUT or SUP guidelines set forth in these specifications.

429.2 SPECIFICATIONS

A. MULTI-USE TRAIL

1. Trails shall be located within an exclusive 30 foot minimum public trail easement. This easement is exclusive for the PUE, trail and Landscaping unless modified by Development Services. Trails along an open space or wash corridors will be a minimum 25 foot public trail easement.
2. Users: Users are hikers, joggers, bicyclist, equestrians and the disabled.
3. Grade: Maximum sustained longitudinal grade 5% (20:1). The cross slope shall be 2% maximum.
4. The tread surface shall be a minimum of 10 feet wide with a 2-foot shoulder on each side. No shoulder will be required for the MUT in turf area. Trail shall allow for side-by- side travel and ease of passing by horses and bicycles. Tread conditions must provide an adequate walking or riding surface free of obstacles or hazards.
5. Vegetation Clearance and Removal:
 - a. Horizontal width: 2-feet measured from the edge of the tread surface.
 - b. Vertical Height Clearance: 10-foot minimum as measured from the tread surface.
 - c. Dead vegetation will remain in place unless considered a hazard or obstruction. Cut and remove all downed limbs including saguaro cactus. Tree and brush cuttings, broken limbs and other vegetative debris, exclusive of leaves, shall be removed from the trail easement, right of way or landscape setback and disposed of.
6. Spiny and Poisonous Plants:
 - a. Spiny plants such as cacti, cats claw, desert spoon etc., shall not be planted or allowed to grow within 10 feet of the MUT.
 - b. Poisonous plants like Nerium oleander or Sophora secundiflora etc., shall not be planted or allowed to grow within 10 feet of the MUT.
7. Surface Treatment:
 - a. The SUP surface shall be ¼” minus decomposed granite, 3” depth, compacted and stabilized the full 3 inch depth. The sub-grade shall be 90% compacted. The decomposed granite shall be a contrasting color from the surrounding surface.
 - b. MUT shall have 6”x8” concrete headers on each side when located in turf.

- c. When concrete headers are used at the trail edge the concrete shall meet or exceed MAG Standards.

8. Path Locations:

- a. Public MUT/SUP shall not be placed in retention basins, drainage ways, and channels or in naturally occurring or man made washes, unless otherwise approved by the City.
- b. There shall be a minimum 5-foot horizontal clearance between sidewalks and trails and other obstacles i.e., fences, walls, utility boxes and other fixed objects. Safety Rails or ADA railing are the exception to this requirement.
- c. Where the trail surface ties into another hardscape surface material i.e., sidewalk or curb, the trail shall meet and match the grade of the other surface.
- d. Trails shall feed directly into ADA ramps at all roads or driveway crossings.

9. Switchbacks:

- a. The inside radius of a trail switchback shall be a minimum of 5 feet. Longitudinal slopes shall not exceed 5% (20:1) and cross slopes shall be 2%. Any exceptions to be approved by the Parks and Recreation Dept.

B. SHARED-USE PATHWAY

- 1. Trails shall be located within 20 foot public trail/sidewalk easements.
- 2. Users: Users are hikers, joggers, bicyclist and the disabled.
- 3. Grade: Maximum sustained longitudinal grade 5% (20:1). The cross slope shall be 2% maximum.
- 4. The tread surface shall be a minimum of 10 feet wide. Pathway shall allow for side-by-side travel and ease of passing by pedestrians and bicycles. The tread conditions must provide an adequate walking surface free of obstacles or hazards.

5. Vegetation Clearance and Removal:

- a. Horizontal width: 2-feet measured from the edge of the tread surface.
- b. Vertical Height Clearance: 10 foot as measured from the tread surface.
- c. Dead vegetation will remain in place unless considered a hazard or obstruction. Cut and remove all downed limbs including saguaro cactus. Tree and brush cuttings, broken limbs and other vegetative debris shall be removed from the trail easement, right of way or landscape setback and disposed of.

6. Spiny and Poisonous Plants:

- a. Spiny plants such as cacti, cats claw, desert spoon etc., shall not be planted or allowed to grow within 10 feet of the SUP.

7. Surface Treatment:

- a. The SUP surface shall be concrete. The sub-grade shall be 90% compacted. Concrete shall meet or exceed MAG Standards.

8. Path Locations:

- a. SUP shall not be placed in retention basins, drainage ways, and channels or in naturally occurring or man made washes, unless otherwise approved.
- b. There shall be a minimum 5-foot horizontal clearance between sidewalks and trails and other obstacles i.e., fences, walls, utility boxes and other fixed objects.
- c. Where the pathway surface ties into another hardscape surface material i.e., sidewalk or curb, the trail shall meet and match the grade of the other surface.

9. Switchbacks:

- a. The inside radius of a pathway switchback shall be a minimum of 5 feet. Longitudinal slopes shall not exceed 5% (20:1) and cross slopes shall be 2%.

C. Grade Separated Crossing (Underpass for Pedestrian/Equestrian Usage)

- 1. When major trails cross under streets or roads, a pedestrian and/or equestrian cell (a barrel within a culvert) shall be provided for user safety.
- 2. The underpass/bridge shall have a minimum 10-foot vertical and 10-foot horizontal clearance.
- 3. Unobstructed sight lines shall be maintained.
- 4. Underpasses /bridges more than 50-foot in length shall be artificially lit to an average of 2 footcandles minimum.
- 5. The underpass shall be connected to the MUT/SUP with a concrete tread surface, rough broom finished. The MUT shall receive a heavy broom finish to improve equestrian footing. The concrete shall meet or exceed MAG Standards.

LANDSCAPING AND PLANTING

430.1 DESCRIPTION:

This section shall govern the preparation and planting of landscape areas required in the Plans or Specifications. Materials will be in accordance with Section 795.

Existing utilities and improvements not designated for removal shall be protected in place. Any damages will be repaired by the Contractor at no additional cost to the Contracting Agency.

Unless otherwise provided, walls, curbs, planter boxes, irrigation systems, and other improvements shall be constructed after rough grading has been completed and prior to finish grading.

430.2 GENERAL:

Landscape or planting areas shall not be cultivated when they are so wet as to cause excessive compaction or so dry as to cause excessive dust or the formation of large clods.

Prior to any grading the areas shall be cleared and grubbed in accordance with Section 201, Clearing and Grubbing.

Finish grade for these areas shall not vary more than 1 inch from the specified grade and cross-section and shall be a smooth uniform surface, free of any abrupt grade changes or depressions. Unless otherwise specified, finish grade below adjacent paving, curbs, or headers shall be 1 inch for lawn and granite areas and 3 inches for planting areas.

Unless otherwise specified, in-place soil will be prepared and conditioned for utilization as topsoil. If imported topsoil is specified or has to be used, the existing soil, before subgrade, shall be scarified to a depth of 6 inches prior to placing the topsoil and the thickness of the topsoil layer shall be at least 6 inches.

All landscape and planting areas, except those intended for lawns, shall be treated with a pre-emergence control, such as "Surflan" or equal, applied in accordance with the manufacturer's recommendations.

430.3 LAWN AREAS:

430.3.1 Preparation of In-Place Soil: After clearing and grubbing has been completed, the existing surface shall be scarified and cultivated to a minimum depth of 8 inches; then brought to finish grade. During the operation, debris, including all stones over 1 inch in any dimensions, shall be removed and disposed of offsite.

After clearing and grubbing and initial cultivation has been completed, chemical fertilizer, 16-20-0 composition, shall be mechanically spread over the entire area at an average rate of 10 pounds per 1000 square feet. After spreading, the fertilizer shall be cultivated into the top six inches of soil using suitable equipment. The resulting soil shall be in a friable condition, suitable for planting.

The Engineer shall inspect and approve these areas prior to seeding.

430.3.2 Seeding: If a Bermuda summer lawn has not been established during its normal planting season, April through September, then rye grass (*Solium Multi-folium*) seed will be planted.

The rate of seeding shall be 3 ½ pounds of Bermuda seed or 15 pounds of rye seed per 1000 square feet.

After seeding has been completed, the entire area shall be rolled with a lawn roller for leveling and seed retention. Immediately after rolling, the area shall be watered with a mist type spray until the soil is wet to a depth of 2 inches.

The Contractor shall provide the necessary safeguards to protect the planted areas from damage by erosion or trespass. Any damaged areas or any areas, greater than 6 inches in diameter, which fail to show a good stand shall be repaired and replanted until an acceptable stand of grass is obtained.

430.3.3 Maintenance: The Contractor shall be responsible for maintenance of the lawn areas until they are accepted by the Contracting Agency. This shall include watering, mowing, weeding and removal of all debris.

430.4 DECOMPOSED GRANITE AREA:

Decomposed granite shall be in accordance with Section 795. The Contractor shall confirm that a sufficient quantity is available so that the entire area will be of the same composition and appearance, and shall furnish a sample to the Engineer for approval as to color.

After preliminary grading is completed and the area has been cleared and grubbed, a pre-emergence control, such as Surflan, or equal, shall be applied over the entire area, in accordance with the manufacturer's recommendations. In flat areas, a 10 mm black polyethylene film shall be placed prior to spreading the granite. The decomposed granite shall be evenly distributed over the area with a minimum depth of 2 inches. Finish grading will be accomplished and the granite will be lightly watered and then compacted to an extent satisfactory to the Engineer. After compaction, a second treatment with the pre-emergence control will be accomplished.

430.5 TREE, SHRUB, AND GROUND COVER PLANTING:

The species, sizes, the manner in which to be furnished, and the approximate number are as shown in the plant list. The quantities, as listed, are approximate and the Contractor shall furnish and install all plant material necessary to complete the plantings as shown on the landscape plan. Change order adjustment will be made for unit price proposals, but not for lump sum proposals.

430.5.1 Substitutions: All requests for substitutions must be submitted in writing to the Contracting Agency prior to commencement of work on the project. The Contractor shall not take any further action concerning his request until a written approval or denial is received from the Contracting Agency. Plants of kinds other than those indicated on the plant list will be considered by the Contracting Agency only upon submission of proof that the specified plant is not reasonably procurable in the local region. Substitutions will resemble the specified plant in regards to appearance, ultimate height, shape, habit of growth, and general soil requirement.

Substitution of a larger size of the same specie may be made by the Contractor without written approval. However, the Contracting Agency will not be responsible for any additional costs incurred by the Contractor, either for the additional cost of the plants or for any additional planting costs.

430.5.2 Plant Inspection Prior to Delivery to the Project Site: Prior to delivery of any species to the project site, the Contractor shall make the necessary arrangement with the Engineer for an inspection of the plant material at the offsite location. Any plants found to be unsuitable in growth or condition or which are not true to name shall be removed and replaced with acceptable plants.

430.5.3 Plant Protection After Delivery to the Project Site: Plants transported to the site shall be planted as soon as possible. During any interim storage period, they shall not be exposed to excessive sun or drying winds. Any stock, that in the opinion of the Engineer, has deteriorated due to exposure or has been damaged during transporting, will be removed and replaced at the Contractor's expense.

430.5.4 Plant Location: The Contractor shall stake out the location of planting areas and plantings pit prior to any excavation. Subject to the Engineer's approval, minor relocations may be accomplished at this time to avoid unsuitable conditions, such as utilities, rocky areas, poor soil, etc. If major relocations are necessary, the Engineer will provide revised plans.

430.5.5 Ground Cover Areas: The planting beds shall be brought to finish grade before spreading the fertilizer or conditioning material specified. Fertilizing and conditioning material shall be mechanically spread at a uniform rate over the entire bed area. After spreading, this material shall be uniformly cultivated into the upper 6 inches of soil using suitable equipment. The resulting soil shall be in a friable condition suitable for planting. A pre-emergence control application is required prior to planting.

Ground cover shall be planted in moist soil with the spacing as indicated on the plans. Each plant shall be planted with its proportionate amount of soil so as to minimize root disturbance. After planting, the area shall be raked to restore a smooth finish grade and to provide drainage. Watering will begin immediately.

The Contractor is responsible for maintaining these areas until acceptance by the Contracting Agency. Maintenance will include protection from trespass or damage, weeding, watering, and removal of all debris. It may be necessary to install a protective fence or barrier around these areas until growth is assured.

430.5.6 Shrub and Tree Pits: Planting pits shall be approximately circular with a diameter and depth at least twice the size of the plant ball or container. It must be large enough to permit handling and planting without injury or breakage of the root ball or root system. Unless otherwise specified, the excavated soil will be conditioned and used as prepared soil mix for backfill. Plants will not be allowed to stand in these pits without watering.

Prepared soil mix shall consist of one part organic soil conditioner (Section 795), two parts excavated soil and one pound of gypsum and four ounces of soil sulphur per tree or one-half pound of gypsum and two ounces of soil sulphur per shrub. The backfill shall be produced by thoroughly combining these components into a homogeneous mixture. The Contractor shall notify the Engineer prior to mixing prepared soil so that he may observe the mixing process. In addition, during backfilling, slow release fertilizer tablets, Agriform 21 gram tablets with a 20-10-5 analysis, shall be added in the following quantities:

- For one-gallon container 1 tablet
- For five-gallon container 2 tablets
- For fifteen-gallon container 4 tablets
- For twenty-four inches or larger box 6 tablets

All containers shall be opened and removed in such a manner that the roots of the plant are not damaged. Balled plants wrapping shall be loosened or cut back after the plant is positioned in the pit.

A layer of prepared soil mix shall be placed in the pit and the plant shall be set approximately in the center of the hole with the root crown at its natural growing depth with respect to finish grade. The plant shall be faced so as to present the best appearance and relationship to adjacent plants or structures. It shall be rigidly constrained until backfilling with prepared soil mix and slow release fertilizer tablets is completed. The backfill will be thoroughly settled by tamping and watering so that all voids are filled.

Trees shall be supported by two tree stakes (Section 795) with a top tie placed for maximum support and a second tie placed midway between top tie and ground level.

After planting, the plants shall be pruned as directed by the Engineer.

Municipality	Supplements
GL	<p>Planting of trees, shrubs, and groundcover 10.43 Planting of trees, shrubs, and groundcover.</p> <p>A. General: All retention basins shall receive a minimum average of fifteen (15) trees per acre, based on the net acreage.</p> <p>B. Quality and Size:</p> <ol style="list-style-type: none"> 1. All trees shall be of a size and quantity to satisfy applicable provisions of the Landscape Ordinance; shall have sufficient rootball to hold the soil together after removal from the containers, but shall not be root-bound or girdled. Plants shall have been grown in pots, cans or boxes for a minimum of three (3) months, and a maximum of one year. 2. All plants shall exhibit normal growth and shall be sound, healthy, vigorous and free from disease, insect infestations or weeds. 3. Trees shall have a straight trunk throughout their height, and shall be in accordance with the American Standard for Nursery Stock. <p>C. Nomenclature: For inspection and identification, durable legible labels, stating in weather resistant ink the correct plant name and size, as specified in the plant list, shall be securely attached to all tree trunks delivered to the site.</p>

D. Materials for Planting:

1. Organic matter for prepared soil shall be decomposed stabilized and fortified, treated (nitrolized) organic mulch, with no more than 1% nitrogen after treatment, and shall be fir mulch, pine mulch or redwood mulch type.
2. Mulch in planting basins shall consist of 25 pounds of soil sulphur thoroughly mixed with one cubic yard of organic mulch. Mulch shall be evenly spread throughout the tree basin to a depth of 2 inches.
3. Prepared soil for backfilling tree pits shall be composed of three (3) parts of topsoil and one (1) part organic mulch by volume, and thoroughly mixed to insure uniformity. Topsoil shall be natural, fertile, friable soil which shall not be excessively acid or alkaline, nor contain toxic substances harmful to plant growth, and be reasonably free of noxious weeds, clay lumps, clods, stones, roots, stumps and debris of any kind.
4. Staking materials:
 - a. Stakes for supporting trees shall be 2-inches x 2-inches x 10-foot lodgepoles and shall be straight, sound, stout and free of knots and cracks which weaken the stake. Each tree shall receive two (2) stakes outside of the rootball on the side from which the prevailing winds come.
 - b. Wire for fastening trunks to stakes shall be No. 12 gauge, annealed galvanized steel (not iron). One wire shall be placed at the top of the stakes, and another halfway down the stakes. If necessary, nail wire to stakes to hold firm.
 - c. Hose to protect trunk from wire rubbing shall be new 2-ply reinforced rubber or plastic garden hose.

E. Plant Material:

1. Unless otherwise indicated, all plant materials furnished shall be nursery-grown in accordance with the American Standards for Nursery Stock, well-branched and well-proportioned. All plants are subject to inspection and approval before planting, whereupon all plants found unsuitable shall be removed and replaced.
2. Plant substitution for those indicated on the plant list will be considered by the City upon submission of proof that any plant is not reasonably available. Substitution of a plant shall have the same appearance, ultimate height, shape, growth habit, and same soil type. In no case shall the average cost and value of the substituted plants be less than the cost and value of plants indicated.
3. Upon delivery to the site, all nursery stock shall be planted as soon as possible. Until planting, stock plants shall not be exposed to excessive sun or drying winds and watered during planting operations.

F. Setting Plants: Unless otherwise specified, all plants shall be planted in pits and shall be set so that the finish grade level after settlement will be the same as that at which plants were grown. They shall be planted upright and faced to give the best appearance and relationship to adjacent plants or structures. All trees shall be set plumb and rigidly braced in position until the soil has been tamped solidly around the ball. Plants shall be backfilled with planting soil which shall be thoroughly settled by watering and tamping to fill all voids but not compacting soil. A water basin shall be created at the base of each tree, and shall be a minimum of 4-feet in diameter. Side slopes shall be no greater than 3:1.

G. Cleanup: Any soil, manure or other material dropped onto paved areas by hauling operations or otherwise, shall be removed promptly, keeping these areas clean at all times. Upon completion of planting, all excess soil, stones and debris not heretofore disposed of under this scope of work, shall be removed from the site or disposed of as directed by the developer.

H. Maintenance Period:

1. The developer shall maintain all trees for a minimum period of 60 days beginning with the preliminary acceptance by the City. If all trees are not healthy at the end of the maintenance period, the maintenance shall be continued until the trees meet the approval of the City, or

	<p>replaced.</p> <p>2. The contractor shall guarantee all plant material to be in a vigorous, healthy condition for a period of 60 days from the date of acceptance or replacement and shall guarantee to replace any plant material which proves to be not true to name, regardless of the length of time it takes to make this determination.</p>
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Municipality	Supplements
MC	<p>430.5.7 Water Truck Irrigation:</p> <p>When trees, shrubs, and groundcover are planted, they shall immediately be started on an irrigation schedule. All trees, shrubs, and groundcover shall receive ½” of water weekly. The water is to broadcast evenly by a 2200 gallon water truck with a wand. All cacti are to be omitted from the irrigation schedule. The Contractor is responsible for irrigating the above mentioned plant material for a period of no less then (6) six months after the start of the maintenance period. Watering truck shall place a “Watering in Progress” warning sign a minimum of 400 ft. away and a maximum of 2,000 ft. away from the watering truck. There shall be a “Watering in Progress” sign placed at the beginning of that days work area. Cones shall be used to divert traffic away from the lane the watering truck occupies.</p> <p>430.5.8 Native Hydro Seeding:</p> <p>The Contractor shall Hydro seed with the indicated seed mix the areas indicated by the plans or special provisions. The various native seed is to be mixed thoroughly and spread evenly throughout the designated area. Seed shall be broadcast at a rate equal to the amount shown on the plans or as specified.</p> <p>430.5.8.1 Native Seed Mixture:</p> <p>The following requirements shall apply:</p> <ul style="list-style-type: none"> - Deliver seed packaged with identification of mixtures, weights, analysis and source. - Protect from moisture, heat and sunlight until application. - Do not soak seed in hydro seeder tank for more than 20 minutes before application. - Provide seed mixture as shown on the landscape plans or as specified. - Application rates of seed as specified are for pure live seed (PLS). - Seed source shall be from elevations below 3,000 feet. <p>Deliver in sealed undamaged containers labeled in accordance with Arizona Revised Statutes and the U.S. Department of Agriculture regulations under the Federal Seed Act. Labels shall indicate the variety of strain of seed, the percentage of germination, purity and weed content, and the date of analysis which shall not be more than nine months prior to the delivery date.</p> <p>Weed content shall not exceed 0.5%.</p> <p>Seed that has become wet, moldy, or otherwise contaminated or damaged is not acceptable.</p> <p>430.5.8.2 Seeding Materials and Equipment:</p> <p>The following requirements will apply:</p> <p>Wood pulp or similar organic material suitable for application with mulch blower equipment shall be applied at the rate of 1,500 pounds per acre.</p> <p>Binder: Free flowing, non-corrosive powder produced from natural plant gum.</p>

	<p>Chemical fertilizer: Ammonium phosphate (16-20-0) standard commercial grade, suitable for application with standard equipment shall be applied at the rate of 300 lbs. Per acre. Ammonium phosphate shall have the minimum analysis and in the physical form of 16-20-0. The first number shall represent minimum percent soluble nitrogen; the second, the minimum percent available phosphoric acid; and the third, the minimum percent water soluble potash. Furnish in sealed containers labeled with name, weight and guaranteed analysis of contents.</p> <p>Seeding equipment: Standard grass seeding equipment with double disk openers, disk bands, packer wheels or drag chains, rate control adjustments, seed boxes with agitators, and separate boxes for small seed.</p>
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430.6 HEADER INSTALLATION:

Headers shall be installed at the location and grades as shown on the plans prior to planting operations. Stakes shall be located at corners and at intervals not to exceed 5 feet and shall be driven to slightly below the top of the header. Headers shall be nailed to the stakes with two nails, clinched ½ inch. Splice plates shall be used at butt joint; centered on the joint and nailed with four nails.

430.7 CLEAN UP:

Any debris or other material dropped onto paved or graded area during excavation or hauling operation shall be promptly removed and these areas shall be kept neat and clean at all times. Upon completion of planting operation, all remaining soil, stones, and other debris shall be removed from the site and disposed of to the satisfaction of the Engineer.

430.8 PLANT GUARANTEE AND MAINTENANCE:

The Contractor shall insure that all plant materials are in a sound, healthy, vigorous condition free from insects, bark abrasions, or other objectionable disfigurements and shall immediately replace any plant which is unacceptable at any time up to and including final acceptance of the project or completion of the plant establishment period whichever occurs later. When the termination of the plant establishment period extends beyond the final acceptance date for the project, this additional period of time for plant establishment may be considered as a special warranty period within the standard 1-year guarantee period and the Engineer may authorize final payment in accordance with Section 109. Unless otherwise authorized by the Engineer, the Contractor shall maintain all landscaped areas on a continuous basis as they are completed during the course of work and until final project acceptance or the termination of the plant establishment period, whichever occurs later. Maintenance shall include keeping the landscape areas free of debris and weeding and cultivating the planted areas at intervals acceptable to the Engineer. The Contractor shall provide adequate personnel to accomplish the required maintenance. Pruning and restaking of plants shall be as directed by the Engineer.

Municipality	Supplements
GL	<p>H. Maintenance Period:</p> <ol style="list-style-type: none"> 1. The developer shall maintain all planted areas for a minimum period of 60 days, beginning immediately after preliminary City acceptance. 2. If all plantings are not acceptable at the end of the maintenance period, the maintenance shall be continued until the work meets City approval. 3. During the maintenance period, two applications of complete fertilizer (6:10:4) shall be made (at 30 days and 60 days) at the rate of 20 pounds per 1,000 square feet with each application. 4. Maintenance shall include continuous operations of watering, weeding, mowing, edging, fertilizing, spraying, insecticide and pest control, reseeding, replacement, and/or any other operations necessary to assure good normal growth. The developer shall be responsible for applying lawn moth control sprays or other materials, as often as may be required, to protect turfs during the entire maintenance period. 5. When the turf has established sufficient root structure and an approximate height of 3 inches, mowing should begin immediately to a 2-inch height and shall be mowed thereafter and reduced

	<p>in safe increments to a height of 1 inch.</p> <p>6. During the installation period and during the maintenance period, the developer shall be responsible for maintaining adequate protection for all areas. Any damaged planting shall be repaired at the developer's expense.</p> <p>7. At termination of each maintenance period all turf shall be live, healthy, undamaged and free of infestations. All areas shall be completely covered at the time of acceptance, leaving no barren spots larger than 3 inches by 3 inches. Inferior plantings shall be replaced and brought to a satisfactory condition before final acceptance of work will be made. The developer shall immediately replace any and all turf that dies or is damaged.</p> <p>8. Two (2) inspections shall be made that affect each maintenance period: The first shall be after all plantings have been completely installed in order to approve the beginning of the maintenance period of not less than 60 calendar days, and the second shall be at the end of the 60 day maintenance period. If there are differences due to improper or insufficient maintenance, then maintenance shall be continued by the developer until all work meets with the specifications and can be approved by the City.</p>
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430.9 PLANT ESTABLISHMENT PERIOD:

The Contractor shall request an inspection by the Engineer whenever substantial completion of the planting and related work has been accomplished. After this initial inspection, and subject to his approval of the work, the Engineer will issue a written field notification to the Contractor setting the effective, beginning date for plant establishment. The plant establishment period shall be for a period of 60 calendar days, but is subject to extension by the Engineer if the landscape areas are improperly maintained, appreciable plant replacement is required, or other corrective work becomes necessary.

At final project acceptance or at the end of the plan establishment period, a final acceptance inspection of the planted areas will be made by the Engineer.

430.10 MEASUREMENT AND PAYMENT:

Measurement and payment shall be in accordance with Section 109.

The lump sum or unit prices established on the proposal sheet shall be full compensation for furnishing all labor, material, tools, and equipment and for performing all work necessary to complete the landscaping operation to include planting of trees, shrubs, and ground cover.

Municipality	Supplements
AP	<p>Landscaping and Irrigation</p> <ol style="list-style-type: none"> 1. All plans for landscaping within the city right-of-way, retention basin, or open space areas will be submitted to the Parks and Recreation Department for review and approval. 2. The developer may need to enter into a maintenance agreement on the form provided by the City (see Exhibit "D"). 3. Landscaping themes already initiated within a quarter-mile (400m) of the proposed development should be continued, except as required by the Parks Director. 4. A project's landscaping plant materials shall conform to the list contained in the "Parks, Open Space, and Rights-of-Way Landscape Standards". The Arizona Department of Water Resources approved list is included in this list, specifically for the climate and growing conditions present in this area. These plants are considered to be of low to moderate water use, which will be beneficial to water conservation measures. 5. All landscaping that requires water for establishment and future growth shall have an irrigation system designed and constructed with the type of materials and maintenance practices as specified in the "Parks, Open Space, and Rights-of-Way Landscape Standards".

Municipality	Supplements
PH:	<p>LANDSCAPING AND PLANTING: Delete this section in its entirety and substitute the following:</p> <p>430.1 DESCRIPTION:</p> <p>This section shall govern the preparation and planting of landscape areas required in the Plans or Specifications. Materials shall be in accordance with Section 795.</p> <p>Existing utilities and improvements not designated for removal shall be protected in place. The Contractor, at no additional cost to the Contracting Agency, will repair any damages.</p> <p>Unless otherwise provided, walls, curbs, planter boxes, irrigation systems, and other improvements shall be constructed after rough grading has been completed and prior to finish grading</p> <p>430.2 GENERAL:</p> <p>Furnish all labor, materials, equipment, and incidental needs to install the landscape to the drawings, details and specifications shown in the plans.</p> <p>Applicable publications listed below form a part of this specification to the extent referenced:</p> <p>Arizona Nursery Association Growers Committee Recommended Tree Specification (latest edition)</p> <p>American Society for Testing and Materials</p> <p>(ASTM) C136, Standard method for sieve analysis of fine and coarse grained aggregates;</p> <p>(ASTM) F1632, Test methods for particle size analysis and sand grading of golf course greens and sports field rootzone mixes;</p> <p>(ASTM) D2974 Method B, Test moisture, ash, and organic matter of peat and other organic soils;</p> <p>(ASTM) F1647, Test methods for organic matter content of golf course greens and sports turf root zone mixes.</p> <p>All landscaping and irrigation work shall be installed by a contractor licensed to perform this specialty work.</p> <p>Perform work in accordance with all applicable laws, codes and regulations required by authorities having jurisdiction over such work and provide for all inspections and permits required by Federal, State and local authorities in furnishing, transporting and installing materials as shown or for completing the work identified herein.</p> <p>430.2.1 Source Quality Control: Ship materials with Certificate Of Inspection required by governing authorities.</p> <p>Do not make substitutions: If specified material is not obtainable, submit proof of non-availability, together with proposal for use of equivalent material, similar in appearance, ultimate height, shape, habit of growth and general soil requirements. The Contractor may make substitution of a larger size of the same species with approval by the Engineer. However, any additional cost for these substitutions will be borne by the Contractor.</p> <p>Before delivery of the following materials, a letter of compliance shall be submitted, certifying that materials meet the requirements for legal transportation of State and Local government agricultural laws, and are true to analysis as specified. Certify the following:</p>

Nursery propagated plants
Cacti, succulents, and native plants
Soil Amendments, and conditioners
Lawn seeds, stolons, and sod
Native seed mixes

430.2.2 Samples and Tests: The Engineer reserves the right to take and analyze samples of materials for conformity to specifications at any time. Contractor shall furnish samples upon request. Rejected materials shall be immediately removed from the site at the Contractor's expense. The Contractor shall pay cost of testing materials not meeting specifications.

430.2.3 Herbicide / Pesticide Applicators: All herbicide / pesticide applicators shall be properly licensed for application of non-restricted use chemicals with an A-20 license or an A-21 license with Pesticide Endorsement from the State Registrar of Contractors and Structural Pest Control Commission. All Landscape Contractors are required to furnish a copy of their application from the Registrar of Contractors, which shall list the names of those employees approved as applicators by the Registrar of Contractors. Application of non-restricted use pesticides shall not take place until the Engineer receives a copy of the application.

430.3 PLANT ESTABLISHMENT GUARANTEE AND MAINTENANCE:

Unless otherwise authorized, the Contractor shall maintain all landscape areas on a continuous basis as they are completed during the course of work and until final Plant Establishment Guarantee and Maintenance Acceptance. The Contractor shall provide adequate personnel to accomplish maintenance. Maintenance shall include keeping the landscape areas free of debris on a weekly basis, chemical control of weeds and fertilization as needed, cultivating the planting areas, and mowing of turf where lawns are part of the project.

Plants shall be kept in a healthy, growing condition by watering, pruning, spraying, weeding and any other necessary operation of maintenance. Plant saucers and beds shall be kept free of weeds, grass and other undesirable vegetation. Plants shall be inspected at least once per week and appropriate maintenance performed. Pruning and re-staking is to include removal of any growth conflicting with vehicular or pedestrian movement.

Turf from seed or stolons shall be considered established when it is ready for use, and turf exceeds 95 percent coverage of a 18 inch diameter ring when placed on the ground by the Engineer. The turf shall be vigorously growing, uniform in color, and cut to a uniform height designated by the Engineer. Roots shall have penetrated the soil to a depth of not less than 4 inches.

The Contractor shall maintain the irrigation system and make any necessary repairs regardless of cause to assure a complete and operational system as originally designed and constructed. Repairs shall be made within 48 hours of detection.

Chemical mixing for weed control shall be done in the presence of the Engineers representative. The method of application shall be approved by the Engineer.

The Contractor shall request an initial inspection by the Engineer when all planting and related landscape work is accomplished. After this initial inspection, and subject to approval of work by the Engineer, written field notification to the Contractor, setting the effective date for beginning of the Plant Establishment Guarantee and Maintenance Period will be issued. This Period shall last for 90 days or as specified, unless extended by the Engineer. If the landscape areas are improperly maintained; if appreciable plant replacement is required (for whatever reason); if corrective work is required for the operation of the irrigation system; or if other corrective work is necessary; the Plant Establishment Guarantee and Maintenance Period shall be extended and the Contractor shall

continue to maintain the entire site until accepted at no increased cost to the Owner.

At the end of the Plant Establishment, Guarantee and Maintenance Period a final inspection will be performed. If, after inspection, the Engineer is of the opinion that all planting areas are weed free, plant materials are in satisfactory growing condition, the Engineer will give the Contractor written Notice of Acceptance of the landscape installation. Any plants which need to be replaced, regardless of the cause, shall be replaced prior to final acceptance.

430.4 JOB CONDITIONS:

Site Examination: The prospective Contractors are encouraged to visit the job site prior to bidding on this project, and to satisfy their concerns as to the magnitude of the work involved.

Water costs are the Contractors responsibility, until Final Acceptance or end of Plant Establishment, Guarantee, and Maintenance Period which ever is longer and the water meters are transferred to the City.

Before the beginning of landscape work, all planting areas shall be left free of construction debris and/or toxic material and subgraded to a level to permit landscape and irrigation construction. Trenches, foundation backfill or other filled excavations shall be compacted prior to the beginning of any landscape work. No soil preparation or planting shall begin before the site has been cleared and cleaned of debris. Commencement of work indicates acceptance of job site conditions.

Cooperate and coordinate with other Contractors and trades working in and adjacent to landscape areas.

430.4.1 Utilities: Determine location of underground utilities and perform work in a manner, which will avoid possible damages. The Contractor, at no additional costs to the Contracting Agency, will repair any damages. Hand excavate, as required. Maintain stakes by others until removal is mutually agreed upon by parties concerned.

430.4.2 Obstructions: If rock or other obstructions are encountered in excavation for planting, notify the owner's representative. Proceed with work only as directed.

430.4.3 Existing Surface Soils (Borrow Excavation): Shall be used for plating non-pave (non turf) areas, and as part of the backfill mix for planting Nursery Stock.

430.4.4 Imported clean fill: Shall be used for turf areas and amended per 430.11 Preparation for Lawn. Unless otherwise specified the minimum clean fill depth in lawn areas shall be 6 inches.

430.5 DELIVERY, STORAGE AND HANDLING:

Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored on site.

Sod: Time delivery so that sod will be placed within 24 hours after stripping at the sod farm. Protect against drying, cracking, and breaking of soil on the rolled strips.

Trees and Shrubs: Do not prune prior to delivery unless otherwise approved by owners representative. Do not bend or bind trees or shrubs in such a manner as to damage bark, break branches or destroy natural shape. Provide adequate protection for root systems. Protect root balls from drying wind and sun.

Deliver trees/shrubs just prior to planting. If planting is delayed more than 6 hours after delivery,

set trees and shrubs in shade, protect from weather and mechanical damage. Keep roots moist. Water as often as necessary.

Plant Inspection Prior to Delivery to the Project Site: Before delivery of any species to the project site, the Contractor shall make the necessary arrangements with the Engineer for an inspection of the plant material and tagging of representative plant stock. The Contractor will pay for travel to non-local Nurseries, out of the metropolitan Phoenix area, when plants are not available locally.

The Contractor shall notify the Engineer, at least 7 days in advance for inspection of the plant material. Prior to notification of the Engineer for inspection, the Contractor shall physically verify that the plant material meet the size specified.

After delivery, any plants found to be unsuitable in growth or condition, or plants, which are not true to the specification, or equal to the tagged plant stock, shall be removed, and replaced with acceptable plants at the Contractor expense.

430.6 MATERIALS AND PRODUCTS:

Shall conform to the requirements of the City of Phoenix Supplement to MAG Specifications Section 795.

430.7 SEQUENCING AND SCHEDULING:

Proceed with and complete landscape work as rapidly as portions of the site become available, working with reasonable limitations for each kind of work required.

Plant or install lawns during normal planting seasons or as directed by the Engineer.

For Bermuda, seed from April 15 to the end of September, provided nighttime temperatures are averaging above 60 degrees Fahrenheit.

For Perennial Rye Grass, when directed by the Engineer.

Coordination: Plant trees and shrubs after final grades are established and prior to planting lawns, unless otherwise accepted in the construction schedule by the Engineer. If trees and shrubs occurs after lawn work, protect lawn areas and properly repair damage to lawns resulting from tree or shrub planting operations.

430.8 PREPARING THE SITE FOR LANDSCAPING:

All non-paved areas, as directed by the Engineer, shall be treated with a chemical control, such as Round-up or equal, to control and kill weeds. All applications of the chemical control agent shall contain a blue or green dye so that treated areas can be identified. These areas shall be cleared and grubbed, no sooner than two weeks after the last application of chemical weed control, or when week kill has been established to the satisfaction of the Engineer. Any area to receive seed mix or which is to remain undisturbed shall be excluded from treatment.

Clear and grub landscape areas in accordance with MAG Section 201.

Remove or relocate trees, shrubs, grass, improvements or obstructions that interfere with the installation of new work. Removal includes digging out stumps and roots to a depth of 12 inches below existing or proposed grade which ever is lower.

Fill depressions caused by clearing and grubbing operations with satisfactory soil material. Place fill in 6" loose depths and compact to adjacent ground densities.

Soil Preparation in non-turf areas including planters: After clearing and grubbing is complete, rough grade and remove all deleterious materials. Fine grade the areas. Rocks and debris, including miscellaneous concrete spillage clumps, over 1 inch in any dimension, shall be removed and disposed of offsite.

The finish grade for landscape areas shall not vary more than 1 inch from specified grade and cross section and shall be a smooth, uniform surface, free of abrupt grade changes or depressions. Surface drainage shall flow as designated on the plans.

Finished soil grades, adjacent to paving, curbs or headers will consider the depth of applied toppings materials such as granite or river run. Unless otherwise specified the soil grade for granite areas shall be 3 inches below adjacent pavements, for application of 2 inches of granite. Apply a pre-emergent weed suppressant, to the finish soil surface, include dye as specified with the application.

430.9 HEADER INSTALLATION:

Headers shall be installed at the locations and elevations shown on the plans.

Concrete forms, shall be approved by the Engineer prior to pouring concrete. Concrete shall be Class B. Follow MAG specifications and City Supplements Section 340.

430.10 EXECUTION OF PLANTING:

Clearing and grading areas shall be free of construction debris and/or toxic materials and graded to permit landscape construction.

Landscape or planting areas shall not be cultivated when they are so wet as to cause excessive compaction or so dry as to cause excessive dust or the formation of large clods. Layout individual trees and shrubs for owner's representative to approve, prior to excavating plant pits. Make minor adjustments as might be requested.

Protect existing vegetation from damage during planting operations. The Contractor is responsible to replace any damaged vegetation in kind as directed by the Engineer.

430.10.1 Deciduous and Evergreen Plantings:

Excavation: Plant pits shall be dug to produce vertical sides and flat, non-compacted but firm bottoms. If pits are dug with an auger and sides of pits are glazed, scarify the glazed surface. The size of the pits shall be twice the diameter of plant root ball or container size, and only as deep as the rootball.

Drainage: Test drainage of plant pits by filling with water twice in succession. Plant pits retaining water for more than 24 hours shall be brought to the attention of the owner's representative. Submit in writing a proposal for correction, for approval by Engineer, before proceeding.

Plant Backfill Mix: Shall consist of 1 part organic mulch, two parts excavated soil and 4 pounds gypsum and 1 pound of sulfur per cubic yard. The backfill shall be produced by thoroughly blending these components into a homogeneous mixture. The Contractor shall notify the Engineer prior to mixing prepared soil so that he may observe the mixing process. When requested submit a letter and test analysis results from a certified horticultural testing laboratory.

Setting and Backfill for Plants: Set plant material on non-compacted firm soil, plumb and in center of pit or trench. The crown (juncture of the root and shoot) shall be at grade when planting

is complete. Remove pallets or containers before placing backfill. Do not handle container plants by foliage, branches or trunks. After removing plant from container, scarify side of root ball. Do not plant stock if root ball is cracked, broken, or root bound. When set at the proper elevation and orientation, place additional backfill mix, brace plant, and place fertilizer tablets. Work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water the plant thoroughly; before placing remainder of backfill. Repeat watering again after placing final layer of backfill mix until soil is completely saturated.

Place fertilizer tablets approximately 6" below grade and evenly spaced around the plant.

For one-gallon container	1 tablet
For five-gallon container	2 tablets
For fifteen-gallon container	4 tablets
For twenty-four inch box	6 tablets

Plant Saucers: Prepare an example plant saucer for the Engineer's review and approval. Schedule this review with the Engineer before starting planting operations.

Stake All Trees Per Plans: Set stakes vertically and spaced to avoid penetrating balls or root masses. Place tree ties for maximum support with top tie above scaffold branches and second tie midway to the ground level. Avoid "rigid" restraint of tree and allow for some trunk movement. Stakes to be set into native soil.

430.10.2 Agave, Aloe, Cactus, Ocotillo and Yucca Plantings:

Excavation and Drainage: Shall be completed per Section 430.10.1, except plant pit shall be 6" deeper than rootball.

Backfill Mix: Shall be a mixture of 3 shovel's full of sand, or very coarse dirt (not clay or silt), one shovel of gypsum, one shovel of organic matter (avoid cow manure), 1/2 cup of sulfur, and 1/2 cup of phosphate (0-45-0). As you need more backfill mix, increase in these proportions.

Setting and Backfill: Do not set plant deeper than the plant grew naturally. Prior to placement, lay the plant down just over the hole. Trim off old dead roots to no longer than 2 inches and clean out any rocks stuck in the plant. All new plant root growth will come from the center of the root ball, not from the old roots or from the side of the stem or trunk. Sprinkle a tablespoon full of phosphate (0-45-0) in the hole. Place plant in the hole and orient to match the previous heliotropic growing condition. Set plant elevation to the visible dirt line mark of the plant. Backfill the plant using the specified backfill mix. Plant shall be planted to maintain positive drainage away from the root collar of the plant. Tamp the soil to stabilize the plant. Now drench and wash off the plant.

Monitor watering closely. Normal watering for Agave, Aloe, Cactus, Ocotillo and Yuccas are once per week. During the heat of the summer, briefly spray or mist these plants from a hose, to cool the plants surface temperature. During cooler temperatures, adjust the watering schedule for the time of day and frequency.

430.11 PREPARATION FOR LAWN:

430.11.1 Soil preparation and Fine Grading New Turf areas: Excavate as necessary to accommodate depth of clean fill, topsoil and soil amendments. Prior to placing fills and amendments till to a depth of not less than 4 inches, making alternate passes at right angles. Remove rocks and debris greater than 1 inch, in any dimension. Remove high areas and fill depressions. Apply soil amendments (refer to section 795 Landscape Materials) as follows:

Organic matter 2 inches deep

Sulfur 10 lbs/1,000 SF
Iron Chelate 1 oz./1,000 SF

Roto-till soil and amendments to homogenous fine mixture, free of lumps clots, stones, roots and other extraneous matter. Till mixture until uniform in color and appearance, to the satisfaction of the Engineer.

Fine grade lawn areas to a smooth, even surface with a loose uniformly fine texture. Finish drag or rake lawn areas removing all deleterious material ½” or larger from the surface and to a depth of 2 inches below the surface. Roll the lawn surface to obtain the desired compaction and remove ridges. Finish grade shall be as shown on the plans. Finish grade shall be set 1-1/2” inches below adjacent paving, curb and headers.

Apply fertilizer, reference City Supplement to MAG Section 795, fertilizer percentages (N-P-K) and the rate of application per soil fertility test results; For bidding purposes, the fertilizer shall be (15-15-15), applied at 5 LBS/ 1000 SF. Apply additional fertilizer at the end of the turf establishment or date agreed upon with the City. Establishing turf is the contractor's responsibility.

430.11.2 Recondition Existing Lawn Areas: Areas damaged by Contractor's operations, including damage caused by movement of vehicles, or from the storage of materials or equipment shall be reconditioned prior to seeding or sodding.

Remove ridges, ruts, and aerate compacted soils. Fill depressions with topsoil soil. Rake surfaces, removing clumps and debris and other deleterious material ½” or larger from the surface. Apply fertilizer, reference City Supplement to MAG Section 795, at the rate recommended by the manufacturer (stated on bag) before initial seeding operations.

430.12 LAWNS

The Contractor shall not begin planting until the irrigation system is completely installed and is adjusted for full coverage and is completely operational.

430.12.1 Sod: Allow for sod thickness in areas to be sodded. Apply commercial fertilizer at rates specified by the manufacturer and thoroughly mix into upper 2 inches of soil. Delay applications of fertilizer if planting will not follow within a few days.

Lay sod within 24 hours of initial cutting. Form a solid mass of sod with tightly fitted joints. Butt ends and sides of sod. Do not overlap joints. Stagger sod strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Sod edges and joints shall be leveled with approved soil mix.

430.12.2 Seeding Lawns: Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.

Sow seed using a spreader or seeding machine at a rate of 3 1/2 pounds Bermuda per 1,000 square feet. Do not seed when wind velocity exceeds 5 MPH. Distribute seed evenly over the entire area by sowing equal quantities in two (2) directions at right angles to each other.

Bermuda seed shall be planted only at times when daytime atmospheric temperatures are consistently above 90 degrees F. and the nighttime atmospheric temperatures are consistently above 60 degrees F.. If turf establishment from seed can not be completed during the contract period, then Perennial Rye grass seed will be planted when required by the Engineer, at no additional cost to the City. Apply Rye grass at the rate of 15 pounds per 1,000 square feet. Distribute Rye seed evenly over the entire area by sowing equal quantities in two (2) directions at right angles to each other.

Rake lightly into top 1/8 inch of soil, roll and water with a fine spray.

430.12.3 Hydroseeding Lawn Areas: Contractor shall follow a two-step process of hydroseeding followed immediately by hydromulching. Equipment used shall be manufactured for the purpose of hydroseeding. It shall be equipped with a tank capable of continuous agitation, suspension, and blending of the slurry components. It shall be equipped with a pumping system capable of maintaining a continuous spray. It shall be equipped with nozzles and hoses to obtain a uniform application on designated areas. The tank and accessories shall be cleaned and be free of contaminants. The storage tanks shall have a means of estimating the volume used or remaining in the tank.

For hydroseeding and mulching materials, refer to City of Phoenix Supplement to MAG Section 795. All materials shall be labeled or supplied with test information concerning analysis of the various components. All work shall be performed in a professional manner to the best industry standards. Care shall be taken to avoid drift and displacement of material or any damage to structures and landscape. Protective covering shall be used where material would be objectionable. Clean up shall be done daily. Seeded areas shall be protected from traffic and construction activities.

Water, fertilizer, mulch and seed shall be combined in proportion in the first application to cover the areas at the specified rates. The ingredients shall be allowed to mix thoroughly. Allow the ingredients to mix for a minimum of 5 minutes before application of the slurry, but Do not allow seed to be in the tank longer than 60 minutes, inclusive of the time to agitate.

Hydroseed an even first application of the following components.

Bermuda Seed	200 LBS / Acre
Fertilizer	200 LBS / Acre
Mulch (100% Wood Cellulose Fiber)	400 LBS / Acre

Hydromulch an even second application immediately after hydroseeding with the following components.

Mulch (100% Wood Cellulose Fiber)	1400 LBS / Acre
Tackifier	100 LBS / Acre

Hydroseeding or mulching deposited on adjacent trees and shrubs, on roadways, structures or other area surfaces where they are not specified, shall be removed.

Water to germinate the seed and continue watering until established. Monitor watering every day. DO NOT over water or under water. It may be necessary to water several times a day. Newly germinated areas must be kept moist.

430.13 DECOMPOSED GRANITE AND RIVER RUN AREAS:

The areas on which the granite mulch or river run rock is to be placed shall be graded according to the drawings, prior to the placement of any granite or river run rock. The ground shall be reasonably smooth and rocks larger than 1" in diameter, within the top 1" of soil shall be removed and disposed of off-site.

The Contractor shall stake out all areas to receive granite mulch or river run rock. These areas shall be treated with a pre-emergent control, such as Surflan or equal, prior to and after placement of the cover material.

Decomposed granite shall be evenly distributed on the designated areas to a depth as indicated on the plans and details. If a depth is not indicated the minimum depth shall be two inches.

After placing and grading the granite mulch, the Contractor shall water granite with a light spray to settle the to granite and remove fine materials from the surface. Immediately after watering, the Contractor shall roll the granite mulch with an appropriate device to an extent satisfactory to the owner's representative.

River run rock used shall be as specified on the plans. The rock shall be evenly distributed on the designated areas to depth 1-1/2 to 2 times the maximum gradation size.

430.14 CLEANUP AND PROTECTION:

During Landscape Work, keep pavements clean and work areas in an orderly conditions. Sweep, scrub or hose affected areas as directed by the owners representative to maintain a clean and neat work area.

Protect Landscape Work and Materials from damage due to landscape installation, operations by other Contractors and trades, trespassers and animals. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged work as directed by the owner's representative. Remove all debris, trash and excess materials generated by the landscape installation.

430.15 MEASUREMENT AND PAYMENT:

The lump sum or unit prices established on the schedule of values shall be full compensation for furnishing all labor, material, tools and equipment and for performing all work necessary to complete the landscaping operation to include planting of trees, shrubs and ground cover.

The quantities of lawn seeding will not be measured but shall be the quantities designated in the contract documents, except that measurements will be made for revisions requested by the Engineer, or for discrepancies of plus or minus five percent of the total quantity designated in the Contract. The quantity of lawn shall include soil preparation, fertilizer, seed, and water, established and accepted.

The quantity of sod to be measured will be the actual number of square feet, including soil preparation, water, fertilizer and sod, established and accepted.

When line item bids or schedule of values do not initially include a cost for the Plant Establishment and Maintenance Period the cost shall be assumed in the schedule of values for landscape items (i.e., plant materials, irrigation, and inert materials, such as decomposed granite, river run and boulders). Ten percent of the sum total of landscape items in addition to retention will be held for distribution during the maintenance period. Equal monthly payments for maintenance will be authorized, based on inspection and subject to extensions, where the Contractor fails to comply with previously stated requirements in Section 430.3. Payment may or may not be supplemental to final project payment.

Municipality	Supplements
PH:	<p>Add this section</p> <p>SECTION 431 PALM TREE TRANSPLANTING</p> <p>431.1 DESCRIPTION:</p> <p>This section shall govern the relocation (transplanting) and planting of palm trees required by the plans or specifications. The Contractor shall furnish all labor, materials and equipment required to complete the excavation, lifting, transporting and transplanting of palm trees.</p> <p>431.2 GENERAL:</p> <p>Unless otherwise provided by this section the work shall conform to the City of Phoenix Supplement to MAG Specifications Section 430 and the following.</p> <p>431.3 Palm Establishment Guarantee and Maintenance:</p> <p>Palm establishment, guarantee and maintenance shall be per City of Phoenix Supplement to MAG Specifications, Section 430 with the following modifications or additions:</p> <p>The palm establishment, guarantee and maintenance period shall be for 90 days, unless otherwise extended.</p> <p>Guarantee palms against the vascular disease <u>Penicillium (Gliocladium) vermoeseni</u>, the fungus <u>Fusarium oxysporum</u>, and the root disease <u>Phytophthora</u> and similar vascular infections for a period of five (5) years.</p> <p>Replace without additional cost to the City all dead palms and all palms not in a vigorous condition as determined by the Engineer. Replacement shall be when directed by the Engineer.</p> <p>431.4 Job Conditions:</p> <p>Prospective Contractors are encouraged to visit the job site prior to bidding on this project, and to satisfy their concerns as to the magnitude of the work involved.</p> <p>It may be necessary to supplement the irrigation system and provide additional water to establish newly planted palm trees. Water from the existing irrigation system will be paid for by the City. The Contractor is responsible for delivery and payment of water from other sources.</p> <p>Remove all debris, trash and excess materials found on site or generated by the Contractor's operations.</p> <p>Prior to digging and transplanting of palm trees the Contractor shall notify the Engineer at least two (2) working days before starting any work.</p> <p>431.5 Delivery, Storage and Handling:</p> <p>Palms shall be free of dead or dying fronds with all fronds of a normal size and color.</p> <p>The Landscape Architect will be available to review and tag palms at place of growth and will again review palms upon delivery for conformity to the specifications. Travel to non-local Nurseries, out of the metropolitan Phoenix area, when requested by the Contractor, will be paid for by the Contractor. In lieu of non-local nursery review, the Contractor may elect to provide photographs with a person adjacent to each palm for preliminary review. Such review shall not impair the right of review and rejection during progress of the work should the palms not meet the specifications. The selected palms shall not exceed the specified height by more than 1 foot. It is</p>

unacceptable to plant the rootball deeper than 1 foot above the soil line of the palm.

The Contractor must certify that the palms are free of disease prior to shipment.

After tagging of the palms, remove all thatch from older leaves and cut back all resulting stems to within 2 inches of the base of the trunk. The crown of the palm shall be reduced per standard nursery practice prior to shipping. Use soft rope (organic twine) to tie remaining fronds to protect crown bud. Do not permit fronds to become damaged by means of restraint.

Exercise extreme caution while pruning palms, to prevent spread of vascular diseases. Dip pruning tools in a sterilizing agent before beginning pruning and before moving from one palm to another. Do not use any chain type saws for pruning operations.

Lifting, Off-loading, and Transporting: A lattice type crane, a telescoping type crane or a specially designed tree crane is acceptable for lifting and off-loading palm trees. For transporting, the trailer used shall be long enough to avoid damage to the heart of the palm. Loading and unloading of palms must be accomplished with the aid of nylon or fabric sling/straps with a minimum width of 4 inches. Excessive scarring or trunk damage will not be permitted and will be cause for rejection of the palms at the project site.

If the palms are not planted the day they arrive at the project site, the crowns and root ball should be protected from the sun and from reflected heat from the ground. Avoid storing on an asphalt surface.

Covering material must allow air movement so that heat does not build up under the covering. Do not use plastic or rubberized tarpaulins. Trees may not be stored for more than 48 hours. Do not stack palms, but lay them in a single layer on a flat surface. Covered rootballs must be watered lightly every couple of hours.

431.6 Materials and Products:

All palms shall have been grown in accordance with good horticultural practices under climatic conditions similar to those for the project for at least two (2) years prior to shipment to the site.

All palms shall be well-grown, symmetrical, without curvature or leaning trunk from the perpendicular and so trained or favored in development and appearance as to be superior in form, compactness and symmetry of crown. All palms shall be within one foot above or below the height specified, measured from the bottom of the crown bud to finish grade after installation.

All palms shall be sound, healthy and vigorous, well foliated prior to pruning and showing no signs of disease. They shall be free of disease, insect pests, eggs or larvae. They shall also have well developed root systems. All palms shall be free from physical damage or adverse conditions which would prevent thriving growth.

Verify that all field dug palms contain an adequate root ball to guarantee transplantation. Do not wrap root ball in plastic. Do not install palms that have damaged root balls.

Accessories:

Clean washed river sand.

FronD Tie: Minimum 1/2 inch diameter soft sisal rope capable of maintaining frond in tied condition for 1 year.

Fungicides: Soil Drench: "Subdue" by CIBA-GIEGY

431.7 Sequencing and Scheduling:

Coordinate delivery of palms with planting operations to avoid on site storage longer than 48 hours. Planting delays may result in rejection of the palm.

431.8 Preparing the Site for Landscaping:

Remove palms designated for replacement. Removal includes digging out stumps and roots to make room for replacement material. Remove all debris, trash and excess materials generated, and dispose of this material off-site.

Protect existing plant material, walls, pavements and other site amenities from damage.

431.9 Palm tree salvaging:

Prior to excavation, the palm tree shall be thoroughly watered.

Excavation: A trenching machine, a backhoe with a narrow bucket or a properly sized tree spade is acceptable as the excavation equipment. The exact equipment used must be approved by the Engineer.

Reduce the crown of palm trees per standard nursery practice. Use soft sisal rope to tie remaining fronds to protect crown bud.

The size of the root ball taken shall be a minimum of 18" to 24" deep and have a 2" to 3" wider radius than the base of the palm, unless otherwise directed by the Engineer. Certify that all field dug palms contain adequate root ball to guarantee successful transplanting.

Carefully lift and transport palm tree to the new location so as not to cause damage to the tree or site.

431.10 Execution of Planting:

Layout palms at locations shown on the plans. Use 3 foot lath, color coded for each palm. The Engineer will check location of palms in the field to exact position before planting begins.

Where palms are to be preplanted to permit site improvements to be installed around them, be responsible for the accurate layout of those palms, measured to their centerlines. Be responsible for the protection of those palms while work is taking place. Provide regular irrigation as necessary until final acceptance.

The palm tree excavation shall be a minimum of 1.5 times (x) larger than the root ball depth and 1 foot larger on all sides. It is acceptable for the final site grade around the palm to be 6 to 12 inches higher than the original soil line of the root ball. The depth of the pit shall be approved by the Engineer prior to planting the tree.

Water test each tree pit for drainage by filling the holes twice in succession with water. If when filled with water the second time the pit fails to drain within 24 hours, then additional excavation is necessary to break through the impermeable layer or provide a thick under layer of sand below the root ball. The cost for over excavation and for the installation of a drainage chimney will be considered should the tree pit not drain.

Clean moist washed river sand should be added to the bottom of the hole and tamped or water jetted, prior to insertion of the tree.

Install drainage and viewing pipe(s) in each tree pit to assure wetting of the whole root ball and to enable monitoring and viewing of the tree pit chamber. The vents shall be 4" diameter perforated PVC, with sufficient length to extend to the bottom of the tree pit. Do not backfill drainage or viewing pipes.

Backfill should be clean washed river or concrete sand amended with 25% native soil. In areas where soils are heavy in cliche, 100% sand shall be used. After placement of the palm, moistened sand shall be thoroughly tamped as backfill is being added to assure stability of the tree.

A 6" deep swale shall be made around each palm tree to provide water holding capability.

Mulch: Apply a 2" layer of decomposed granite in all palm tree watering basins.

After planting, the crown buds of all the palms shall be within 1 foot of the designated palm height above finish grade.

After planting, drench the soil with the fungicide, "Subdue" per manufacturers recommendations by flooding the planting basin. Reapply as often as label permits throughout the maintenance period.

Irrigation: It is essential that irrigation be deep enough to assure wetting of the whole root ball. The Contractor shall maintain the irrigation system to the existing trees and supplement additional water to newly planted trees as necessary for establishment. Use a tensiometer weekly during the maintenance period to verify correct watering at the surface and at the bottom of the rootball, report moisture levels to the Engineer.

431.11 Measure and Payment:

Measurement will be made on the number of trees that survive the planting operations. Unless otherwise specified by the Engineer, the Contractor shall be responsible for the cost of replacement and planting of any palm tree, in kind, that does not survive. Palms that do not survive become the property of the Contractor for disposal. Payment will be made at the unit bid price for each surviving tree which will be full compensation for all labor, materials, tools, equipment required for excavating, transporting, transplanting, and watering of the tree(s).

Municipality	Supplements
SC	<p>SECTION 430: LANDSCAPING AND PLANTING</p> <p>430.1 SUMMARY</p> <p>This Section includes the following:</p> <ol style="list-style-type: none"> 1. Trees. 2. Shrubs. 3. Ground covers. 4. Plants. 5. Lawns 6. Topsoil and soil amendments. 7. Proper staking. 8. Landscape edgings. <p>430.2 SUBMITTALS</p> <p>A. General: Submit each item in this Article according to the Conditions of the Contract.</p> <p>B. Product certificates signed by manufacturers certifying that their products comply with specified requirements.</p> <ol style="list-style-type: none"> 1. Manufacturer's certified analysis for standard products. 2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable. 3. Label data substantiating that plants, trees, shrubs, and planting materials comply with specified requirements. <p>C. Certification of grass seed from seed vendor for each grass-seed mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed content. Include the year of production and date of packaging.</p> <p>D. Samples of each of the following:</p> <ol style="list-style-type: none"> 1. 5 lb (2 kg) of granite stone mulch for each color and texture of stone required for Project, in labeled plastic bags. <p>E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of architects and owners, and other information specified.</p> <p>F. Material test reports from qualified independent testing agency indicating and interpreting test results relative to compliance of the following materials with requirements indicated.</p> <ol style="list-style-type: none"> 1. Analysis of imported topsoil (by certified soil laboratory). <p>G. Planting schedule indicating anticipated dates and locations for each type of planting.</p> <p>H. Maintenance instructions recommending procedures to be established by Owner for maintenance of landscaping during an entire year. Submit before expiration of required maintenance periods.</p> <p>I. Adhere to the City of Scottsdale Native Plant Ordinance and make necessary submittals to obtain a Native Plant permit.</p> <p>430.3 QUALITY ASSURANCE</p> <p>A. Installer Qualifications: Engage an experienced Installer who has completed landscaping work</p>

similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that landscaping is in progress.

B. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

C. Provide quality, size, genus, species, and variety of trees and shrubs indicated, complying with applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock."

D. Topsoil Analysis: Furnish a soil analysis made by a qualified independent soil-testing agency stating percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for growth of applicable planting material. State recommended quantities of nitrogen, phosphorus, and potash nutrients and any limestone, aluminum sulfate, or other soil amendments to be added to produce a satisfactory topsoil.

E. Measurements: Measure trees and shrubs according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches (150 mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

F. Preinstallation Conference: Conduct conference at Project site prior to planting of trees and shrubs with City owners and contractor discuss the COS Parks Department planting details.

430.4 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

B. Trees and Shrubs: Do not prune before delivery, except as approved by COS Parks Department Representative. Protect bark, branches, and root systems from sunburn, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy natural shape. Provide protective covering during delivery. Do not drop trees and shrubs during delivery of all plant material, this includes flatbed semi-trailer.

C. Deliver trees, shrubs, ground covers, and plants after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist. Contractor is responsible for providing water to plant material on site.

1. Do not remove container-grown stock from containers before time of planting. Option of COS Parks Department to sample 2% of lot material.

2. Water root systems of trees and shrubs stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

430.5 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities and perform work in a manner which will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Architect before planting.

C. Clean backfill (native backfill) no rocks larger than ½” diameter.

430.6 COORDINATION AND SCHEDULING

A. Coordinate installation of planting materials during normal planting seasons for each type of plant material required.

B. Scheduling: Irrigation system shall be operational in both landscape and turf areas before being planted.

C. Turf: October-March – overseed bermuda sod
 March-October 1 – bermuda sod
 June 1-June 15 -hybrid stolens for areas which will be overseeded.
 June 1-July 15 – Selected Bermuda seed type or hybrid stolens if turf will not be overseeded.
 August 1– September 30 – No sod to be installed until overseeded Bermuda sod is available.

430.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Warrant the following living planting materials for a period of one year after date of Final Completion, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, abnormal weather conditions unusual for warranty period, or incidents that are beyond Contractor's control.

C. Remove and replace dead planting materials immediately. All plants to be replaced in-kind size specified in the original design.

D. Replace planting materials that are in an unhealthy condition at end of warranty period.

430.8 TREE AND SHRUB MAINTENANCE

A. Maintain trees and shrubs by cultivating, watering, weeding, fertilizing, following COS Parks Department planting details, tightening and repairing stakes, and resetting to proper grades or vertical position. Spray as required to keep trees and shrubs free of insects and disease. Maintain trees and shrubs for the following period:

1. Maintenance Period: 3 months following final acceptance.

430.9 GROUND COVER AND PLANT MAINTENANCE

A. Maintain ground cover and plants by watering, weeding, fertilizing, and other operations as required to establish healthy, viable plantings for the following period:

1. Maintenance Period: 3 months following final acceptance.

430.10 LAWN MAINTENANCE

A. Begin maintenance of lawns immediately after each area is planted and continue until acceptable

lawn is established, but for not less than the following periods:

1. Seeded Lawns: 90 days after date of final acceptance.

a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established at that time, continue maintenance during next planting season. Lawns shall be substantially complete when entire area is covered with uniformly and mowed to a uniform height of 1 ½ inch.

B. Maintain and establish lawns by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawns uniformly moist to a depth of 4 inches (100 mm).

D. Mow lawns as soon as there is enough top growth to cut with mower set at specified height for principal species planted. Repeat mowing as required to maintain specified height without cutting 1/3 height of the grass. Remove no more than 1/3 inch of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Never mow grass when wet, or frosted. All mowing schedules will be confirmed by COS Parks Department representative.

E. Postfertilization: Apply fertilizer to lawn after first mowing and when grass is dry, then schedule water cycle.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb. Per 1,000 sq. ft. (0.5 kg per 100 sq. m) of lawn area.

430.11 PRODUCTS

430.11.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs conforming to ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully-branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees and shrubs of sizes and grades conforming to ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Label at least 1 tree and 1 shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

D. Plants protected by federal trademark or patent must include the correct name with genus and species along with registered cultivar name and be attached to all plants delivered and planted on specific project.

430.11.2 GRASS MATERIALS

A. Grass Seed: Fresh, clean dry, new-crop seed complying with the Association of Official Seed Analysts' "Rules for Testing Seeds" for purity and germination tolerances.

1. Seed Mixture: Provide Bermuda Triangle (mix of Sultan, Sidney and Yuma), 80% minimum germination, 85% minimum pure live seed, 0.5% maximum weed seed.

B. Sod: Hybrid Bermuda 328 overseeded perennial rye with winter grass variety approved by COS Parks Department.

1. Sod shall be ¾ inch thick.
2. Size of sod pad shall be cut not less than 12 inches x 24 inches nor more than 42 inches x 96 inches. Torn or uneven ends are unacceptable.
3. Sod shall not break apart when handled and be moist and fresh upon arrival to site.
4. Sod shall be mowed prior to cutting.
5. Sod shall be scrim free during installation.

430.11.3 DESERT RESTORATION

A. Hydroseed: Seed mixture shall consist of the following varieties at the rates shown below. Seed mixture shall be applied with the wood fiber mulch slurry.

PLS#/ACRE	BOTANICAL NAME	COMMON NAME
2	ENCELIA FARINOSA	BRITTLEBUSH
1	VIGUERIA DELTOIDEA	SHRUBBY GOLDEN EYE
2	AMBROSIA DELTOIDEA	BURSAGE
4	PLANTAGO INSULARIS	INDIAN WHEAT
2	CASSIA COVESII	DESERT SENNA
1	LOTUS RIGIDA	ROCK PEA
1	GUIITERREZIA MICROCEPHALA	SNAKEWEED
1	HALOPAPPUS ACRADENIUS	TURPENTINE BUSH

14 TOTAL PER ACRE

ALL SEED QUOTED IN PLS POUNDS PER ACRE.
 PLS = PURE LIVE SEED = PURITY X GERMINATION SEED TO BE BROADCAST ACCORDING TO RECOMMENDED RATES. RAKE INTO SURFACE 1/4".

B. Application rates of seed as specified are for Pure Live Seed (PLS). PLS = (% germination + % hard or dormant) x % purity. Weed content of seed shall not exceed .05%.

C. Binder: Binder shall be a free flowing, non-corrosive powder produced from natural plant gum of Plantago Insulares (Indian Wheat) such as Muciloid Tac or approved equal. Binder shall be applied at 40 lbs. per acre on slopes less than 3:1 and 80 lbs per acre on slopes 3 to 1 and above.

D. Wood Fiber Mulch: Wood fiber mulch shall consist of a specially prepared virgin wood fiber processed to contain no growth or germination inhibiting factors. Further, the mulch shall be manufactured and processed so the wood cellulose fibers will remain in uniform suspension in water under agitation and will blend with seed, fertilizer, and other additives to form a homogeneous slurry. The processed mulch material shall have characteristics to form a blotter-like ground cover on application, with moisture and percolation properties and the ability to cover and hold seed in contact with the soil. Wood fiber mulch shall be applied at 2000 lbs per acre.

430.11.4 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 8, 4 percent organic material minimum, free of stones ½ inch (25mm) or larger in any dimension, and other extraneous materials harmful to plant growth.

1. Topsoil Source: Reuse surface soil stockpiled on the site for planter areas. Import topsoil for turf areas. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary.
2. Turf area topsoil shall be an organic material free of deleterious material with a pH of 5.5 to 8.0. Maximum soluble salts shall be 1500 ppm. Soil texture shall be as follows: sand 60%-90%, clay 10%-20%, silt 10%-20%. The soil shall be classified as loamy sand or sandy loam. Volume of

stones, cinders, slag, or extraneous material shall not exceed five percent. Obtain topsoil from an offsite borrow area selected by the Contractor and approved by the Architect-Engineer. Onsite stockpiled topsoil may be used in planter areas if meeting the above specifications.

430.11.5 SOIL AMENDMENTS

A. Sand: Clean, washed, natural or manufactured sand, free of toxic materials.

B. Peat Humus: Finely divided or granular texture, with a pH range of 6 to 7.5, composed of partially decomposed Daota peat (other than sphagnum), peat humus, or reed-sedge peat.

C. Sawdust or Ground-Bark Humus: Decomposed, nitrogen-treated, of uniform texture, free of chips, weed pathogens, stones, sticks, soil, or toxic materials.

1. When site treated, mix with at least 0.15 lb (2.4 kg) of ammonium nitrate or 0.25 lb (4 kg) of ammonium sulfate per cu. Ft. (cu. M) of loose sawdust or ground bark.

D. Manure: Well-rotted, unleached stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed pathogens, and material harmful to plant growth.

E. Herbicides: EPA registered and approved, of type recommended by manufacturer.

F. Water: Potable.

430.11.6 FERTILIZER

A. Superphosphate: Homogenous commercial 0-45-0, phosphate mixture, soluble; minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea-form, phosphorous, and potassium in the following composition:

1. Composition: 1 lb per 1000 sq. ft. (0.5 kg per 100 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

C. Slow-Release Fertilizer: Granular fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in homogenous composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

D. Tree and shrub fertilizer shall be a complete, commercially available inorganic material. Fertilizer shall contain sulfur coated slow release components.

E. All fertilizers and application shall be as required by the soils analysis of the import soil.

430.11.7 MULCHES

A. Peat Mulch: Provide Dakota peat moss in natural, shredded, or granulated form, of fine texture, with a pH range of 4 to 6 and a water-absorbing capacity of 1100 to 2000 percent.

B. Fiber Mulch: Biodegradable dyed-wood cellulose-fiber mulch, nontoxic, free of plant growth- or germination-inhibitors, with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Asphalt Emulsion Tackifier: Asphalt emulsion, ASTM D 977, Grade SS-1, nontoxic and free of plant growth- or germination-inhibitors.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application, nontoxic and free of plant growth- or germination-inhibitors.

E. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:

1. Type: Decomposed granite.
2. Size Range: 1/2 inch (19 mm) maximum, 1/4 inch (6 mm) minimum.
3. Color: Readily available natural gravel color range, similar to naturally occurring onsite materials.

430.11.8 WEED-CONTROL BARRIERS

A. Pre-emergent type herbicide.

430.11.9 STAKES

A. Upright Stakes: Comply with COS Parks Department Planting Detail. Round, 2 inch, pressure-preservative-treated lodge poles, free of knots, holes and other defects.

B. Tie Wire: ASTM A 641 (ASTM A 641M), Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch (2.7 mm) in diameter.

C. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2 inch (13 mm) in diameter, black, cut to lengths required to protect tree trunks from damage.

D. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

430.11.10 SOIL STABILIZER

A. Stabilizer to be applied to desert pavement areas indicated on plans or approved equal by COS Parks Department representative.

1. "Stabilizer" as manufactured by Stabilizer, 22nd Street & Magnolia, Phoenix, Arizona 85018, (602) 225-5900.

B. Ballfield infield mix shall consist of crushed Coral granite fines, as processed by Fort McDowell Sand and Gravel and Stabilizer organic binder. Stabilizer is to be mechanically blended with the fines in a pug mill type blender with a metered feeder unit which mechanically measures Stabilizer to the fines at a rate of 20 lbs. Of Stabilizer per 1-ton of fines.

To ensure that a proper blend has been attained, Chuck Dixon at Turf Diagnostic and Design Lab, 310-A North Winchester, Olathe, Kansas shall conduct a Stabilizer recovery test, at the contractor's expense.

Submit two 1-gallon samples of fines, one before treatment and one after treatment. A Stabilizer recovery test will also be required for mound and homeplate mixes and warning track mix.

The Coral fines must meet the USDA particle size analysis in the range as follows for the infield mix:

	ACCEPTABLE RANGE
GRAVEL	0 – 2.0%
COARSE	30 – 35%
MEDIUM FINE SAND	45 – 50%
SILT AND CLAY	15 – 20%
BULK DENSITY	1.5
STABILIZER BINDER ORGANIC MATTER	1.0%

TOTAL PORE SPACE	41
UNIFORMITY COEFFICIENT CU	5.0

C. Ballfield mound and homeplate mix will also be blended with Stabilizer, clay and Coral fines to the following specifications and must meet USDA particle size analysis as follows:

**MOUND AND HOMEPLATE MIX
RANGE**

GRAVEL	0 – 2”
VERY COURSE	20 – 25%
COARSE	20 – 25%
MEDIUM AND FINE	25 – 30%
SILT AND CLAY	50 – 60%
STABILIZER CONTENT 12 LBS. PER TON	.6%

D. Ballfield warning track mix will consist of 1/4” minus Coral granite and Stabilizer, which meet the following specifications:

WARNING TRACK MIX

1/4”	100%
#4	99%
#8	74%
#10	68%
#16	51%
#30	34%
#40	27%
#50	21%
#100	12%
#200	6%

STABILIZER CONTENT 20 lbs. per ton	1.0%
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430.11.11 GRANITE BOULDERS

A. Boulders shall be surface select, free of equipment marks and cracks. Size as indicated on the drawings.

430.12 EXECUTION

430.12.1 EXAMINATION

A. Examine areas to receive landscaping for compliance with COS Parks Department representative requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

430.12.2 PREPARATION

A. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, and secure City of Scottsdale’s COS Parks Department representative for acceptance before the start of planting work.

430.12.3 PLANTING SOIL PREPARATION

A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

E. Mix soil amendments and fertilizers with topsoil at rates indicated for lawn areas. Delay mixing

fertilizer if planting does not follow placing of planting soil within a few days.

F. Tree and shrub backfill shall be native soil per COS Parks Department detail.

G. For lawns, mix imported topsoil with recommended amounts of fertilizer and 1/10 percent (by volume) Dakota peat mulch.

430.12.4 LAWN PLANTING PREPARATION

A. Limit subgrade preparation to areas that will be planted in the immediate future.

B. Loosen subgrade to a minimum depth of 4 inches (100 mm). Remove stones larger than ½ inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous materials.

C. Spread planting soil mixture to a minimum depth of 12 inches, after light rolling and natural settlement.

D. Grade lawn and grass areas to a smooth, even surface with loose, uniformly fine texture. Roll and water settle, rake, remove ridges, and fill depressions to meet final grade. Limit fine grading to areas that can be planted in the immediate future. Remove trash, debris, stones larger than ½ inch (38 mm) in any dimension, and other objects that may interfere with planting or maintenance operations.

E. Moisten prepared lawn areas before planting when soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

430.12.5 EXCAVATION FOR TREES AND SHRUBS

A. Pits and Trenches: Excavate with vertical sides and with bottom of excavation slightly raised at center to assist drainage. Loosen hard subsoil in bottom of excavation.

1. Container-Grown Trees and Shrubs: Excavate to 1-1/2 time the container width. Follow COS Parks Department planting detail.

B. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Increase planting pit.

C. Fill excavations with water and allow to percolate out, before placing setting layer and positioning trees and shrubs.

430.12.6 PLANTING TREES AND SHRUBS

A. Set container-grown stock plumb and in center of pit or trench with top of ball raised above adjacent finish grades as indicated.

1. Carefully remove containers so as not to damage root balls.
2. Place stock on setting layer of compacted planting soil.
3. Place backfill around ball in layers, tamping to settle backfill. When pit is approximately 1/2 backfilled, water thoroughly before placing remainder. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.

B. Perform planting in accordance with City of Scottsdale Standard Details and Specifications.

430.12.7 TREE AND SHRUB PRUNING

A. Prune, thin, and shape trees and shrubs according to ANZI standard A-300

430.12.8 TREE AND SHRUB STAKING

A. Upright Staking and Tying: Stake trees per COS Parks Department planting detail of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend at least 72 inches (1800 mm) above grade. Set vertical stakes and space to avoid penetrating balls or root masses. Support trees with 2 strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

430.12.9 PLANTING GROUND COVER AND PLANTS

- A. Space ground cover and plants as indicated.
- B. Space ground cover and plants not more than 48 inches (600 mm) apart.
- C. Dig holes large enough, 1 ½ times rootball size, to allow spreading of roots, and backfill with planting soil. Water thoroughly after planting.

430.12.10 MULCHING

- A. No mulch in backfill of planted areas. Mulch on surface at final grade..
- B. Granite: Apply the following average thickness of granite and finish level with adjacent finish grades. Do not place mulch against trunks or stems.
 - 1. Thickness: >2 inches (50 mm).
- C. Desert Pavement from stockpiles shall be spaced to a depth of 2 inches in all disturbed by grading and not receiving other ground treatment. The finished appearance shall be that of the surrounding natural desert. Pre-emergent shall not be applied in desert pavement areas.

430.12.11 HYDROSEEDING NEW LAWNS

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.

1. Hydroseed mixture shall contain the following:

<u>Material</u>	<u>Quantity</u>
Seed	2 lbs./1,000 S.F.
Fertilizer	As indicated by Laboratory Analysis
Wood Fiber	1500 lbs./Acre

- 2. Mix slurry with nonasphaltic tackifier.
- 3. Apply slurry uniformly to all areas to be seeded in a 2-step process. Apply first slurry application at the minimum rate of 500 lb per acre (5.5 kg per 100 sq. m) dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 lb per acre (11 kg per 100 sq. m).

430.12.12 SOD (ALTERNATE NO. 2)

A. Lay sod perpendicular to direction of slope and in a manner permitting end of pad joints to alternate. Lay sod tightly together. Do not stretch pad or overlap joints. Tamp, secure sod on slopes greater than

one vertical to three horizontal. Netting scrim must be removed.

B. Water sod immediately after installation to a depth of 1 inch below sod. After a short drying period, roll sod and smooth minor surface irregularities.

430.12.13 HYDROSEEDING/RESTORATION AREAS

**Delete Para 5 in its entirety and add this revised paragraph.*

1. After the surface treatment is completed and accepted by the Architect, seed mix shall be hydroseeded.

2. The following materials shall be combined to form a seed mulch mixture for hydroseeded applications.

- a. Seed mix
- b. Binder
- c. Wood Fiber Mulch
- d. Sufficient water to form a homogenous mixture capable of being applied by commercial hydromulching equipment.

3. Hydroseeding which is deposited on adjacent trees and shrubs, roadways, in drain ditches, on structures, and upon any area where seeding is not specified or which is placed in excessive depths on seeding areas shall be removed.

4. Seeding areas flooded or eroded as a result of irrigation shall be repaired, reseeded, and refertilized by the Contractor at his expense.

5. * Care During Construction: The Contractor shall be responsible for protecting and caring for seeded areas until final acceptance of the work and shall repair, at his expense, any damage to seeded areas caused by pedestrian or vehicular traffic, erosion due to excessive water application or other causes. A temporary aboveground irrigation system shall be designed, installed and maintained by the Contractor to germinate and establish native seeding (the use of a water truck for this purpose is not acceptable). A temporary irrigation controller capable of providing a minimum of six irrigation run cycles per day will need to be installed along with temporary remote control valves.

6. Germination: Seed germination is dependent upon a variety of factors, many of which are interacting. Temperature, light time of year, internal seed dormancy, gas exchange, and moisture are involved in seed germination.

a. Under favorable conditions, most non-dormant desert seeds will germinate in 7 to 10 days with constant available moisture. Watering should not be so much that it runs off or puddles. Frequent light applications of water are generally needed for good germination results. It will probably be necessary to irrigate several times per day if it is hot, windy, or the soil is well drained or sloped. Irrigation 4 to 6 times per day is not uncommon. Irrigation should be checked daily for run off and drying between cycles. Careful attention by the Contractor is required because too wet or too dry of conditions will affect germination.

b. Following germination of approximately 80% of the Pure Live Seed, or as accepted by the Architect, the Contractor shall request start of the Native Seed establishment period. The establishment period shall be for 90 days from the start date set by the Architect.

c. Establishment: Establishment is considered to be after germination and before plant maturity. Water during the establishment period shall be that of gradual decrease in water application. The intent is to provide water in soil profiles where it is retained and where root growth occurs. Decreasing the water frequency allows for natural characteristics of drought tolerance to develop.

d. The Contractor shall inspect the ground closely as soon as plants have emerged, as many seedlings are small and inconspicuous. Adjust water frequency accordingly. Inspection of plants and soil will determine the watering requirements during the establishment period. Wilting is an obvious sign of

water stress. Overwatered plants may appear yellow due to nutrient deficiency or very lush with excess growth. Overwatered plants will not develop drought resistance.

e. Water after germination should be 1 to 3 times per week on average, however, this is a variable depending on many factors. Water should be allowed to soak the soil profile as deeply as possible to encourage deep rooting. As the plants mature and develop woody tissue, the water can be decreased dramatically and temporary irrigation suspended or removed.

f. The Contractor shall be responsible to re-apply hydromulch and seek until establishment is acceptable to the Architect based on 40% of the germinated plants surviving with no increase costs to the Contract. Maintenance of Native seed areas shall be concurrent with establishment of these areas.

430.12.14 CLEANUP AND PROTECTION

A. During landscaping, keep pavements clean and work area in an orderly condition.

B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

430.12.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

SPRINKLER IRRIGATION SYSTEM INSTALLATION

440.1 DESCRIPTION:

The Contractor shall furnish all the necessary labor, materials, and equipment required to complete the installation of the automatic sprinkler irrigation system providing full coverage to all plants and shrubs.

440.2 GENERAL:

Unless otherwise specified, the automatic sprinkler irrigation system layout as shown on the plans shall be considered schematic. The Contractor shall lay out the entire system using stakes to indicate the location of the various components. Preliminary adjustments to conform to actual site condition shall be accomplished at this time and the approval of the Engineer obtained prior to any actual work being performed. Utility connections, both water and electrical, shall be as shown on the plans or as designated by the utility concerned. Unless specifically exempted in the plans or specifications, the Contractor shall pay all costs concerned in providing these services.

Prior to the acceptance of the project, the Contractor shall furnish the Engineer 4 copies of the manufacturer’s instruction and maintenance manual for each component or group of components to include parts listings and source of supply.

Prior to final inspection, the Contractor shall submit one set of corrected, as-built drawings showing the location of all pipe, valves, wiring, and utility services.

All permits for installation or construction of any of the work included under this section, which are required by legally constituted authorities having jurisdiction, shall be obtained and paid for by the Contractor, each at the proper time. He shall also arrange for and pay all costs in connection with any inspections and examinations required by these authorities.

Municipality	Supplements
GL	<p>Irrigation</p> <p>10.11 All irrigation systems installed in the City shall conform to the following:</p> <p>A. A flood irrigation system may be used for flat level areas, if available. A sprinkler irrigation system must be used for all areas not covered by flood irrigation which will be developed as turf.</p> <p>B. The City will review and approve all irrigation systems prior to any installation. All sprinkler systems shall be automatic, and shall utilize a pressure type vacuum breaker assembly or a reduced pressure principle backflow prevention assembly (as required) before the remote control valves. All plans submitted for approval must specify the brand, model, and nozzle size(s) of the heads; the brand, model, and size of all electric valves; the brand and model number of the electric controller; the brand, model and size of the backflow prevention assembly, and all pertinent data on such miscellaneous items as valve boxes and covers, size and type of pipe, all necessary details and friction pressure loss calculations for the longest run in the system for both full-circle and part-circle circuits. All subdivisions, industrial parks and large scale development projects shall provide an irrigation key map identifying the location of all controllers and the location, addresses and sizes of all water meters. All applicable codes shall be adhered to and plumbing and electrical permits will be required. Irrigation systems installed in conjunction with commercial entities, Home Owner’s Associations, City of Glendale Right-of-Way and City of Glendale Parks are to have separate systems, clocks, meters (water and electric), vacuum breakers, etc. (stand alone systems). The irrigation plans shall also clearly state the areas that are maintained by the City and maintained by the Home Owner’s Association.</p> <p>D. Existing Utilities, Structures and Trees: The developer shall protect existing structures, utility services and trees and be responsible for their replacement. The location of existing trees and the requirements for performing work around them shall be shown on all irrigation plans. Minor adjustments to the system will be permitted to clear existing obstructions subject to the approval of the City.</p>

440.3 MATERIALS:

Prior to the start of construction, the Contractor shall submit shop drawings per Section 105 on all material for approval of the Engineer. All materials shall conform to Section 757.

Municipality	Supplements
GL	Materials E. Once the plans have been approved by the City, no substitutions shall be allowed, except when unavailable from the supplier, and another approved product is locally available. All such substitutions must be approved in writing by the City. All materials shall be new and the best of their class and kind.

440.4 LANDSCAPE IRRIGATION SYSTEM REMOVAL AND RESTORATION

When construction encroaches into an existing landscaped irrigation system, the Contractor shall remove the conflicting portion of the system within the right-of-way and/or easements and any portion which may remain under the proposed improvements, whether shown or not shown on the plans. If the removals affect other areas of the system not in conflict with the construction, the Contractor shall permanently or temporarily restore or modify the existing system to provide water to the unaffected areas. The restoration or modifications shall be completed within 24 hours after the disruption occurs or notification by the Engineer.

The Contractor shall restore the affected landscape irrigation system to an operational condition equal to or better than the existing system. When necessary, bubbler and/or sprinkler heads shall be reinstalled at the edge of the new improvements. The reconstructed or modified system shall provide completed irrigation coverage without overspray onto walks, pavement, walls, buildings, etc.

The Contractor shall have the option to salvage and reuse existing materials. In the event that it is not feasible to reinstall the salvaged materials, new materials shall be installed.

To provide ample notification for owners who desire to remove and restore their own system, the Contractor shall notify the affected property owners at least fourteen (14) days prior to the scheduled removal of the irrigation system.

When determined by the Engineer that the existing sprinkler system can not be practically restored, the existing system shall be plugged and removed as directed.

Unless specified by the agency and called out in the bid documents, this work shall be considered incidental to the contract and no separate payment shall be made to comply with these provisions.

440.5 TRENCH EXCAVATION AND BACKFILL:

Trenches and other excavations shall be sized to accommodate the irrigation system components, conduit, and other required facilities. Additional space shall be provided to assure proper installation and access for inspection. Unless otherwise specified, the minimum depth of cover over pipelines and conduits shall be as follows:

- (A) Electrical conduit – 18 inches
- (B) Waterlines continuously pressurized – 18 inches
 - G. 1 Lateral sprinkler lines - 12 inches).....Plastic lines under pavement - 24 inches

The bottom of trenches shall be true to grade and free of protruding stones, roots or other matter which would prevent proper bedding of pipe or other facilities.

Trenches and excavations shall be backfilled so that the specified thickness of topsoil is restored to the upper part of the trench. Compaction shall be in accordance with Section 301.

Water settling of trench backfill will not be permitted unless approved by the Engineer.

Municipality	Supplements
GL	<p>Excavation, Backfilling and Compaction: C. Trenches for sprinkler lines and control wiring shall be excavated to a minimum depth of 18 inches for mains under constant pressure and 12 inches for laterals not under constant pressure. When in common trenches, all control wires shall be placed first, followed by a layer of fine backfill; then the main line followed by a minimum of 6 inches fine backfill; then the laterals, and final backfill and compaction, all in accordance with Section 601 of the Maricopa Association of Governments' Specifications</p>

440.6 PIPE INSTALLATION

General: Pipe fittings shall be installed in accordance with the manufacturer's recommendations and these specifications. When requested by the Engineer, the Contractor shall furnish the manufacturer's printed installation instructions before pipe installation.

Pipe shall be bedded in at least 2 inches of finely graded native soil or sand to provide a firm, uniform bearing. After laying, the pipe shall be surrounded with additional finely graded native soil or sand to at least 2 inches over the top of the pipe. Trench backfill, sufficient to anchor the pipes, may be deposited before the pipeline pressure testing, except that joints shall remain exposed until satisfactory completion of testing.

When two or more pipelines are installed in the same trench, they shall be separated by a minimum horizontal clear distance of 6 inches and they shall be installed so that each pipeline, valve, or other pipeline component may be serviced or replaced without disturbing the other.

Piping under concrete or asphalt shall normally be installed by jacking, boring, or hydraulic driving. When any cutting or removal of asphalt and/or concrete work is necessary, it shall be saw cut in accordance with Section 601. Permission to cut asphalt and/or concrete shall be obtained from the Engineer. Where piping on the drawings is shown under paved areas, but running parallel and adjacent to planted areas, the intent of the drawings is to install the piping in the planted area.

When plastic to steel pipe connectors are required, these connections shall be accomplished first. A non-hardening, non-oil base pipe compound or liquid teflon shall be used on the male threads only. The joint shall be hand-tightened with final tightening as necessary to prevent leaks accomplished with a strap wrench.

Threads shall be cut with clean sharp dies and shall conform to American Standards Association Specification B2.

- (A) Joints shall be made with a non-toxic non-hardening joint compound applied to the male threads only.
- (B) When wrapped pipe is specified, joints and connectors shall not be wrapped until completion of the pressure test.

(C) Plastic Pipe: Plastic pipe shall be cut square, externally chamfered approximately 10-15 degrees, and all burrs and fins removed. It shall be joined utilizing threaded fittings or socket type, solvent welded fittings. Schedule 80 pipe only will be used for threaded joints. Field threading will be accomplished in the same manner as specified for steel pipe, except that a plug will be installed in the bore of the pipe prior to threading to prevent distortion. Threaded pipe joints shall be made teflon tape on the male threads. Solvent will not be used for threaded joints. Threaded joints shall be hand tightened with final tightening as necessary to prevent leaks with a strap wrench. Solvent welded joints shall be made in accordance with ASTM D-2855, and the type of solvent recommended by the pipe manufacturer shall be used. Solvent shall be applied to the pipe ends in such a manner that no material is deposited on the interior surface or forced into the interior of the pipe during insertion. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly.

The pipe shall be protected from damage during assembly. All vises shall have padded jaws and only strap wrenches shall be used. Any plastic pipe which has been nicked, scarred, or otherwise damaged shall be removed and replaced. Care shall be exercised so that stresses on the previously made joints are avoided. Movement of the pipe following assembly, such as

lowering the pipe into the trench, shall not occur prior to the set time recommended by the manufacturer of the solvent cement used.

The plastic pipe will be snaked from side to side within the trench so as to provide approximately 1 foot of slack per each 100 feet of pipe.

The pipeline will not be exposed to water for at least 12 hours after the last solvent welded joint has been made.

440.7 VALVES, VALVE BOXES, AND SPECIAL EQUIPMENT INSTALLATION:

Valves, backflow preventers, pressure regulators and related accessories shall be furnished and installed as specified.

All valves and other equipment shall be installed in a normal upright position unless otherwise recommended by the manufacturer, and shall be readily accessible for operation, maintenance and replacement. Sectional control valves shall not be located within range of sprinklers they control.

Gate valves and sectional control valves shall be installed below ground. Gate valves shall be housed in a covered concrete or plastic box that will permit access for servicing. Sectional control valves shall be equipped with a sleeve and cap centered on the valve stem.

Quick-coupler valves and garden valves projecting above grade shall be installed a minimum of 3 feet from curbs, pavement and walks. In non-irrigated areas, quick-coupler valves shall be set flush with finish grade, and in irrigated areas at or just above water level. They shall be installed on a double swing joint riser assembly. Garden valves shall be set 12 inches above finish grade, and shall be installed on a galvanized riser. In non-irrigated areas all valve boxes, valve access sleeves, and caps shall be set to finish grade, and in irrigated areas set adjacent to curbs, sidewalks or pavement at or just above water level. Valves shall be set at sufficient depth to provide clearance between the cover and the cap, valve handle, or key when the valve is in the fully open position. Backflow preventers shall be provided with pipe supports and the accessories necessary to properly secure the assembly. All backflow preventers shall be assembled with pipe, fittings, and risers of an approved material by the contracting agency.

Municipality	Supplements
GL	<p>Pipe</p> <p>H: Pipe</p> <ol style="list-style-type: none"> 1. No galvanized pipe shall be used. Schedule 80 PVC nipples shall be used for sprinkler swing joints, and Type K hard copper shall be used for all main line piping above grade, and extending 18 inches below finished grade. 2. PVC lines below paving shall be installed within separate Schedule 40 sleeves (sized, as required). Piping shall be installed by jacking, boring, or hydraulic driving. 3. All pipe (PVC or copper) installed in rocky or caliche soils shall be thoroughly embedded and completely covered in sand or approved imported topsoil. 4. Plastic pipe shall be as described on the drawings. It shall be unplasticized PVC extruded from virgin parent materials of the type specified on the plans. The pipe shall be homogeneous throughout and free from cracks, holes, foreign materials, blisters, deleterious wrinkles and dents. All pipe shall be continuously and permanently marked with the following information: Manufactur'er's name, size, schedule, and type of pipe, working pressure at 73oF, and N.I.S.F. approval. 5. All mainlines that do not have valve wires run beside them should have a separate wire run, including main lines crossing streets, and labeled in clock for future locating purposes. Wire shall be of a different color than valve wires or common. If battery/solar clock installed, run wire with laterals. All mainlines, laterals and wires which cross underneath roads and sidewalks must be sleeved.

	<p>I. Plastic Pipe, Fittings and Connections on Mains: All pipe and fittings shall be approved Type 1, Grade 1, PVC, Schedule 40 pipe, conforming to ASTM D1784-L65T, and shall be either solvent weld pipe or rubber ring joint pipe. When a connection is plastic to metal, either a PVC Schedule 80 nipple, brass nipple, or male adapters shall be used. The male adapter shall be tightened as not to leak under pressure. Joint compound shall be Teflon tape or Teflon liquid joint compound. All PVC pipe to be cleaned with a PVC solvent primer before gluing.</p> <p>J. Plastic Pipe, Fittings and Connections on Laterals: All pipe shall be as follow 1/2" -" - PR 315, P3/4" an" -" - Class 200, SDR 21, PVC 1-2" and -p - Class 200, SDR 21, PVC</p> <p>All fittings shall be molded fittings manufactured of the same materials as the pipe and shall be suitable for either solvent weld or screwed connections. Use male adapters as described above. Only Schedule 80 PVC pipe may be threaded.</p> <p>P. Installation of Plastic Pipe: Plastic pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer. Burrs at cut ends shall be removed prior to installation so that a smooth, unobstructed flow will be obtained. Pipe for use with rubber gaskets will be tapered as recommended by the manufacturer.</p> <p>Q. Pipe Routing shall be as follows:</p> <ol style="list-style-type: none"> 1. Meter to backflow prevention assembly shall be Type K soft copper. 2. Backflow prevention assembly rise-s - Type K hard copper. 3. All other exposed main line pi-e - Type K hard copper. 4. All buried mains and laterals downstream of a backflow prevention assembly (or booster pum-) - PVC pipe.
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Municipality	Supplements
GL	<p>K. Remote Control Valves and Valve Boxes: Remote control valves shall be electric and have brass or high strength plastic bodies and flow controls. Provide expansion coils at each wire connection in valve box. Irrigation valves are to be labeled on a sheet of paper placed in the controller(s), with stations corresponding to valve areas in the field.</p> <p>O. Gate Valves:</p> <ol style="list-style-type: none"> 1. Gate valves shall be bronze, in sizes of 2" through 2-2/2", and cast iron, in sizes o" 3" through"12". 2. The body of bronze valves shall be of heavy duty bronze conforming to the requirements of ASTM B62 (85-5-5-5 alloy)., Valves shall have a service rating for non-shock, cold water, or 200 pounds per square inch. Valves shall be of the double disc, taper seat type with non-rising stem, union bonnet and handwheel. Identification of valves by trade name, manufacturer, etc., shall be stamped or cast on the valve. Valves shall be assembled as detailed on the plans or as specified in the special provisions. 3. The body of cast iron valves shall conform to the requirements of ASTM A126, Class B. Valves shall be of the double disc, parallel seat type, with non-rising stem a"d"O" ring seal. Valves shall conform to the requirements of A.W.W.A. C500 and shall be iron bodied, bronze mounted. Valves shall have a service rating for non-shock, cold water of 200 pounds per square inch. 4. The Y strainer attached to the Hardie 700 Series valve shall be an agricultural product type.

440.8 SPRINKLER HEAD INSTALLATION AND ADJUSTMENT:

In accordance with the requirements of Subsection 440.7 all mains and laterals, including risers, shall be flushed and pressure tested before installing sprinkler heads. A water coverage test shall be performed after the sprinkler heads are installed.

(A) Location, Elevation and Spacing: Sprinkler head spacing shall not exceed the maximum shown on the drawings or recommended by the manufacturer. They shall be installed with at least 4 inches clearance from adjacent vertical elements projecting above grade such as walls, planter boxes, curbs and fences. Bubbler heads shall be installed a minimum of 2 inches above finish grade. The Engineer will notify the Contractor in writing when the planted beds are sufficiently planted and settled to make the necessary adjustments to the bubbler heads. Any adjustments are to be made within sixty (60) calendar days after this notification is received and at no additional cost to the Contracting Agency.

(B) Riser Assembly: A top outlet riser assembly shall consist of a pipe riser threaded into a top outlet ell or tee installed in the lateral supply line. Double-swing joint and single-swing joint riser assemblies shall utilize a horizontal 6 inches pipe nipple threaded into a side outlet ell or tee installed in the lateral supply line. For a double-swing joint, 3 ells shall be used in the remaining assembly ahead of the vertical riser pipe. For a single-swing joint, one ell shall be used.

(C) Sprinkler Head Adjustment: After all sprinkler heads are installed and the irrigation system is operating, each section or unit shall be adjusted and balanced, with all section control valves fully open to obtain uniform and adequate coverage. Sprinkler heads having adjustable pin nozzles or orifices shall have the pins adjusted to provide adequate distribution of water over the coverage pattern. The Contractor shall substitute larger or smaller nozzle cores in non-adjustable sprinkler heads as necessary.

Municipality	Supplements
GL	<p>Sprinkler Heads</p> <p>1. Sprinkler heads shall be pop up, rotary pop-up or gear drive sprinklers, part circle, adjustable and full circle types.</p> <p>2. All heads of a particular type of function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and be identified without being removed from the system. All sprinkler heads shall be set perpendicular to finished grades unless otherwise designated on the plans. Sprinkler heads adjacent to existing walks, curbs or other paved areas shall be set to grade. All nozzles on rotary pop-up sprinklers shall be tightened after installation. All sprinklers shall be tightened after installation. All sprinklers having an adjustment stem shall be adjusted on a lateral line for the proper radius, diameter and/or gallonage</p>

440.9 AUTOMATIC CONTROL SYSTEM INSTALLATION:

The Contractor shall install a complete automatic irrigation control system including the automatic controller, remote control valves and wiring, and all necessary accessories and utility service connection including the junction box and any work required from the stubout provided by the power company.

The automatic controller shall be installed outside of the coverage pattern of the irrigation system at the location designated in the contract documents. The foundation for the controller shall be Class C concrete of the size shown on the plan or recommended by the manufacturer. The control components in the controller shall be fused and the chassis shall be grounded. The controller shall be installed in a steel security cabinet with metal hasp and padlocks unless the controller is to be placed with a building or walled enclosure.

Remote control valves shall be compatible with the automatic controller. The valve is to be housed in a plastic box with locking cover, and it shall be installed with at least a 6 inches clearance below the plastic cover. The box shall be set to finish grade in non-irrigated areas and adjacent to curbs, sidewalks or pavement at or just above high water elevation in irrigated areas.

All service wiring shall be installed in rigid conduit from the service point to the controller at the minimum depth specified in Subsection 440.2. A separate disconnect switch or combination meter socket, as required, shall be installed between the source of power and the controller. The minimum service wire shall be No. 12 AWG copper 600 volt type, TWH or larger as required by the contract documents or controller manufacturer. Wire splices shall be located only in specified pull boxes and shall be made with a packaged kit approved for underground use. Pull boxes shall be plastic with locking covers set to proper elevations on a 12 inches layer of crushed rock or washed gravel.

All wiring issuing from the controller shall be direct burial installed in main or lateral waterline trenches wherever practicable. The wiring shall be bundled and secured to the lower quadrant of the irrigation pipeline at 10 foot intervals with plastic electrical tape. Sufficient slack shall be left in the wiring or tubing to provide for expansion and contraction. When the control wiring or tubing cannot be installed in a pipe trench, it shall be installed a minimum of 18 inches below finish grade.

All pilot or “hot” wires are to be of one color and all common wires are to be of another color.

Unless otherwise required, all control wiring shall be direct burial Type UF, No. 14 AWG copper. Splices in control wire shall be made in accordance with the requirements for service wire. Sufficient slack shall be left at each splice and point of connection in pull boxes and valve boxes so that in case of repair the valve bonnet or splice may be brought to the surface without disconnecting the wire. No splices shall be permitted under pavement.

All wiring shall be tested for continuity, open circuits, and unintentional grounds prior to connecting the equipment.

Upon completion of the work the control system shall be in operating condition with an operational chart mounted within the controller cabinet.

Municipality	Supplements
GL	: N. Electric Controller: The sprinkler controller shall be capable of operating on 117 volts, 60 cycle A.C. current, and shall provide output of 24-26.5 volts and 1.1 amps for electric solenoid valves, and 115 volts for a pump start circuit (if required). Controller shall be pedestal mount or wall mount with factory supplied hardware for either. Controller shall be sized to perform the sprinkling adequately. The electric solenoid valves do not have to be of the same manufacturer as the controller. The controller shall be enclosed in a lockable rounded metal cage per Detail G-673 . Provide source of power where applicable

440.10 FLUSHING AND TESTING:

After completion and prior to the installation of any terminal fittings, the entire pipeline system shall be thoroughly flushed to remove all foreign material. After flushing, the following tests shall be conducted in the sequence listed below. All equipment, materials, and labor necessary to perform the tests shall be furnished by the Contractor and all tests shall be conducted in the presence of the Engineer

A) Pipeline Pressure Test: A water pressure test shall be performed on all pressure mains and laterals before any couplings, fittings, valves, and the like are concealed. All open ends shall be capped after the water is turned into the lines in such a manner that all air will be expelled. Pressure mains shall be tested with all control valves to lateral lines closed. After the pressure main test, all valves shall be opened to test lateral lines. The constant test pressure and the duration of the test are as follows:

- Mains..... 6 hours at 125 psi
- Laterals..... 2 hours at 100 psi

(B) Sprinkler Coverage Test: The coverage test shall be performed after sprinkler heads have been installed and shall demonstrate that each section or unit in the irrigation system is balanced to provide uniform and adequate coverage of the areas serviced. The Contractor shall correct any deficiencies in the system.

(C) Operational Test: The performance of all components of the automatic control system shall be elevated for manual and automatic operation.

During the maintenance period specified and at least 9 days prior to final acceptance, the Contractor shall set the controller on

automatic operation and the system shall operate satisfactorily during this period. All necessary repairs, replacement and adjustment shall be made until all equipment, electrical work, controls and instrumentation are functioning in accordance with the contract documents.

440.11 MEASUREMENT AND PAYMENT:

Measurement and payment shall be in accordance with Section 109. The lump sum or unit prices established in the proposal sheets shall be full compensation for furnishing all labor, materials, tools and equipment, and performing all work necessary to complete the sprinkler irrigation system described or specified in the contract documents.

Municipality	Supplements
GL	<p>F. Screening: All irrigation control equipment shall be appropriately screened from view.</p> <p>G. Control Cable: All wiring to be used for connection of the automatic controller to the electric solenoid actuated remote control valves shall be Type UF, , UL approved underground feeder cable. All pilot "r" "ot" wires are to be one color and a "l" "com" "on" wires are to be of another color. Wiring shall conform to local codes and shall be installed according to the manufacturer's recommendation. Minimum wire size shall be No. 14.</p> <p>L. Backflow Prevention Assemblies:</p> <ol style="list-style-type: none"> 1. A reduced pressure principle backflow prevention assembly or a pressure vacuum breaker assembly shall be required. The requirement will be established by system design and service connection. Those systems served by a separate water meter used in elevated areas or with drip irrigation shall require a reduced pressure principle backflow prevention assembly. Those systems served by a water meter used for both domestic water service and landscape irrigation may use a pressure vacuum breaker if installation requirements can be met. 2. All assemblies shall comply with local and state codes and have current approval by the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California and current listing with the International Association of Plumbing and Mechanical Officials. All assemblies shall be equipped with resilient seated shutoff valves and test cocks. 3. All assemblies shall be rated at 150 psi working pressure and 160oF water temperature. 4. All backflow assemblies shall be FEBCO 825YA or a City approved equal. 5. Assemblies shall be installed in compliance with City standards for reduced pressure principle assemblies or pressure vacuum breakers. Assemblies shall be enclosed in a lockable, expanded metal cage such as that manufactured by Wayne Vowell, Inc., B.P.D.I., or approved equal. All assemblies shall be tested by a certified tester prior to final inspection. <p>R. Water for Trees: All trees shall receive water from one of the following systems:</p> <ol style="list-style-type: none"> 1. An emitter system with electric solenoid valves, Y-strainer and pressure regulating valve, or 2. A bubbler system with electric solenoid valves, surface bubblers and PVC pipe. <p>10.2 NON-PRIVATE SYSTEMS</p> <p>In addition to the requirements of Section 10.11, the following irrigation system standards shall be considered as the minimum standard for the design and construction of projects which fall into either of the following categories: city-maintained properties; or landscape installations of residential common areas and private parks whose maintenance effort is collectively financed, e.g. maintained by a "homeowners association"</p> <p>A. Materials: Once the plans have been approved by the City, no substitutions shall be allowed, except when unavailable from the supplier, and another approved product is locally available. All such substitutions must be approved in writing by the City. All materials shall be new and the best of their class and kind. All materials and workmanship shall be guaranteed for a period of one (1) year against defective material and workmanship. Irrigation systems shall consist of PVC pipe (mainlines Schedule 40, laterals Schedule 20).</p> <p>B. Remote Control Valves and Valve Boxes: Remote control valves shall be electric and have brass or high strength plastic bodies and flow controls, and shall be Hardie 700 Series, or an approved equal.</p>

Remote control valve boxes shall be Carson, Brooks or an approved equal with locking cover. Irrigation valves shall be labeled on a piece of paper placed in the controller. The stations shall correspond to valve areas in the field.

C. Sprinkler Heads:

1. The following manufacturers and models or an approved equal shall be used:
 - a. Hunter I-20, I-25 and I-40 series.
 - b. Rainbird, pop-up 1800 series.
2. Swing Joints: All sprinklers and quick coupler valves shall be installed on swing joints consisting of one PVC Schedule 80 nipple. Schedule 80 nipples shall be 8 inches to 12 inches in lengths attached with one Marlex Street ell at the bottom and two Marlex Street ells at the top end, so that the sprinkler can rise or fall without breaking the pipe.
3. Emitters shall be Bowsmith multiport emitters, 6 port, 2 gallons per hour or single port, 2 gallons per hour.

D. Electric Controllers: The following manufacturers and models or an approved equal shall be used:

1. Irri-Trol MC-Plus-B 4, 6, 8, 12, 18, and 24.
2. Motorola MIR 5000.i.

E. Solar Controllers: The following manufacturers and models or an approved equal shall be used:

1. Leit 8000
2. Leit 4000

F. Fertilizer Injector System (5 gallons only): Shall be installed in a lockable metal cage on the down side of the vacuum breaker, prior to electric control valves. Fertilizer injector to be in same cage as the backflow preventor.

G. Calculations: Provide complete calculations for sizing irrigation systems.

H. Inspections: The City shall be required to inspect and approve the work at the following stages of completion. Any work completed without these inspections must be removed prior to acceptance of that phase of the work.

These stages are:

1. Completion of all trenching and installation of all control wires prior to backfilling.
2. Installation of all main line piping prior to backfilling, including the vacuum breaker, quick coupler circuits, and any shut-off valves. The main line shall be pressure tested for 30 minutes at this inspection.
3. Installation of all lateral valves, lines and heads. I. Flushing and Testing: At the end of each run, flush caps in Telco boxes shall be installed. After all new sprinkler piping and risers are in place and connected and all necessary division work has been completed and prior to the installation of sprinkler heads, control valves shall be opened and a full head of water used to flush out the system. After the system is thoroughly flushed, risers shall be capped off and the system pressure tested prior to backfilling the laterals.

J. As-Built Drawings: The developer shall be responsible for providing a digital or photo mylar drawing system with all changes in location marked on the drawing. This shall be submitted to the City prior to final acceptance.

(See Section 8.0 "As-Built Requirements")

10.4 LANDSCAPE STANDARDS

A. Quality and Size:

1. All trees shall be of a size and quantity to comply with applicable portions of the Landscape Ordinance; shall have a sufficient rootball that holds the earth together after the removal of the containers, but shall not be root-bound or girdled. Plants shall have been grown in pots, cans or boxes for a minimum of three (3) months, and a maximum of one year.
2. All plants shall exhibit normal growth and shall be healthy, vigorous growth and disease, insect

and weed free.

3. Trees shall have a straight trunk throughout their height, and shall be in accordance with the American Standard for Nursery Stock.

B. Nomenclature: For inspection and identification, durable legible labels, stating in weather resistant ink the correct plant name and size, as specified in the plant list, shall be securely attached to all tree trunks delivered to the site.

C. Tree Staking:

1. Stakes for supporting trees shall be 2-inches x 2-inches x 10-foot lodgepoles and shall be straight, sound, stout and free of knots and cracks which weaken the stake. Each tree shall receive two (2) stakes outside of the rootball.
2. Wire for fastening trunks to stakes shall be No. 12 gauge, annealed galvanized steel (not iron). One wire shall be placed at the top of the stakes, and another halfway down the stakes. If necessary, nail wire to stakes to hold firm.
3. Hose to protect trunk from wire rubbing shall be new 2-ply reinforced rubber or plastic garden hose.

D. Plant Material:

1. Unless otherwise indicated, all plant materials furnished shall be nursery-grown in accordance with the American Standards for Nursery Stock, well-branched and well-proportioned. All plants are subject to inspection and approval before planting, whereupon all plants found unsuitable shall be removed and replaced.
2. Plant substitution for those indicated on the plant list will be considered by the City upon submission of proof that any plant is not reasonably available. Substitution of a plant shall have the same appearance, ultimate height, shape, growth habit, and same soil type. In no case shall the average cost and value of the substituted plants be less than the cost and value of plants indicated.
3. Upon delivery to the site, all nursery stock shall be planted as soon as possible. Until planting, stock plants shall not be exposed to excessive sun or drying winds and watered during planting operations.

E. Setting Plants: Unless otherwise specified, all plants shall be planted in pits and shall be set so that the finish grade level after settlement will be the same as that at which plants were grown. They shall be planted upright and faced to give the best appearance and relationship to adjacent plants or structures. All trees shall be set plumb and rigidly braced in position until the soil has been tamped solidly around the ball. Plants shall be backfilled with planting soil which shall be thoroughly settled by watering and tamping to fill all voids but not compacting soil. A water basin shall be created at the base of each tree, and shall be a minimum of 4' in diameter. Side slopes shall be no greater than 3:1.

F. Cleanup: Any soil, manure or other material dropped onto paved areas by hauling operations or otherwise, shall be removed promptly, keeping these areas clean at all times. Upon completion of planting, all excess soil, stones and debris not heretofore disposed of under this scope of work, shall be removed from the site or disposed of as directed by the developer.

10.42 City projects: Site preparation for all city-maintained landscape areas shall be in accordance with Sections 425 thru 430 and 795, MAG Uniform Standard Specifications. An exception to this shall be the exclusion of the requirement in section 430.4 for polyethylene film under decomposed granite. In addition to the requirements of the Landscape Ordinance and Section 10.12, all city-maintained properties shall conform to the following turf installation requirements:

A. Materials:

1. Seed: The kind of seed planted shall be appropriate for the planting season and conditions, and shall be one of the following
 - a. Winter Lawn Seed: Shall be annual rye grass (*Lotium Multiflorum*) planted when the nighttime temperatures fall below 60 degrees; shall have a minimum percentage of purity and

germination of 95% and 88% respectively. If rye is planted, the developer must provide the Bermuduada grass seed to be used for reseeding the following summer. The Bermuda seed shall comply with requirements noted in this Section. The amount of seed shall be based on the application rate specified in Sub-section 6 b. The seed shall be delivered to the City prior to acceptance of the basin.

- b. Summer Lawn Seed: Shall be common or hybrid Bermudauda (Cynodon Dactylon) planted when the nighttime temperatures rise above 60 degrees; shall be fancy hulled seed having minimum percentage of 98% (certified), and 95% purity respectively; and a weed seed content not exceeding 0.5%.
- 2. Mulch shall be one of the following decomposed, stabilized and fortified, treated (nitrolized) wood products with no more than 1% nitrogen after treatment: fir mulch, pine mulch, or redwood mulch.

B. Soil Test in Lieu of Removing and Replacing Topsoil: The developer may request to perform grading without replacing topsoil if a specific and compelling reason is provided.. If the City concurs, upon final grading of the site, soil samples will be taken by the developer for analysis to an independent soils lab. And recommendations will be made for improving the soil. Any recommendations must be implemented by the developer and inspected by the City prior to proceeding with lawn construction.

C. Soils Moisture Content: The soils shall not be worked when the moisture content is so great that excess compaction will occur; nor when it is so dry that a dust will form in the air or that clods will not break readily. Water shall be applied if necessary to provide ideal moisture content for tilling and for planting herein specified.

D. Preparation of Seedbed: Where soil tests show that existing topsoil is satisfactory, a seedbed shall be prepared by scarifying to a depth of at least 3 inches and dragging to a smooth surface. Where existing soil is caliche type, it shall be excavated to a depth of 6 inches, removed from the site, and replaced with acceptable topsoil. Irregularities in the surface shall be leveled before seeding operations commence.

E. Surface Preparation: After raking, roll entire area in two directions at approximate right angles with a water ballast roller weighing 100 to 300 pounds. Any irregularities that develop shall be re-raked, scarified for bond, and again rolled until the area is true and uniform and free from lumps or depressions. Water shall be applied to surface whenever necessary to insure proper working and draining of soil. No heavy objects except lawn rollers shall be taken over these areas. Grade and compaction must be approved by the City prior to planting.

F. Planting:

- 1. Immediately prior to broadcasting the seed, apply and lightly rake into the surface the following:
 - a.. 5 pounds ammonium sulfate (21-0-0) per 1,000 square feet.
 - b. 15 pounds Superphosphate (0-20-0) per 1,000 square feet.
- 2. After the City has approved the areas to be seeded, the seed will be broadcast at the rate of 3-1/2 pounds Bermuda or 10 pounds of Rye seed per 1,000 square feet. One half of the seed will be sown with the sower moving in one direction and the other half shall be sown with the sower moving at right angles to the first sowing. Broadcasting shall not be done in windy weather.

G. Mulching: Top dress all seeded areas with an approved organic mulch as specified. Spread mulch evenly over all areas at a rate of one cubic yard per 1,000 square feet, or as recommended by the manufacturer, whichever is greater. Lightly roll all areas and thoroughly water with a fine spray. Turf shall then be kept continually moist by watering as often as required. Any areas that do not root properly shall be replanted at 10-day intervals until an acceptable stand of grass is obtained.

Municipality	Supplements
PH:	<p>SPRINKLER IRRIGATION SYSTEM INSTALLATION</p> <p>Section 440 Sprinkler Irrigation System Installation: delete this section in its entirety and substitute the following:</p> <p style="text-align: center;">LANDSCAPE IRRIGATION SYSTEM INSTALLATION</p> <p>440.1 GENERAL:</p> <p>The Contractor shall furnish all labor; materials, tools, equipment, and services necessary for the execution and completion of the irrigation system work as indicated on the drawings and as described in these specifications and the General Conditions.</p> <p>Due to the scale of the drawings, it is not possible to indicate all offsets, fittings and sleeves, which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such offsets, fittings and sleeves as may be required to meet such conditions. All work called for on the drawings by notes or details shall be furnished and installed whether or not specifically mentioned in the specifications.</p> <p>The work of this Section generally includes provisions of an automatic underground irrigation system including the following:</p> <p>Trenching, stockpiling excavation material, and refilling trenches.</p> <p>Complete system including but not limited to piping, backflow preventer assemblies, valves, fittings, emitters, controllers and wiring, and final adjustments to insure complete coverage.</p> <p>Replacement of unsatisfactory materials.</p> <p>Clean-up, inspection, and approval.</p> <p>Tests: The system shall efficiently and uniformly irrigate all areas and perform, as required, by the plans and specifications.</p> <p>No irrigation work is to be performed until all areas are finished to proper grade and until soil preparation is completed, and has been approved by the Engineer.</p> <p>440.1.1 Work by the Water Services Department:</p> <p>The Contractor will coordinate with the Engineer at the Preconstruction Meeting to schedule water service dates well in advance of need. The Engineer will contact the Water Services Department to authorize work required to be performed by Water Services Department crews. At least six weeks prior to need the Contractor will make application with the Water Services Department. At the time of application, the Contractor will contact the Water Services Department to schedule installation of a water tap and meter, and to provide them with his billing address.</p> <p><i>The Contractor shall pay for all water used until the project is accepted, or until completion of the Landscape Maintenance period, whichever is later, and the water meter accounts are transferred back to the City. At the close of the project, the Contractor shall submit water meter account numbers to the Engineer and request transfer of the meter to the City. The Contractor will remain responsible for water used and payment thereof, until transfer.</i></p> <p>440.1.2 Work by the Power Company:</p>

The Contractor will be responsible for coordinating with the power company to locate power drops for the irrigation controller(s), when power is not serviced by a Service Entrance Section.

Unless otherwise specified or directed by the Engineer, the Contractor will obtain an account with the utility company and will pay for all electrical power used until the project is accepted, or until completion of the Landscape Maintenance period, whichever is later, and the utility accounts are transferred. At Final Acceptance, Contractor will submit electrical meter account numbers to the Engineer and request transfer of the meter to the City, or the Contractor will remain responsible for electrical use and payment thereof, until transfer.

440.2 REFERENCES:

Conform to the requirements of reference information listed below except where more stringent requirements are shown or specified in the Contract Documents.

American Society of Testing Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.

Underwriters Laboratories (UL) - UL Wires and Cables.

440.3 QUALITY ASSURANCES:

Work involving plumbing for installation of copper piping, backflow preventer(s), and related work shall be executed by licensed and bonded plumber(s). Secure a permit at least 48 hours prior to start of installation.

440.3.1 Tolerances: Specified depths of mains and laterals and pitch of pipes are minimums. Settlement of trenches is cause for removal of finish grade treatment, refilling, re-compaction, and repair of finish grade treatment.

440.3.2 Coordinate work with other trades.

For period of one year from Final Acceptance, guarantee/warranty irrigation materials, equipment, and workmanship against defects. The Contractor shall replace any pavement damage resulting from the installation of the irrigation system and repair damage to grading, soil preparation, seeding, sodding, or planting at no additional cost to the owner. Make repairs within 3 days following notification by the Engineer.

440.3.3 Delivery Storage and Handling: During storage protect pipe from heat and sunlight. Provide shade protective cover and allow air to circulate between pipe. Transport pipe so as not to subject pipe to bending or concentrated external loads. Pipe, which is sun tanned, dented, or damaged will be rejected.

440.4 SUBMITTALS:

440.4.1 Shop drawings and product information: Prepare and make submittals in accordance with conditions of the Contract, and as follows: A minimum of ten days prior to beginning work on the irrigation system the Contractor shall submit six (6) copies of manufacturers literature. Highlight product specifics including name, and model numbers of materials listed below and any other items requested by the Engineer. Do not order materials until the Engineer approves products.

Items to be submitted:

Sprinklers (Turf heads, Shrub
bubblers and emitters)
Pipe & Fittings
Swing joint assemblies
Fittings and Solvents
Gate Valves
Valve Boxes, pull boxes, et al.

Backflow Preventers
Automatic Valves
Controllers
Quick coupling Valves
Wire and Connectors
Wye Strainers
Pressure Regulating Valves

Flow meters
Flushcaps
Micro tubing & stakes

All items shall be those specified and approved by the Engineer. Substitutions will not be allowed without approval.

440.4.2 Record Drawings: The Contractor shall maintain an accurate set of as-built plans on site. At the end of each day work accomplished shall be updated on the as-built plans. The Contractor shall dimension from two permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following:

- a. Connection to existing water lines
- b. Connection to existing electrical power
- c. Gate valves
- d. Routing of Sprinkler pressure lines (dimension at a minimum of 100 feet along routing)
- e. Emitter control valves
- f. Routing of control wiring
- g. Quick-coupling valves
- h. Other related equipment as directed by the Engineer

The Contractor shall indicate any non-pressure pipe routing changes on the as-built drawings.

Before the final inspection, the Contractor shall deliver to the Engineer one copy of the as-built plans to review. Delivery of this set of plans does not relieve the Contractor of the responsibility of furnishing required information that may be requested by the Engineer. The Contractor shall make corrections noted and submit final as-built plans to the Engineer for approval and acceptance. The Engineer will not certify payment requests or make final payment if as-built plans are not current or complete.

440.4.3 Controller Charts: As-Built drawings shall be approved by the Engineer before controller charts are prepared. The chart shall show the area controlled by the automatic controller and shall be 24" x 36" sheet size, unless a reduced size is approved by the Engineer. Identify the area of coverage of each remote control valve, using a distinctively different color, drawing over the entire area of coverage. Following review of the charts by the Engineer, they shall be hermetically sealed between two layers of 20 mm thick plastic sheets. These charts shall be completed and approved prior to final inspection of the irrigation system. When approved by the Engineer a separate card listing stations and areas covered may be substituted for the 24" x 36" hermetically sealed plan sheet(s).

440.4.4 Operation and Maintenance Manuals: Submit four (4) operation and maintenance manuals to the Engineer for review prior to final acceptance. The manuals should include the complete technical description of materials and products used, guarantee statement, complete operating and maintenance instructions on all major equipment. Contractor to provide a demonstration to maintenance personnel, with the Owner's Representative present, of how to adjust and maintain all sprinkler head types, controller functions, and recommended controller programs, as established by the Contractor. Contractor is also to review recommended watering rates for new plant materials.

440.4.5 Equipment to be furnished: All materials to be new and bear the appropriate National Association seal of approval for example, NSF, UL. etc. Similar units shall be procured from the same manufacturer and internal parts shall be common and interchangeable. Parts listing and source replacement will be furnished to the Engineer.

Equipment to be furnished:

- a. Two sets of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied to the project.
- b. Two quick-coupler keys and matching hose swivels for each type of quick-coupling valve installed.
- c. One five foot valve key for operation of gate valves

Extra Stock to be furnished:

- a. 2 sprinklers of each type and 5 nozzles of each precipitation rate.
- b. 2 bubblers of each flow rate used.
- c. 5 Single Port Emitters of each flow rate used.
- d. 2 Multi-port Emitters of each flow rate used.

The above mentioned equipment and stock shall be turned over to the Owner at the conclusion of the project. Before final inspection, evidence that the Owner has received this material must be provided to the Engineer.

440.5 PERMITS:

All permits for installation or construction of the work included under this section, which are required by legally constituted authorities having jurisdiction, shall be obtained and paid for by the Contractor, each at the proper time. He shall also arrange for and pay all costs in connection with any inspections and examinations required by these authorities.

440.6 EXECUTION:

Examine areas and conditions under which work of this section is to be performed. Do not proceed with work until unsatisfactory conditions have been corrected.

440.6.1 Staking: Mark the routing of the pressure supply line with powdered lime, and stake the locations of various components. Coordinate locations with other trades. Coordinate sleeving with other trades. Preliminary adjustments to conform to actual site conditions shall be accomplished during staking. Should changes be required, the Contractor shall obtain approval of the Engineer prior to actual work being performed. Utility connections, both water and electrical, shall be as shown on the plans or as designated by the utility concerned.

440.6.2 Trench Excavation: Trenches and other excavations shall be sized to accommodate the irrigation system components, conduit, and other required facilities. Additional space shall be provided to assure proper installation and access for inspection. Unless otherwise specified, the minimum depth of cover over pipelines and conduits shall be as follows:

- a. Electrical conduit - 18 inches cover
- b. Waterlines continuously pressurized - 18 inches cover
- c. Lateral sprinkler lines - 12 inches cover
- d. Plastic lines under pavement - 24 inches cover

The bottom of the trenches shall be true to grade and free of protruding stones, roots or other matter, which would prevent proper bedding of pipe or other facilities. Where ledge rock, hard pan, or boulders are encountered, the trench bottom shall be undercut and filled with sand or fine

grained material approved by the Engineer.

Clearances:

- a. Piping 3" and larger - minimum trench width of 12 inches.
- b. Piping smaller than 3" - minimum trench width of 7 inches.
- c. Provide not less than 4 inches of clearance between each line, and not less than 12 inches of clearance between lines of other trades, to permit service or replacement without disturbing the other line.

Grading and Stockpiling of trenched materials shall comply with City of Phoenix Supplement to MAG Section 601.

440.6.3 Sleeving: Piping located under asphalt, concrete, or other pavements shall be sleeved, size and schedule as noted on the plan. If not noted, sleeves shall be Schedule 40, sized to easily accommodate piping. Use separate sleeve for wiring.

Boring will be permitted only where pipe must pass under obstructions, which can not be removed, or when approved by the Engineer. When any cutting or removal of asphalt and or concrete work is necessary, it shall be saw cut in accordance with City of Phoenix Supplement to MAG Section 601. Permission to cut asphalt or concrete shall be obtained from the Engineer. When piping on the drawings is shown in paved areas, but running parallel and adjacent to planted areas, the intent of the drawings is to install the piping in the planted area.

440.6.4 Piping: Provide pipe, schedule and size as shown on the drawings and per these specifications.

PVC Pipe: Snake pipe in trench as much as possible to allow for expansion and contraction. Provide a firm, uniform bearing for the entire length of each pipeline to prevent uneven settlement. Installation of pipe shall be installed in accordance with ASAE Standard: ASAE 376. Pipe shall be clean prior to installation and shall be maintained in that condition during installation. When pipe lying is not in progress, the open ends of the pipe shall be closed by approved means.

Sand bedding or fine-grained material shall be provided where ledge rock, hard pan, or boulders are encountered. Compact bedding material to provide a minimum depth of bed between pipe and rock of 4 inches.

Solvent welded joints shall be made in accordance with ASTM D-2855, and the type of solvent and primer recommended by the pipe manufacturer shall be used. Primer and solvent shall be applied to the pipe ends in such a manner that no material is deposited on the interior surface or forced into the interior of the pipe during insertion. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly. The pipeline will not be exposed to water for at least 12 hours after the last solvent welded joint has been made.

Schedule 80 pipe shall be used for threaded joints. Field threading shall be accomplished in the same manner as specified for steel pipe, except that a plug will be installed in the bore of the pipe prior to threading to prevent distortion. Solvent will not be used on threaded pipe. Threaded joints shall be hand tightened with final tightening as necessary to prevent leaks with a strap wrench.

The pipe shall be protected from damage during assembly. All vises shall have padded jaws and only strap wrenches will be used. Any plastic pipe, which has been nicked, scarred, or otherwise damaged, shall be removed and replaced. Care shall be exercised so that stress on a previously made joint is avoided.

When PVC to metal pipe connectors are required, these connections shall be accomplished first. A plastic adapter with external pipe threads should be used, screwing it into the metal internal pipe

threads. Use a non-hardening pipe dope, such as Permatex #2, or equal, on all plastic to metal threaded joints. The joint shall be hand-tightened. Utilize a light wrench, as necessary, to prevent leaks.

When wrapped pipe is specified, joints and connectors shall not be wrapped until completion of the pressure test.

Use 45 degree fittings at all changes in depth of pipe. Couplings to be schedule 80 unless otherwise noted. Minimum length of PVC nipple shall be 3 inches.

440.6.5 Wiring:

Service wiring shall be installed in rigid conduit from the service point to the controller at the minimum depth specified. A separate disconnect switch or combination meter socket, as required, shall be installed between the source of power and the controller. The minimum Service wire shall be No. 12 AWG copper 600 volt type, TWH or larger, as required by the contract documents or controller manufacturer. Wire splices for Service wiring shall be located in pull boxes where required to facilitate installation of wiring. Pull Boxes shall be plastic, except where subject to vehicular traffic, concrete rated boxes shall be required. Service wiring shall be per current Local, State, National NEC requirements.

Low Voltage Control Wiring issuing from the controller shall be direct burial, type UF, No.12 AWG copper, unless otherwise required and installed in main or lateral waterline trenches wherever practical. Install common ground wire (type UF No. 12 AWG Copper) and one pilot or hot wire (type UF No. 14 AWG Copper) for each remote control valve (These are minimum wire sizes allowed when not noted otherwise on plans.). Multiple valves on a single control wire are not permitted.

Install two (2) control wires along the entire length of the mainline. Locate wire adjacent to main line piping. Never place wire on top of pipe. Bundle wires at 10 foot intervals with plastic electrical tape. Sufficient slack shall be left in the wiring to provide for expansion and contraction. Provide 12" loop (2 feet) at all changes in direction or at a minimum of 250 feet. When control wiring cannot be installed in the pipe trench it shall be installed a minimum of 18 inches below finish grade. Attach wire markers to the ends of the control wires and label valve stations at controller locations.

All pilot or "hot" wires are to be of a different color and all common wires are to be of another (common) color. If multiple controllers are being utilized, and wire paths of different controllers cross both common and control wires, from each controller, shall be of different colors.

Splices in control wire shall be made only in Junction Boxes with approval from the Engineer. Splices shall be made with waterproof connector, approved for underground use. Sufficient slack shall be left to allow splices brought to the surface without disconnecting the wire. No splices shall be permitted under pavements.

All wiring shall be tested for continuity, open circuits, and unintentional grounds prior to connecting the equipment. All controllers shall be grounded independent of any other controller as recommended by the controller manufacturer, and all valves shall be connected to the common ground wire of their respective controller. A single separate pilot or hot wire (different color) shall be extended from the valve to the specified controller. Low voltage wire splices outside of the valve box are not permitted, unless approved by the Engineer, at which case they must be made in a PVC Pull Box.

One spare #12 AGW wire "Pilot" (orange) and one #12 "Common" wire, (total 2 - #12 wires) shall be installed from the controller along the entire length of pressure lines to last (farthest) electric control valve on each and every leg of mainline. Color of spare control wire to be of an

alternate color. Provide 3 foot length of all spare wires in each remote control valve box along wire routing.

440.6.6 Valves, Valve Boxes, and Special Equipment:

Backflow Preventer Assembly: The Backflow Prevention assembly shall be installed per the details shown on the drawings and associated governing code requirements. Provide pipe supports and the accessories to properly secure the assembly. The irrigation system shall not be operated until the assembly has been tested and certified to meet the requirements of the Water and Wastewater Department - Water Quality Section.

After the backflow assemblies have been properly installed by the Contractor and approved by Development Services Department - Building Safety Division, the Contractor shall pay for testing and be responsible for having the assembly(ies) tested by a certified backflow prevention assembly tester, approved by the City. The tester shall prepare test report(s), showing the condition of the assemblies and confirming that the assemblies are properly functioning. It is the Contractors responsibility to submit the forms to the Engineer and to Water Quality Division, Backflow Prevention Unit. Final acceptance will not be given until the reports are approved by the Engineer.

Valves, Pressure Regulators, and Related Accessories shall be installed as shown on the plans, or as specified. They shall be installed in a normal upright position unless otherwise recommended by the manufacturer, and shall be readily accessible for operation, maintenance and replacement. The equipment shall be set at a sufficient depth to provide clearance between the valve box cover and the valve handle, cap, or key for operation of the system.

Gate Valves and Isolation Valves shall be installed below ground and shall be housed in a concrete or plastic pipe, with bolt down locking cover that will permit access for servicing. The pipe shall be centered on the valve stem. Isolation valves shall not be located within range of the sprinklers they control without approval of the Engineer.

Drain Valves shall be installed at all low points in pressure supply line as detailed. Provide drainage sump for each drain valve based on the table below:

CUBIC FEET OF GRAVEL PER DRAIN VALVE
DISTANCE OF PIPING TO BE DRAINED

Pipe Size	0-250 LF	251-500 LF	501-750 LF	751-1000 LF
1"	0.75	1.50	2.25	3.00
1-1/4"	0.75	1.50	2.25	3.00
1-1/2"	1.50	3.00	4.50	6.00
2"	2.50	5.00	7.50	10.00
2-1/2"	4.00	8.00	12.00	16.00
3"	6.00	12.00	18.00	24.00
4"	11.00	22.00	33.00	44.00
6"	25.00	50.00	50.00	50.00

Quick Couplers and Hose Bibcocks shall be installed as shown on the plans, or as specified. Their location shall be a minimum of 3 feet from curbs, pavements and walks, unless approved

otherwise by the Engineer. Hose bibcocks shall be set 12 inches above finish grade and installed on a galvanized riser or as detailed.

Quick Coupler Assemblies: shall have double swing joint mobility to allow for full and optimal positioning. A pre-manufactured swing joint assembly as manufactured by Lasco Inc., or approved equal is specified. All quick couplers shall be set perpendicular to finish grade unless otherwise designated on the plans or instructed by the Engineer.

Valve Boxes: Install one valve box for each valve installed as shown on the plans, or specified unless directed otherwise by the Engineer. Install gravel sump after compaction of all trenches. Place final portion of gravel inside valve box after valve box is backfilled and compacted. Set valve boxes 1/2 inch above finish grade.

The valve boxes shall be branded with the controller letter and station number of the contained valve. The letter and number size shall be no smaller than 1 inch and no greater in size than 1-1/2 inches. Depth of branding shall not be more than 1/8 inch into the valve box lid. All labeling shall be neat and legible.

440.6.7 Sprinklers, Bubblers, and Emitters

Sprinklers, Bubblers, and Emitters: Install where indicated on the drawings, staked and approved. Set to finish grade as detailed; spacing of Sprinklers shall not exceed maximum recommended by the manufacturer without approval of the Engineer. Assemblies shall be installed as detailed, provide at least 4 inches clearance from vertical elements projecting above grade such as walls, planter boxes, curbs, and fences.

Turf Heads Assemblies shall have double swing joint mobility to allow for full and optimal positioning. A pre-manufactured swing joint assembly such as that manufactured by Lasco Inc., or approved equal is specified. All sprinkler heads shall be perpendicular to finish grade unless otherwise designated on the plans or instructed by the Engineer. Install for head to head coverage and uniform distribution throughout the turf area.

Plant Bubbler Assemblies shall consist of a horizontal connection to the lateral line with 1/2" S.D.R. 13.5 PVC lateral extension, schedule 40 fittings, and 1/2" flex hose riser (sch 40) with male adaptor (slip x thread) to receive the bubbler. Install bubbler assemblies as detailed on the plans. Locate the top of bubbler:

- a. 1" above finish grade in shrub beds.
- b. In turf areas - provide 4" diameter (times 12" long) PVC class 200 vertical sleeve filled with pea gravel. Install bubbler 3" below top of sleeve. Set top of pipe flush with finish grade of turf.

Emitter Assemblies provide a horizontal connection to the lateral line using schedule 40 PVC fittings and PVC to flex adapters (slip x slip), 1/2" schedule 40 flex tubing (max. length, 20') and slip x threaded male adaptor to receive the emitter. Emitter outlets shall be installed to the high side of the plant. Provide a minimum of 1 outlet per shrub, and 3 outlets per tree, equally space around the plant, unless otherwise noted in the plans. Single port emitters shall be located 1 inch above grade as detailed. Multi-port emitters shall be located below finish grade, as detailed, and the distribution tubing staked in place then covered with 2 inches of mulch. The distribution tube outlet end shall be exposed above the soil/mulch surface to water the root ball of the plant.

440.6.8 Controller System: The controller and accessories shall be installed at the locations designated and per the details shown on the contract documents. Submit shop drawings of components.

Controllers located outdoors shall be installed in cabinets specifically design to house the

controller, or as detailed on the plans. The concrete pad for controller enclosures shall be Class B, size shall be as shown, or if not shown, as recommended by the manufacturer. All copper pipe in contact with concrete shall be type k copper and sleeved or wrapped with "Scotchwrap #50" or equal minimum thickness 40 mils.

Controllers located in building: Prepare an elevation plan detailing placement of equipment, conduit, sleeves and wire gutter runs to the Engineer, for approval. Stub out all conduit 2 feet beyond concrete foundations or walls and provide bushings for all conduit. All RGS conduit in contact with earth, shall be wrapped with "Scotchwrap #50, or equal, minimum thickness 40 mils.

440.6.9 Pipe bedding, backfill, and compaction:

Bedding: Pipe shall be bedded in at least 4 inches of finely graded native soil or sand to provide a firm uniform bearing. After laying, the pipe shall be surrounded with additional finely grained native soil, or sand, then covered with not less than 4 inches of the same material. Bedding sand shall be required when site conditions dictate and clean finely grained native soil is not available. Contractor shall verify site conditions and satisfy his concern prior to bidding, no separate payment shall be made for bedding sand.

Backfill trenches and excavations with clean material. Remove organic material, as well as rocks larger than 1 inch in diameter. Place acceptable backfill material in lifts, the height of which shall not exceed that which can be effectively compacted, pending on the type of equipment and methods used. Trenches and excavations shall be backfilled to match Engineered earthwork sections.

Partially backfill the irrigation trenches and pressure test the system, prior to completing backfill operations. Center load the pipe with sufficient backfill to hold the line in place, keeping the joints exposed for observation until completion of testing.

Compaction shall be in accordance with MAG Section 301. Water settling of the trenches is not permitted unless approved by the Engineer.

440.6.10 Cleaning: Maintain continuous cleaning operations throughout the duration of the work. Dispose of, off-site at no additional cost to the Owner, all trash or debris generated by installation of the irrigation system.

440.7 FLUSHING AND TESTING:

After completion and prior to the installation of any terminal fittings, the entire pipeline system shall be thoroughly flushed to remove all foreign material. After flushing, the following tests shall be conducted in the sequence listed below. All equipment, materials, and labor necessary to perform the tests shall be furnished by the Contractor, and all tests shall be conducted in the presence of the Engineer.

Pipeline Pressure Test: A water test shall be performed on all pressure mains. Pressure mains shall be tested with all control valves installed and in the closed position. The constant test pressure and duration of the test shall be for 6 hours at 125 psi. Any leaks, which occur during the test period, will be repaired immediately following the test. The pressure mains will then be re-tested until accepted by the Engineer.

Sprinkler Coverage Test: The coverage test shall be performed after the sprinkler heads have been installed and shall demonstrate that each section or zone in the irrigation system is balanced to provide uniform and adequate coverage of the areas served. The Contractor shall correct any deficiencies in the system.

Operational Test: The Contractor shall perform an operational test of the system to ensure proper

and even distribution of water to all plants. Adjust or replace any type of irrigation equipment not operating correctly prior to the walk-through inspection.

440.8 PRELIMINARY, SUBSTANTIAL AND FINAL WALK-THROUGH INSPECTIONS:

Arrange for a preliminary walk-through with the General Contractor's Superintendent, when the entire system is operational. Operate each zone in its entirety, additionally, open all valve boxes and expose items covered, if directed. Generate a list of items to be corrected and make adjustments, "fine tuning" the entire system by regulating valves, adjusting patterns and break-up devices, and setting pressure regulators at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all outlet devices for optimum performance and to prevent run-off or spray on to walks, roadways, and buildings.

Arrange for a Substantial Completion walk-through with the Engineer when all items generated from the preliminary walk-through have been corrected. Items deemed not acceptable by the Engineer shall be reworked to complete satisfaction. The Landscape Maintenance Period will not begin unless the irrigation system is operating correctly and until authorization by the Engineer. All accessories, charts, record drawings and equipment, as required, will be provided before scheduling the Final walk-through.

Following the Landscape Maintenance Period a Final walk-through inspection will be scheduled to review the system and make adjustments to the watering schedules.

440.9 MEASUREMENT AND PAYMENTS:

Measurement and payment shall be in accordance with the General Conditions. The lump sum established in the schedule of values shall be full compensation for furnishing all labor, materials, tools and equipment, and performing all work necessary for completion of the irrigation system described or specified in the contract documents.

When unit bid items are included in the proposal sheets, the unit prices quoted shall include the following items of work and material.

- (A) Water Service Tap and Meter: The work under this item will be performed by the City of Phoenix Water and Wastewater Department and consists of furnishing and installing a curb stop, concrete meter box with cover, tap to main and pipeline to the curb stop at the locations and in accordance with the details shown on the plans. The curb stop and water meter box will be paid for under this item. Payment will be made at the current price for this service as charged by the City of Phoenix. With some projects an allowance may be shown in the bid proposal for this item, reference Section 440.1.1.
- (B) Backflow Prevention Unit: The unit price for this item shall include the backflow prevention unit, locking cage assembly, risers and concrete thrust blocks, complete and in place.
- (C) Electrical Remote Control Valve and Assembly: The unit price for this item shall include the valve, the valve box with stainless steel hex bolt secured cover, pea gravel and specified pipe to the meter or backflow prevention unit.
- (D) Sprinkler Controller: The unit price for this item shall include:

Cost of sprinkler controller (automatic);

All wiring for a complete underground control system, including trenching, wire, conduit, boring or jacking;

	<p>Steel security cabinet with concrete base, grounding system, metal hasp and padlocks, and all wiring within the cabinet unless controller is placed on a building or within a walled enclosure.</p> <p>The junction box and any work and materials required from the stub out provided by the power company in order to complete the installation of the controller.</p> <p>(E) Irrigation Pipe: The contract price for this item shall include the pipe and fittings, trenching, backfilling and any necessary boring or jacking to install the pipe. Sleeves shall be Schedule 40.</p> <p>(F) Pull Box: The contract price for this item shall include the pull box (plastic irrigation valve box with stainless steel hex bolt secured cover).</p> <p>(G) Sprinkler Head: The contract price for this item shall include the head and all fittings, nipples, and risers from lateral to the head.</p>
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Municipality	Supplements
SC	<p>▪ MAG Section 440 SPRINKLER IRRIGATION SYSTEM INSTALLATION is deleted in its entirety and the <i>Following section substituted:</i></p> <p style="text-align: center;">SECTION 440</p> <p style="text-align: center;">IRRIGATION SYSTEM INSTALLATION</p> <p>440.1 SUMMARY</p> <p>A. This Section includes piping, sprinklers, specialties, and accessories for the installation of irrigation systems.</p> <p>440.2 DEFINITIONS</p> <p>A. Pipe sizes used in this Section are nominal pipe size (NPS) in inches. Tube sizes are Standard size in inches.</p> <p>B. Lateral Piping: Piping downstream from control valves to irrigation system sprinklers, emitters, devices, and drain valves. Piping is under pressure only during flow.</p> <p>C. Pressure Piping: Piping downstream from supply piping to and including control valves. Piping is under irrigation system pressure. Piping in this category includes pressure regulators, water meters, and backflow preventers, when used.</p> <p>D. Control Valve: Manual or automatic (electrically operated) valve for controlling water flow to irrigation system zone.</p> <p>E. Drain Piping: Downstream from lateral piping drain valves. Piping is not under pressure.</p> <p>440.3 SYSTEM PERFORMANCE REQUIREMENTS</p> <p>A. Location of Sprinklers and Devices: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards.</p>

B. Minimum Water Coverage:

1. Turf Areas: 200%, head to head coverage
2. Other Planting Areas: 100 percent emitter coverage.

C. Components and Installation: Capable of producing piping systems with the following minimum working pressure ratings except where indicated otherwise.

1. Pressure, Lateral and Drain Piping: 200 psig.

440.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract

B. Material List

1. Furnish the articles, equipment, materials, or processes specified by name in the drawings and specifications. No substitution will be allowed without prior written approval by the Owner's Representative from COS Parks Department.
2. Complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, model number and description of all materials and equipment to be used.
3. Equipment or materials installed or furnished without Prior approval of the Owner's Representative from COS Parks Department may be rejected and the Contractor required to remove such materials from the site at his own expense.
4. Approval of any item, alternate or substitute indicates only that the product or products apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted.

C. Record Drawings

1. The Contractor shall dimension from two permanent points of reference (building corners, sidewalk or road intersections, etc.) the location of the following items:
 - a) connection to existing water lines.
 - b) connection to existing electrical power.
 - c) isolation valves.
 - d) routing of irrigation pressure lines (dimension maximum 100' along routing).
 - e) irrigation control valves.
 - f) routing of control wiring.
 - g) quick-coupling valves.
 - h) other related equipment as directed by the COS Parks Department Representative.

440.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handling of PVC Pipe and Fittings: THE CONTRACTOR shall store in covered areas, not exposed to outside elements, and is cautioned to exercise care in handling, loading, unloading, and storing of PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented or damaged will be discarded and, if installed, shall be replaced with undamaged piping.

440.6 GUARANTEE

- A. The guarantee for the irrigation system shall be made in accordance with the form shown below. A copy of the guarantee form shall be included in the operations and maintenance manual. The guarantee form shall be retyped onto the Contractor's letterhead and contain the following information:

GUARANTEE FOR IRRIGATION SYSTEM

We hereby guarantee that the sprinkler irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the drawings and specifications. We agree to repair or replace any defects in material or workmanship which may develop during the period of two years from conclusion of maintenance period, and also to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within 10 working days, as determined by the Owner, after receipt of written notice. In the event of our failure to make such repairs or replacements within specified time after receipt of written notice from the Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefore upon demand.

PROJECT:
LOCATION:

SIGNED:
Contractor
ADDRESS:

PHONE:

DATE OF ACCEPTANCE:

440.7 QUALITY ASSURANCE

- A. Comply with requirements of utility supplying water for prevention of backflow and backsiphonage.
- B. Comply with requirements of authority with jurisdiction for irrigation systems.
- C. Installer Qualifications: Engage an experienced Installer who has completed irrigation systems similar in material, design, and extent to that indicated for Project, and that have resulted in construction with a record of successful in-service performance.
- D. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.
- E. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled shall meet the following guidelines:
 - 1. The Terms "Listed" and "Labeled": as defined in "National Electrical Code," Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- F. Product Options: Irrigation system piping, specialties, and accessories are based on specific types, manufacturers, and models indicated. Components with equal performance characteristics produced by other manufacturers may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by the Owner's Representative in COS Parks Department. The burden of proof of product equality is on the Contractor.

440.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Verify

that irrigation system piping may be installed in compliance with original design and referenced standards.

- B. Site Information: Reports on subsurface condition investigations made during design of the Project are available for informational purposes only; data in reports are not intended as representations or warranties of accuracy or continuity of conditions (between soil borings). **Owner assumes no responsibility for interpretations or conclusions drawn from this information.**

440.9 SEQUENCING AND SCHEDULING

- A. Maintain uninterrupted water service to building during normal working hours. Arrange for temporary water shutoff with Owner.
- B. Coordinate irrigation systems work with landscape work.

440.10 EXTRA MATERIALS

- A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and label clearly describing contents.
1. Quick Couplers: Furnish one unit of each size installed.
 2. Sprinklers Heads: Furnish quantity of units equal to 10 percent of amount of each type installed.
 3. Emitters, Drip Tube, and Devices: Furnish quantity of units equal to 10 percent of amount of each type installed.
 4. Valve Keys: Furnish one unit of each type key-operated, control valve installed.
 5. Quick-Coupler Hose Swivels: Furnish quantity of units equal to 25 percent of amount of each type quick coupler installed.
 6. Quick-Coupler Operating Keys: Furnish quantity of units equal to 25 percent of amount of each type quick coupler installed.
 7. Motorola irrigation controllers: Furnish one controller keypad per project.
 8. Solar irrigation controllers: Furnish one controller programming/access key per project.

440.11 MATERIALS

- A. General: Use only new materials of brands and types noted on drawings, specified herein, or approval equals.
- B. PVC Pressure Mainline Pipe and Fittings (Pressure mainline piping 3" and smaller shall be PVC Schedule 40, 4" and above shall be Class 200, *DR14, C900 with restrained bell ends per manufacturers specification*).
1. *Pipe shall be made from NSF approved Type I, Grade I PVC compound conforming to ASTM specification D 2241. Piping 3" and under shall be SDR solvent weld. Piping over 3" shall be gasketed with ductile iron mechanical joints on all fittings with Megalug joint restraints.
 2. PVC solvent-weld fittings shall be Schedule 80, 1-2, II-I NSF approved conforming to ASTM test procedure D2467.
 3. Solvent cement for PVC solvent weld pipe and fittings shall be as manufactured by "Weld-On" Type 721 or approved equal. Solvent cement for Schedule 80 flex hose shall be "Weld-On" Type 795 or approved equal.
 4. Solvent primer for PVC solvent weld pipes and fittings shall be "all purpose primer" (purple) for PVC and PVC pipe and fittings, Type P-70.
 5. Installation methods of solvent cement and primer for PVC solvent-weld pipe and fittings shall be as prescribed by the manufacturer.
 6. All PVC pipe shall bear the following markings (pipe to be installed with markings face-up for inspection purposes):

- a) manufacturer's name.
- b) nominal pipe size.
- c) schedule or class.
- d) pressure rating in psi.
- e) National Sanitation Foundation (NSF) approval.
- f) date of extrusion.

- 7. All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable IPS schedule and NSF seal of approval.
- 8. Thrust blocks to be installed per COS Std Detail 2643.

C. PVC Non-Pressure Lateral Line Piping (Including Emitter Lateral Piping)

- 1. Non-pressure buried lateral line piping shall be PVC Class 200 solvent-weld joints for sizes 3/4 and larger. Pipe size 1/2" shall be Class 315.
- 2. Pipe shall be made from NSF approved, Type I, Grade I PVC compound conforming to ASTM resin specification D2241. All pipe shall meet requirements set forth in Federal Specification PS-22-70, with an appropriate standard dimension ratio.
- 3. PVC solvent weld fittings for non-pressure lateral line piping shall be Schedule 40, NSF approved conforming to ASTM test procedure D-2466.
- 4. Except as noted in paragraphs 1, 2 and 3 of Section 440.11.C, all requirements for non-pressure lateral-line pipe and fittings shall be the same as for solvent-weld pressure mainline pipe and fittings as set forth in Section 440.11.B of these specifications.

D. Brass Pipe and Fittings

- 1. Where indicated on the drawings, use red brass screwed pipe conforming to Federal Specification #WW-P-351.
- 2. Fittings shall be red brass conforming to Federal Specification #WW-P-460.

E. Copper Pipe and Fittings (Any pipe exposed to elements/above grade)

- 1. Where indicated on drawings, use copper pipe conforming to all requirements of ASTM B-88 Type K.
- 2. All copper pipe shall be new, seamless copper pipe designed for underground water service plumbing purposes, etc.

F. Isolation Gate Valves:

- 1. Gate Valves 2 in. and Larger:

- a) shall be iron body, rubber encapsulated resilient wedge and shall conform to specifications of American Water Works Association Standard C509.
- b) shall have 2 in. square operating nut with arrow cast in metal indicating direction of opening.
- c) shall have ends compatible with pipe in which they are being installed.
- d) shall be similar to those manufactured by Waterous Valve Mfg. Co., or approved equal.

- 2. Other Isolation Valves (1-1/2" and smaller):

- a) isolation valves 1-1/2" and smaller shall be ball valves
- b) approved valves will be 2 piece and constructed of forged brass body and end adapter
- c) ball shall be full port, chrome plated brass
- d) seats and stem packing shall be virgin PTFE
- e) stem shall be brass with adjustable stem packing nut threaded to body to prevent stem leakage if lever is removed
- f) valves shall be rated 600 psi WOG and 150 psi WSP
- g) valves shall be equal to WATTS FBV-3

G. Quick-Coupling Valves: Quick-coupling valves shall have a brass two-piece body designed for working pressure of 150 psi. Key size and type shall be 1" or #44.

H. Control Wiring:

1. Connections between the automatic controllers and the electric control valves shall be made with direct burial copper wire AWG-UF 600 volt. Pilot wires shall be a different color wire for each automatic controller. Common wires shall be white with a different color stripe for each automatic controller. Install in accordance with valve manufacturer's specifications and wire chart. In no case shall wire size be less than #14.
2. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply piping. All remote control valve wiring not installed with mainline pipe shall be installed in a minimum 2" diameter schedule 40 grey electrical conduit or as approved.
3. Where more than one wire is placed in a trench, the wiring shall be taped together in bundle at intervals of 10 feet. Provide loose 20" loop at all changes in direction over 30°.
4. An expansion curl shall be provided within three feet of each wire connection. Expansion curl shall be of sufficient length at each splice connection at each electric control valve, so that in case of repair, the valve bonnet may be brought to the surface without disconnection of the control wires. Control wires shall be laid loosely in trench without stress or stretching of control wire conductors.
5. *All splices shall be made with *Spears DS-100 Dri-Splice connectors and DS-300 sealant*. Grease filled splices are not allowed.
6. Field splices between the automatic controller and electrical control valves will not be allowed without prior approval of the Owner's representative from COS Parks Department.
7. All control wire under paving or structures shall be sleeved in Schedule 40 PVC Pipe. Size as required or as shown on the drawings. Minimum size shall be 2".
8. Sleeve wire and pipe separately during installation.

I. Automatic Controllers (Only Motorola Irrinet, Scorpio or solar controllers are to be installed):

1. 120 Volt
 - a. The controller(s) shall be installed in lockable, weather-resistant, stainless steel Lamax cabinet or approved equal per COS Std. Detail 2631, 2632, 2633 and 2634.
 - b. Final location of automatic controllers shall be approved by the Owner's Representative from COS Parks Department.
 - c. The 120-volt electrical power to the automatic controller location is shown on the drawings. The final electrical hookup shall be the responsibility of the irrigation contractor.
 - d. Location of power source for the controller to be noted on circuit breaker panel inside controller cabinet.
 - e. The programming keypad shall be supplied with Motorola Irrinet and Scorpio controllers.
2. Solar
 - a. Solar controllers are only to be installed with prior written consent by the Owner's Representative from COS Parks Department.
 - b. Only DIG "Leit 4000" solar controllers are to be installed per COS Std. Details 2635-1 and 2635-2.
 - c. Install wire, connectors, sealant, solenoids, adapters and security enclosure per manufacturer's instructions.
 - d. Final location of solar controllers shall be approved by the Owner's Representative from COS Parks Department.
 - e. Programming/access key shall be supplied with the controller.
 - f. **The controller shall be secured inside the manufactures security enclosure if not installed inside the backflow preventer enclosure.*

J. Electric Control Valves:

1. Install Rainbird Series GB valves for domestic water applications and Rainbird PESB valves for reclaimed water, or approved equal.
2. All electric control valves shall be compatible with the automatic controllers.
3. All electric control valves shall have a manual flow adjustment and a brass full port ball valve installed for isolation purposes.
4. Provide and install one control valve box for each electric control valve.
5. One valve per main line tap.
6. Each control valve installed shall have a 1-1/2 inch round brass ID tag with corresponding station number of the valve stamped on it. The tag shall be attached to the valve stem with #10 gauge non-insulated copper wire.

K. Control Valve Boxes:

1. Minimum size to be 16" x 12" x 12" outside dimension. Provide for all valves.
2. Provide valve box with red brick pavers at corner of each portion of the valve box.
3. Boxes shall be Carson/Brooks or approved equal with locking "T" style cover supplied with stainless steel bolts.
3. Provide 6" pea gravel sump below valve body.
4. Install H-20 traffic rated boxes in high traffic areas as determined by the City of Scottsdale.
5. A H-20 traffic rated vault shall be installed for 3 inch and larger master valves.

L. Sprinkler Heads:

1. All sprinkler heads shall be of the same size, type, and deliver the same rate of precipitation with the diameter (or radius) of throw, pressure, and discharge as shown on the plans and/or specified in these special provisions.
2. Riser units shall be fabricated in accordance with COS Std. Details 2644, 2645 and 2646.
3. Swing joints for all sprinkler heads shall be the same size as the riser opening in the sprinkler body.
4. All sprinkler heads of the same type shall be of the same manufacturer.
5. Pre-fabricated swing joints and Marlex fittings will not be allowed.

M. Detectable Tape:

1. Detectable tape shall consist of 0.4mil thick solid foil core, encased in a protective plastic jacket that is resistant to alkalis, acids and other destructive elements commonly found in soil. The lamination shall have sufficient strength that the layers cannot be separated by hand. The total composite thickness shall be 4.3 mils minimum. The foil core is to be visible to ensure continuity.
2. Detectable tape shall have a minimum tensile strength of 63 lbs in the machine direction and 68 lbs in the transverse direction per three-inch strip.
3. A continuous warning message "Non-Potable", repeated every 16 to 36 inches, shall be imprinted on the tape surface. The tape shall be colored: designating the code appropriate to the type of line which the tape is protecting with name brand facing up to indicate location.
4. *The tape shall be installed *12 inches above the top of pipe* on all pressurized main lines.

440.12 EXECUTION

440.12.1 INSPECTION

A. Site Conditions:

1. All scaled dimensions are approximate. The Contractor shall check and verify all size dimensions and receive Owner's Representative from COS Parks Department approval prior to proceeding with work under this Section.
2. Exercise extreme care in excavating and working near existing utilities and irrigation systems.

Contractor shall be responsible for damages to utilities and irrigation systems which are caused by his operation or neglect. Check existing utilities drawings for existing utility locations. Contact Owner's Representative from COS Parks Department for existing irrigation system locations (480-312-2189).

3. Coordinate installation of irrigation materials, including pipe, so there shall be no interference with utilities or other construction or difficulty in planting trees, shrubs, and ground covers.
4. The Contractor shall carefully check all grades to satisfy himself that he may safely proceed before starting work on the irrigation system.
5. No irrigation will be installed unless final grade is (+-) 1" above/below final grade as indicated on the drawings.

440.12.2 PREPARATION

A. Physical Layout:

1. Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of sprinkler heads.
2. All layout shall be approved by Owner's Representative from COS Parks Department prior to installation. Call (480)312-2189.

B. Water Supply:

1. Irrigation system shall be connected to water supply points of connection as indicated on the drawings.
2. Connections shall be made at approximate locations as shown on drawings. Contractor is responsible for minor changes caused by actual site conditions.

C. Electrical Supply:

1. Electrical connections for automatic controller shall be made to electrical points of connection as indicated on the drawings.
2. Connections shall be made at approximate locations as shown on drawings. Contractor is responsible for minor changes caused by actual site conditions.

440.12.3 INSTALLATION

- A. Trenching. Before trenching, contractor shall verify the actual final grade is at (+-) 1". Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow layout indicated on drawings and as noted. If the bottom of a pipe trench excavation is found to consist of rock, caliche, or any other material that, by reason of its hardness, cannot be excavated to give a uniform bearing surface, said rock or other material shall be removed for at least four inches (4") below the specified trench depth, and be refilled to specified trench depth with sand or similar material thoroughly tamped into place. Trenches shall be of sufficient depth to provide minimum earth coverage from finish grade as follows:

1. Pressure mainline: 24 inches
2. Control wires: 24 inches
3. Lateral rotary sprinkler heads: 16 inches
4. Emitter, spray heads and bubbler laterals: 12 inches
5. Sleeves under vehicular paving: 24 inches
6. All other sleeves: 24 inches
7. Electrical conduit: 24 inches

B. Backfilling:

1. The trenches shall not be backfilled until all required tests are performed. Trenches shall be carefully backfilled in 6" lifts with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, or other approved materials, free from large clods of earth or

stones. Backfill shall be mechanically compacted in landscaped areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill will conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.

2. A fine granular material backfill will be initially placed on all lines to a depth of 4" over the top of the pipe. No foreign matter larger than 1/2" in size will be permitted in the initial backfill on top of pipe.
3. All trenches will be water settled.
4. If settlement occurs and subsequent adjustments in pipe, valves, sprinkler heads, lawn or planting, or other construction are necessary, the Contractor shall make all required adjustments without cost to the Owner.

C. Trenching *Sleeving and Backfill Under Paving:

1. Trenches located under areas where paving, asphaltic concrete or concrete will be installed shall be backfilled with sand (a layer four inches below the pipe and four inches above the pipe) and compacted in layers using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and shall be left in a firm unyielding condition. All trenches shall be left flush with the adjoining grade. The irrigation Contractor shall set in place, cap and pressure test all piping under paving prior to the paving work.
2. Compaction percentage of backfill material shall be based on recommendations of the Soils Report. If Soils Report is not available, compaction shall be based on MAG Section 601.
3. Generally, piping under existing walks is done by jacking, boring or hydraulic driving, but where any cutting or breaking of existing sidewalks and/or concrete is necessary, it shall be done and replaced by the Contractor as part of the contract cost. Permission to cut or break sidewalks and/or concrete shall be obtained from the Owner's Representative. Hydraulic driving will be permitted under concrete paving provided a 24" minimum depth is maintained.
4. Provide for a minimum cover of 24" between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete paving.
5. Provide Schedule 40 PVC sleeves for all piping *and wiring. Sleeve shall be 2 times the diameter of the pipe being sleeved. Provide one sleeve per pipe.
 6. *Install sleeves with primed and solvent welded joints to extend a minimum of 12 inches beyond all walks, curbs, pavement and hardscape. All sleeves sized to match the largest required sleeve and the ends shall be securely taped closed.*

D. Assemblies:

1. Routing of irrigation lines as indicated on the drawings is diagrammatic. Install lines and various assemblies to conform with the details shown on drawings and in accordance with the manufacturer's recommendations.
2. Install all assemblies specified herein in accordance with respective detail. In absence of detail drawings or specifications pertaining to specific items required to complete work. Perform such work in the accordance with the best standard practice with prior approval from the Owner's representative from COS Parks Department.
3. PVC pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before installation. Installation and solvent-welding methods shall be as recommended by the pipe and fitting manufacturer. Primer shall be used on all solvent weld joints.
4. On PVC to metal connections, the Contractor shall work the metal connections first. Apply Teflon tape on all threaded PVC-to-metal joints. Light wrench pressure is all that is required when making the joint. Where threaded PVC connections are required, use threaded Schedule 80 TOE or TBE nipples. PVC male adaptors will not be allowed.
5. Thrust Blocks: Concrete thrust blocks shall be installed at all end plugs, ells and tees in main lines per COS Std. Detail 2643.

- E. Line clearance. All lines shall have a minimum clearance of 12 inches from lines of other trades. Parallel lines shall not be installed directly over one another and shall have enough distance between them to facilitate bedding, compaction, and future repairs.

F. Automatic controller. Install as per manufacturer's instructions. Remote control valves shall be connected to controller in numerical sequence as shown on the drawings. The controller shall be grounded with an 8' x 5/8" copper clad ground rod located as close as practical to the controller and connected with #10 wire minimum. Approved clamps shall be used. One ground rod per controller approved by Owner's representative from COS Parks Department.

G. High-voltage Wiring for Automatic Controller

1. 120 –volt power connection to the automatic controller shall be provided by the Irrigation Contractor.
2. All electrical work shall conform to local codes, ordinances, and governing authorities having jurisdiction.

H. Remote control valves. Install where shown on drawings and details. When grouped together, allow at least 18" between valves. Install each remote control valve in a separate valve box. Locate adjacent to walks or curbs where possible. Identify each valve with a permanent marker, tied to stem, with controller and station identification marked. Provide one mainline tap for each lateral line valve. For sports field applications, valves are to be located outside field of play. Remote control valves are not to be located within hardscape.

I. Flushing of System:

1. After all new irrigation pipe lines and risers are in place and connected, all necessary diversion work has been completed, and prior to installation of sprinkler heads and emitters, the control valves shall be opened and a full head of water used to flush out the system.
2. Sprinkler heads shall be installed only after flushing of the system has been accomplished

J. Sprinkler Heads:

1. Install the sprinkler heads as designated on the drawings. Sprinkler heads to be installed in this work shall be as shown on the drawings.
2. Spacing of heads shall not exceed the maximum indicated on the drawings. In no case shall the spacing exceed the maximum recommended by the manufacturer.
3. Ensure 200% coverage, head to head.

440.12.4 TEMPORARY REPAIRS

A. The Owner reserves the right to make temporary repairs as necessary to keep the sprinkler system equipment in operating condition. The exercise of this right by the Owner shall not relieve the Contractor of his responsibilities under the terms of the guarantee as herein specified.

440.12.5 EXISTING TREES

A. Whenever possible, excavation within the drip line or under foliage canopy of existing trees is to be avoided. Where it is necessary to excavate adjacent to existing trees, the Contractor shall use all possible care to avoid injury to trees and tree roots. Excavation in areas where it is reasonably anticipated there to be roots two inches and larger in diameter shall be done by hand. All roots two inches and larger in diameter, except those directly in the path of pipe or conduit, shall be tunneled under and any roots exposed during tunneling shall be covered with burlap to prevent damage and excessive dehydration. Where trenching machinery is operated close to trees having roots smaller than two inches in diameter, the wall of the trench adjacent to the tree shall have the severed roots trimmed by hand, making clean cuts to the severed root ends. Trenches adjacent to trees should be closed within 24 hours, and where this is not possible, the side of the trench adjacent to the tree shall be kept shaded with burlap until the trench is closed. All burlap used for shading and protection shall be removed from trenches prior to closure.

440.12.6 FIELD QUALITY CONTROL

A. Adjustment of the System:

1. The Contractor shall flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible.
2. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, the Contractor shall make such adjustments prior to planting. Adjustments may also include changes in nozzle sizes and degrees of arc as required. Such changes shall be approved in advance by the Owner's Representative from COS Parks Department.
3. Sprinkler, emitter and bubbler height adjustment by the Contractor shall be accomplished within 10 days after notification by Owner Representative from COS Parks Department.
4. All sprinkler heads shall be set perpendicular to finished grades unless otherwise designated on the plans. On slopes, heads shall be angled for optimum coverage.
5. Owner's Representative from COS Parks Department to approve all head relocations and reserves the right to request Contractor to make minor adjustments to head or emitter placement or nozzle selection at no cost to the Owner.

B. Testing of Irrigation System:

1. The Contractor shall request the presence of the Owner's Representative from COS Parks Department at least 48 hours in advance of testing. Call (480) 312-2189.
2. Test all pressure lines under hydrostatic pressure of 150 lbs./sq. in. and prove watertight. ***NOTE:** Testing of pressure main lines shall occur prior to installation of electric control valves. *Prior to the installation of the electric control valves, all mainlines shall be flushed.*
3. All piping under paved areas shall be tested under hydrostatic pressure of 150 lbs./sq. in. and proved watertight prior to paving.
4. Sustain pressure in lines for not less than two hours. Pipe sections shall be center loaded and all couplings shall be exposed. Before testing, the line shall have been filled with water for at least four (4) hours and provisions made for thoroughly bleeding the line of air.
5. All hydrostatic tests shall be made only in the presence of the Owner's Representative from COS Parks Department. No pipe shall be backfilled until it has been inspected, tested and approved in writing.
6. Contractor shall furnish necessary force pump and all other test equipment.
7. When the irrigation system is completed, perform a coverage test in the presence of the Owner's Representative from COS Parks Department to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from plans or where the system has been willfully installed as indicated on the drawings when it is obviously inadequate without bringing this to the attention of the Owner's Representative from COS Parks Department. This test shall be accomplished before any ground cover is planted.
8. Upon completion of each phase of work, the entire system shall be tested and adjusted to meet site requirements.

440.12.7 MAINTENANCE

- A. The entire sprinkler irrigation system shall be under full automatic operation for a period of seven days with all malfunctions and leaks corrected prior to any planting.
- B. The Owner's Representative from COS Parks Department reserves the right to waive or shorten the operation period.

440.12.8 CLEANUP

- A. Cleanup shall be made as each portion of work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be broomed or washed down, and any damage sustained on the work of others shall be repaired at the Contractor's expense to the original

conditions acceptable to the Owner's Representative from COS Parks Department.

440.12.9 FINAL OBSERVATION PRIOR TO ACCEPTANCE

- A. The Contractor shall operate each system in its entirety for the Owner's Representative from COS Parks Department at the time of final observation. Any items deemed not acceptable shall be reworked to the complete satisfaction of the Owner's Representative.
- B. The contractor shall show evidence to the Owner's Representative from COS Parks Department that the Owner has received all accessories, charts, record drawings, and equipment as required before final observation can occur.

440.12.10 OBSERVATION SCHEDULE

- A. Contractor shall be responsible for notifying the Owner's Representative from COS Parks Department in advance for the following observations according to the time indicated:
 - 1. Pre-job conference – Seven (7) days.
 - 2. Pressure supply line installation and testing – 48 hours.
 - 3. Automatic controller installation – 48 hours.
 - 4. Control wire *and valve installation – 48 hours.
 - 5. Lateral line and sprinkler / emitter installation – 48 hours.
 - 6. Coverage test – 48 hours.
 - 7. Final observation – Seven (7) days.
 - 8. Emitter and distribution line placement – 48 hours.
 - 9. Emitter operation – 48 hours.
 - 10. Sleeving Installation – 48 hours.
- B. When inspections have been conducted by other than the Owner's Representative from COS Parks Department, show evidence **in writing** of when and by whom these inspections were made.

MC

Removal of Pavement Markings and Raised Pavement Markers

SECTION 460

REMOVAL OF PAVEMENT MARKINGS AND RAISED PAVEMENT MARKERS

460.1 DESCRIPTION:

The Contractor shall furnish experienced supervision, labor, all materials, equipment, tools, transportation and supplies required accomplish the pavement marking removal in accordance with these specifications, where indicated on the Striping Plans, or where determined by the Engineer.

460.2 CONSTRUCTION:

The Contractor shall determine the type of pavement markings that exist in the field and the appropriate removal methods specified in this Section.

Existing traffic pavement markings shall not be covered over with slurry seal, black paint or stain of any kind.

The Contractor shall accomplish pavement marking obliteration as per the requirements indicated on the Plans or where determined by the Engineer. The Contractor shall be responsible for verifying the striping removal limits of the project before commencement of the work. The striping removal limits may exceed the construction project limits, or new striping limits in order to match and tie into the existing striping.

Existing pavement markings shall be removed to the fullest extent possible from the pavement by one of the methods identified in this Section, unless another method is approved by the Engineer. The method used shall not materially damage the surface or texture of the useable pavement.

Sand or other material deposited on the pavement as a result of removing pavement markings shall be removed as the work progresses. Accumulations of sand or other material, which might interfere with drainage or might constitute adverse safety conditions to traffic, will not be permitted.

Where blast cleaning is used for the removal of pavement markings or for removal of objectionable material, the residue including dust shall be removed immediately after contact between the sand and the surface being treated. Such removal shall be by a vacuum attachment operating concurrently with the blast cleaning operation, or by other methods approved by the Engineer. Blasting shall not be used within 12 ft. of a lane occupied by traffic.

Any damage to the pavement caused by pavement marking removal shall be repaired by methods acceptable to the Engineer. When asphalt slurry is used to repair damage to the pavement caused by pavement marking removal or the obliteration of the marks remaining after the markings have been removed, the asphalt slurry shall be placed parallel to the new direction of travel and shall not be less than two feet in width.

460.2.1 Approved Methods of Removal: The following methods have been approved by the County for the removal of traffic paint, thermoplastic markings, Type 1 (Permanent) performed plastic tape, raised pavement markers and barrier/guardrail markers.

460.2.1.1 Traffic Paint:

(1) Sandblasting

(2) Turbo-blaster (Steel shot method)

(3) Chip Seal: When using this method, the entire roadway surface, edge of asphalt to edge of asphalt, shall be covered.

(4) Asphalt Overlay: The asphalt overlay thickness and dimensions shall meet County specifications.

460.2.1.2 Thermoplastic:

(1) Grinding followed by sandblasting.

(2) Chip Seal: The application of this method depends on the length of time the Thermoplastic Marking has been on the roadway surface. The use of a chip seal before grinding / sandblasting is at the discretion of Contractor. If the chip seal does not adhere to the existing thermoplastic markings, the Contractor shall grind and / or sandblast the thermoplastic markings off and chip seal the exposed area. All costs for this work shall be borne by the Contractor.

When applying chip seal, the entire roadway surface, edge of asphalt to edge of asphalt, shall be covered.

Chip seal shall not be applied to a Portland cement surface.

(3) Asphalt Overlay: The asphalt overlay thickness and dimensions shall meet the County specifications.

460.2.1.3 Type I - Preformed Plastic Pavement Marking Tape:

(1) Grinding

(2) Chip Seal: The application of this method depends on the length of time the Tape has been on the roadway surface. The use a chip seal before grinding is at the discretion of Contractor. If the chip seal does not adhere to the existing tape markings, Contractor shall grind off the tape markings and chip seal over the exposed area. All costs for this work shall be borne by the Contractor.

When applying chip seal, the entire roadway surface, edge of asphalt to edge of asphalt, shall be covered

Chip seal shall not be applied to a Portland cement surface

(3) Asphalt Overlay: The asphalt overlay thickness and dimensions shall meet the County specifications

460.2.1.4 Raised Pavement Markers:

(1) Hammer and Chisel

(2) Blade (Use of Heavy Duty Equipment)

460.2.1.5 Barrier Markers for Bridges, Concrete and Guardrail:

(1) Hammer and Chisel

460.3 METHOD OF MEASUREMENT:

Measurement for removing painted stripe, removing thermoplastic stripe and Type 1 – preformed plastic marking tape will be by the linear foot along the centerline of the pavement stripe to be removed. Skips in dashed lines will not be included in the measurement. Measurement for removing striping with a plan width greater or less than the basic 4” wide stripe will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Foot}}{4.0 \text{ (inches)}}$$

Double marking lines, consisting of two 4” wide stripes will be measured as two individual marking lines. Crosswalk lines, stop bars, stop lines, gore lines, cross hatch lines, chevron lines and railroad marking transverse lines will be measured for centerline length and adjusted for widths other than 4” as defined above.

Thermoplastic pavement symbols and legends will be measured by each unit removed.

Measurement for the removal of raised pavement markers and barrier markers for bridges, concrete, and guardrail will be by the unit for each marker removed.

460.4 BASIS OF PAYMENT:

Payment for Removing Painted Stripe will be at the unit contract price per linear foot for the length of painted line applied to the nearest foot.

Payment for Removing Painted Symbols and Removing Painted Legends will be per each for each symbol or legend removed.

Payment for Removing Thermoplastic Stripe and Removing Type 1 – Preformed Plastic Marking Tape will be per linear foot of striping removed.

Payment for Removing Raised Pavement Markers and for Removing Barrier Markers for Bridges, Concrete and Guardrail will be per each marker removed.

All damage to the surface of the road caused by pavement marking removal shall be repaired by the Contractor at his expense.

Part 400 add the following new Section:

SECTION 461

PAINTED PAVEMENT MARKINGS

461.1 Description:

The work under this section shall consist of cleaning and preparing the pavement surface, furnishing all materials, experienced supervision, labor, equipment, tools, transportation, supplies and applying white or yellow, water-borne, lead-free, rapid-dry traffic paint and reflective glass beads at the locations and in accordance with the details shown on the plans, MUTCD, the requirements of these specifications, or where determined by the Engineer.

461.2 Materials:

461.2.1 Pavement Marking Paint:

(A) General:

All material used in the formulation of the pavement marking paint shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

Certificates of Compliance conforming to the requirements of Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction 2000 edition, section 106-05 shall be submitted for each lot or batch of paint prior to its use.

(B) Composition Requirements:

The pavement marking paint shall be a ready-mixed, one component, water-borne lead-free traffic line paint, of the correct color, to be applied to either asphaltic or Portland cement concrete pavement. The composition of the paint shall be an acrylic polymer emulsion equivalent to or better than PervoStripe™ 6000 Series or a cross link polymer emulsion equivalent to or better than PervoPlastic™ 6050 Series, acceptability of proposed equivalency to be determined by the Engineer. The marking paint shall be a pigmented water-borne paint containing all the necessary co-solvents, dispersant, wetting agents, preservatives and all other additives, so that the paint shall retain its viscosity, stability and all of the properties as specified herein. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, toluene, chlorinated solvents, hydrolyzable chlorine derivatives, ethylene-based glycol ethers and their acetates, and not any carcinogen, as defined in 29 CFR 1910.1200. Lead content shall not exceed 0.06 percent of weight of the dry film, and the test for chromium content shall be negative.

No glass beads will be allowed in the pavement marking paint. Glass beads will be applied after the paint has been applied.

(C) Manufacturing Formulations:

The manufacturer shall formulate the pavement marking paint in a consistent manner and notify the Engineer of any change of formulation. The formulation of the paint shall be determined by the manufacturer. It will be the manufacturer's responsibility to formulate paint which will meet the quantitative and qualitative requirements of this specification. Any change in the formulation of the paint must be approved by the Engineer.

(D) Quantitative Requirements of Mixed Paints:

	White	Yellow
Pigment: percent by weight, ASTM D 3723, allowable variation from qualifying sample	± 2.0	± 2.0
Non-volatile Content: percent by weight, ASTM D 2369, allowable variation from qualifying sample	± 2.0	± 2.0
Viscosity: Krebs Units at 77° ± 1°F, ASTM D 562	80 - 95	80 - 95
Weight per Gallon pounds per gallon at 77° ± 1°F, ASTM D 1475P, allowable variation from qualifying sample	± 0.3	± 0.3
Vehicle Composition: Vehicle Infrared Spectra, ASTM D 2621, allowable variation from qualifying sample	None	None
pH: ASTM E 70, allowable variation from qualifying sample	± 1.0	± 1.0
Fineness of Dispersion: HEGMAN, minimum, ASTM D 1210	3.0	3.0
Volatile Organic Compounds: pounds per gallon of paint, maximum, ASTM D 3960 according to 7.1.2.	2.1	2.1
Flash Point: °F, minimum, ASTM D 93, Method A	100	100
Dry Time to No Pick Up: with no beads, minutes, maximum ASTM D 711	10	10
Dry Through Time: minutes, ASTM D 1640 except no thumb pressure is used when thumb is rotated 90 degrees on paint film	20	20
Flexibility: TT-P-1952D	Pass	Pass

(E) Qualitative Requirements:

(1) Color of Yellow Paint:

The color of the yellow paint shall closely match Federal Standard 595b, Color No. 33538. The color shall be checked visually, and will be checked against Tristimulus Values for the color according to Federal Test Method Standard No. 141.

(2) Dry Opacity:

Dry opacity for the paint will be determined using a black-white Leneta Chart, Form 2C Opacity and a Photovolt 577 Reflectance Meter or equal. Using a 10-mil gap doctor blade, a film of paint is

drawn down, covering both black and white portions of the chart. The film shall be allowed to dry 24 hours. After calibrating the Reflectance Meter according to the manufacturer's instructions, measure the reflectance over the white and black portions with the green Tristimulus filter. Dry Opacity is calculated as follows:

Dry Opacity for both white and yellow paint shall be a minimum 0.90.

(3) Yellowness Index:

Yellowness Index for white paint will be determined as described for dry opacity, only use a 15-mil gap doctor blade to draw down the paint. After 24 hours for drying, measure the reflectance of the paint film, using the green, blue, and amber Tristimulus filters. Calculate the Yellowness Index as follows:

$$\text{Yellowness Index} = \frac{\text{Amber} - \text{Blue}}{\text{Green}} \times 100$$

Yellowness Index for the white paint shall be a maximum of 10.

(4) Reflectance:

Reflectance for both white and yellow paint will be determined using the same 15-mil drawdown film as for the Yellowness Index. For white paint the same sample may be utilized for both the Yellowness Index and Reflectance. Measure the reflectance of the paint film using the green Tristimulus filter. Reflectance for the white paint shall be a minimum of 85. Reflectance for the yellow paint may range from 42 to 59, inclusive.

(5) UV Color Durability:

UV Color Durability shall be determined using a QUV Weatherometer, with Ultra Violet Light and Condensate Exposure according to ASTM G 53, for 300 hours total. The repeating cycle shall be four hours UV exposure at 60 °C followed by four hours condensate exposure at 40 °C. After 300 hours of exposure, the Yellowness Index for white paint shall not exceed 12, and yellow paint must still match Federal Standard 595b, Color No. 33538.

(6) Static Heat Stability:

To determine static heat stability for the paint, place one pint of paint in a sealed can and heat in an air circulation oven at 120° ±1° F for a period of one week. Remove the paint from the oven and check the viscosity in Krebs Units at 77° ±1° F according to ASTM D 562. The viscosity measured must be in the range from 68 to 90, inclusive. Also, check for any signs of instability.

(7) Heat-Shear Stability:

To determine heat-shear stability for the paint, one pint of the paint is sheared in a Waring Blender at high speed to 150° F. The blender should have a tight fitting lid taped onto it to minimize volatile loss. When the paint reaches 150° F, stop the blender, immediately pour the paint into a sample can, and apply a cover to seal the can. Let the paint cool overnight and examine for jelling or other signs of instability. Measure viscosity in Krebs Units at 77° ±1° F according to ASTM D 562. The viscosity measured must be in the range from 68 to 95 inclusive. If not within the upper limit, run total solids on the sheared paint and adjust solids, if necessary, by adding water to reach the original

solids content. If the solids content required adjustment, again check the viscosity of the paint. The viscosity must be in the range from 68 to 95 inclusive.

(8) Scrub Resistance:

Scrub Resistance will be determined according to ASTM D 2486. Use an appropriate doctor blade to provide a dry film thickness of 3 to 4 mils. Allow the paint to cure for 24 hours. Perform the scrub resistance test at $77^{\circ} \pm 1^{\circ}$ F and $50 \pm$ five percent humidity. Record the number of cycles to remove the paint film. The number of cycles recorded must be a minimum of 800.

(9) Spraying Properties:

The paint shall be applied at a 15-mil wet film thickness in the field. The paint shall show the following properties at ambient temperatures of 50° to 100° F with a paint spray temperature of 150° F, maximum, and 6 to 8 pounds of post-applied glass beads per gallon of paint. Beads shall conform to Section 461.2.2.

- (a) Dry to a no-track condition in five minutes or less when the line is crossed over in a passing maneuver with a standard-sized automobile.
- (b) Produce a clean-cut, smooth line with no overspray or puddling.
- (c) Paint immediately after application shall accept glass beads so that the spheres shall be embedded into the paint film to a depth of 50 percent of their diameter.
- (d) Paint when heated to the temperature necessary to obtain the specified dry time, shall show no evidence of instability such as viscosity increase, jelling, or poor spray application.

(10) Freeze-Thaw Properties:

The paint viscosity or consistency shall not change significantly when the paint is tested for resistance to five cycles of freeze-thaw according to ASTM D 2243.

(11) Road Service Rating:

Test stripes of the paint shall be applied transversely across the road, 4" in width and approximately 12 ft. long at a location approved by the Engineer.

Wet film thickness of the test stripes shall be approximately 15-mils as determined according to ASTM D 4414 and ASTM D 713 prior to test stripe application. To aid in obtaining the correct film thickness, a length of roofing paper placed by the side of the road can be used. Place a rigid metal test panel on the roofing paper in the path of a test line. Immediately after the test line is applied by the striper, measure the wet film thickness. If not satisfactory, adjust the spray pressure and repeat until the target wet film thickness is attained. It is important that no glass beads be present that would give a false wet film thickness. When the wet film thickness is correct, apply a test line across a tarred metal test panel. After this, apply another test line across a different tarred metal test panel, this time also adding the beads. These samples are necessary to determine the initial bead retention.

Glass beads conforming to the requirements of Section 461.2.2 shall be applied after the paint has been applied, but during the same striping operation at a rate such that the initial bead retention on the test line is a minimum of 6 pounds of beads per gallon of wet paint. The initial bead retention

will be determined analytically by MCDOT concurrently with the determination of the dry paint thickness utilizing tarred metal test panels. The paint shall accept the glass beads so that the spheres are embedded into the paint film to a depth of 50 percent of their diameter. Test stripes will be observed for a period of 180 days from date of application. Paints will be evaluated for wear according to ASTM D 913.

After 180 days of service, on a visual rating scale of 0 to 100 percent, paints must have a rating of 92 percent or better to be acceptable. All ratings will be taken in the wheel track area. Glass beads shall show no more than a 30 percent loss after 180 days of test. This will be determined by taking close-up photographs of the paint film and by count determining the average bead loss.

The road service test may be waived at the option of the Engineer or evaluated for a period of time less than 180 days.

(12) Workmanship:

Paint shall be free from foreign materials, such as dirt, sand, fibers from bags, or other material capable of clogging screens, valves, pumps, and other equipment used in a paint striping apparatus.

The paint pigment shall be well ground and properly dispersed in the vehicle. The pigment shall not cake or thicken in the container, and shall not become granular or curdled. Any settlement of pigment in the paint shall result in a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sidewise manual motion of a paddle across the bottom of the container, to form a smooth uniform product of the proper consistency. If the paint cannot be easily redispersed, due to excessive pigment settlement as described above or due to any other cause, the paint shall be considered unfit for use.

The paint shall retain all specified properties under normal storage conditions for 12 months after acceptance and delivery. The Contractor shall be responsible for all costs and transportation charges incurred in replacing paint that is unfit for use. The properties of any replacement paint, as specified herein, shall remain satisfactory for eight months from the date of acceptance and delivery.

(F) Manufacturing Requirements:

(1) Inspection:

The manufacturer of the paint shall advise the Engineer when paint is to be manufactured, shall furnish the Engineer free access to all parts of the plant involved in the paint manufacture, and shall furnish every reasonable facility for sampling both the paint and the raw materials during the process of manufacturing.

All materials used in formulation shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

All manufactured paint shall be prepared at the factory ready for application.

When paint is shipped to a distributor or paint applicator who will store the paint prior to its use, the distributor or paint applicator shall furnish the Engineer free access to all parts of the facility where paint is stored and shall furnish every reasonable facility for sampling the paint.

Paint shall normally be sampled at the place of storage either at a warehouse or on the site prior to application of the paint. Application of the paint will not be permitted until the paint has been approved by the Engineer. It is the Contractor's responsibility to notify the Engineer a minimum of

14 working days prior to any traffic painting operation and to allow access at that time for paint sampling at the storage location.

A minimum of one paint sample shall be obtained from each lot of paint.

Check-samples of finished paint while being applied will be taken at intervals as determined by the Engineer.

(2) Testing:

All tests will be conducted in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141, and methods in use by the Materials Group, Highways Division, and the Arizona Department of Transportation as specified herein.

Evidence of adulteration or improper formulation shall be cause for rejection.

(3) Packaging:

All shipping containers for paint must comply with the Department of Transportation Code of Federal Regulations, Hazardous Materials and Regulation Board, Reference 49 CFR. The container and lids must be lined with a suitable coating so as to prevent attack by the paint or by agents in the air space above the paint. The lining must not come off the container or lid as skins.

Containers shall be colored white, including lids, and containers shall have an identifying band of the appropriate color around and within the top one third of the container.

All containers shall be properly sealed with suitable gaskets, shall show no evidence of leakage, and shall remain in satisfactory condition for a period of 12 months after delivery to a distributor or paint applicator. The Contractor shall be responsible for all costs and transportation charges incurred in replacing paint and containers.

(4) Marking:

All containers of paint shall be labeled showing the manufacturer's name, date of manufacture, paint color, product code, manufacturer's batch number, and quantity or weight of paint on both the side of the container and also the lid. Containers shall be clearly marked or labeled Rapid or Fast Dry lead-free Water-Borne Traffic Paints.

All containers of paint shall be labeled to indicate that the contents fully comply with all rules and regulations concerning air pollution control in the State of Arizona, Maricopa County.

The manufacturer of the paint shall be responsible for proper shipping labels with reference to whether the contents are toxic, corrosive, flammable, etc., as outlined in the U.S. Department of Transportation, Hazardous Materials Regulations, Reference 49 CFR.

(5) Unused Paint:

Disposal of unused quantities of traffic paint shall be the responsibility of the Contractor and must meet all applicable Federal regulations for waste disposal. Paint which is saved to be used later shall be packaged as specified previously and shipped to a storage location. Unused paint must be identified on the container. Unused paint may be utilized on a future project provided the paint still conforms to all specifications contained herein.

461.2.2 Reflective Glass Beads (Spheres):

(A) General:

The term "glass bead" shall be synonymous with the term "glass sphere" as used herein.

The beads shall be manufactured from glass of a composition designated to be highly resistant to traffic wear and to the effects of weathering.

The glass beads shall be moisture-proof; contain less than 0.25 percent moisture by weight; and be free of trash, dirt, or other deleterious materials.

Beads shall be essentially free of sharp angular particles showing milkiness or surface scoring or scratching. Beads shall be water white in color.

(B) Physical Requirements:

(1) Gradation:

When tested by the method provided in ASTM D 1214, the grade sizes of the beads shall be as follows:

Size of Sieve	Percent Passing
No. 30	100
No. 50	15 - 35
No. 70	0 - 15
No. 100	0 - 5

(2) Roundness:

When tested by the method provided in ASTM D 1155 (Procedure B except paragraphs (F) and (G) are deleted), beads retained on any screen specified in the gradation requirements shall contain a minimum of 75 percent true spheres.

(3) Index of Refraction:

When tested by a liquid immersion method at a temperature of 25 °C, the beads shall have an index of refraction of 1.50 to 1.57.

(4) Specific Gravity:

The specific gravity of the beads shall be in the range 2.40-2.60 when tested in accordance with the following procedures:

Place 100 grams in an oven at 110 °C for one hour.

Remove beads and place in a desiccator until the sample is cool.

Remove approximately 60 grams of beads from the desiccator and weigh the sample accurately.

Pour the beads slowly into a clean 100-milliliter graduated cylinder containing 50 milliliters

of isopropyl alcohol. Make certain that air is not entrapped among the beads.

The total volume, minus 50, will give the volume of the beads.

Calculate the specific gravity as follows:

$$\text{Specific Gravity} = \frac{\text{Weight of the sample}}{\text{Volume of the sample}}$$

(5) Chemical Stability:

Beads which show any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture, dilute acids, or alkalis or paint film constituents, may be required to demonstrate satisfactory reflectance behavior, prior to acceptance, under such tests as may be prescribed.

(C) Moisture Proofing:

All glass beads shall have a moisture-proof overlay consisting of water repellent material applied during the process of bead manufacture. The beads so treated shall not absorb moisture in storage and shall remain free of clusters and lumps and shall flow freely from dispensing and testing equipment.

The beads shall pass the test for water repellency and free flow using the following equipment:

(1) Test bag:

The bag used is approximately 10½" by 17½" after sewing. The material used in the construction of the bag is unbleached cotton sheeting with a thread count of 48 by 48. The material before sewing is approximately 18" by 22". The cloth is folded in half lengthwise and stitched in the shape of an "L" with the short side left open at the top. The material can be obtained from selected manufacturers of cloth and paper packaging. The finished bag may also be obtained from the manufacturer of the glass beads.

Newly fabricated bags must be thoroughly washed with hot water and detergent and rinsed before use to remove the sizing which may be present in the cloth. Subsequent to the initial washing, the bags need only be rinsed clean of beads from previous tests and dried thoroughly before use.

(2) Funnel:

The funnel used is a standard laboratory funnel with a top opening diameter of 125 millimeters and a 150-millimeter stem length. The inside diameter of the stem is between nine and 10 millimeters. This funnel is available from most laboratory glassware supply houses, Corning No. 6100 or equal.

(3) Ring Stand and Clamp.

(4) Balance accurate to 0.1 grams.

(5) Distilled water.

MOISTURE TESTING PROCEDURE:

Glass beads shall be tested for compliance with specification requirements. Testing shall be conducted at standard conditions of temperature ($25 \pm$ one degrees Celsius) and humidity ($50 \pm$ five percent Relative Humidity) and shall consist of the following procedure or an approved alternate:

Weigh 900.0 grams of glass beads into a clean, dry, flat-bottomed pan.

Dry beads at 150 °C for two hours.

Cool beads to room temperature ($25 \pm$ one degrees Celsius) in a desiccator.

Using the clean, pre-washed bag described under apparatus section, turn the bag inside out so that the sewn seam and seam-allowance are on the outside.

Quantitatively transfer the beads into the inverted cotton bag.

Grasp the gathered top of the bag with one hand and lower the bag into a container of distilled water until the beads are approximately 25 millimeters below the water level. The container shall be of such dimensions that the bag does not contact the bottom or sides during immersion. Each bag shall be immersed individually. Do not allow one bag to contact another if multiple tests are run.

Remove the bag after 30 seconds of immersion time.

Cradle the bottom of the bag uniformly in the palm of one hand and twist the top neck of the bag until the twisted bag is compressed firmly against the beads. Twist until excess water no longer drips from the bag.

After the excess water has been squeezed from the bag, allow the bag to unwind.

Gather the top of the bag and clamp. Suspend the bag on a ring stand or other support such that the bottom or sides of bag do not contact the support.

After a standing time of two hours at room temperature ($25 \pm$ one degrees Celsius), remove bag from support. Mix sample thoroughly by holding the bottom seam allowance in one hand and gathered neck of the bag in the other, invert bag and shake up and down five times. Transfer the sample into a clean, dry funnel of the type described under apparatus. If consecutive tests are run, be sure the funnel is clean, dry and free of beads from prior tests.

The entire sample shall flow through the funnel without stoppage.

At the start of the test only, it is permissible to lightly tap the stem of the funnel to initiate flow.

Small quantities of beads which have adhered to the side of the funnel or stem shall not be cause for failure.

461.3 Construction Requirements

461.3.1 Equipment:

The traffic paint and beads shall be placed on the pavement by a spray-type, self-propelled pavement marking machine except that temporary striping during construction may be placed with

other equipment designed for application of paint and beads with the approval of the Engineer.

The application equipment to be used on roadway installation shall have, as a minimum, the following characteristic and/or apparatus:

The machine shall be capable of applying clear-cut lines of the width specified on the project plans.

The machines shall be equipped with a mechanical device capable of placing a broken reflectorized line with a 10 foot painted segment and a 30-foot gap.

The machine shall be equipped with an air-operated glass bead drop-in dispenser controlled by the spray gun mechanism.

A glass bead dispenser which is capable of placing the glass beads into the paint line as the paint is applied to the pavement shall be utilized. This dispenser shall provide satisfactory marking and delineation.

461.3.2 Application

(A) Pavement Surface

Pavement markings shall be applied when the pavement surface is dry and the weather is not foggy, rainy, or otherwise adverse to the application of markings. The surface shall be free from excess asphalt or other deleterious substances before traffic paint, beads or primer are applied. The Contractor shall remove dirt, debris, grease, oil, rocks or chips from the pavement surface before applying markings. Any area that cannot otherwise be satisfactorily cleaned shall be scrubbed with a biodegradable chemical. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray.

(B) Temperature Conditions:

Painting shall not be performed when the atmospheric temperature is below 50° F when using water-borne paint, nor when it can be anticipated that the atmospheric temperature will drop below said 50° F temperature during the drying period. Water-borne paints shall not be applied if rain is expected within one hour of its application, unless otherwise approved by the Engineer. Water-borne paint shall not be heated to a temperature greater than 150° F to accelerate drying.

(C) Placement Locations:

The placing of traffic markings shall be done only by personnel who are experienced in this work. Pavement markings shall be positioned as defined on the plans and in the specifications. When it becomes necessary for proper installation, the Engineer may revise individual marking locations as necessary.

The Contractor shall spot mark the entire project at 10-foot intervals in conformance with the striping plans. Removal of existing pavement markings shall be completed prior to the spot marking. Upon completion of the spot marking, the Contractor shall notify the Engineer that the project is ready for inspection. County will conduct an inspection after the spot marking is completed, within three working days from notification of Contractor.

Approval of the spot marking shall not relieve the Contractor from obtaining a final inspection. Upon

final inspection, if the Engineer decides that more than one coat is required, it will be done at the Contractor's expense.

The final striping inspection will be made by the Engineer within three working days after all pavement markings and markers have been installed.

The Striping in the field may exceed the construction project limits in order to match and/or tie into the existing striping. Contractor shall perform a field inspection and determine if the striping exceeds the construction project limits.

If a conflict exists between actual field conditions and the pavement marking plans, the Contractor shall cease work and notify the Engineer immediately.

(D) Paint Application

The Contractor shall provide the necessary personnel and equipment to divert traffic from the installation area where the work is in progress and during drying time when, in the opinion of the Engineer, such diversion of traffic is necessary.

The volume of paint in place shall be determined by measuring the paint tank with a calibrated rod. At the option of the Engineer, if the striping machine is equipped with air-atomized spray units (not airless) and paint gauges, the volume of paint may be determined by utilizing said gauges.

The quantity of glass reflectorizing beads in place shall be determined by measuring the glass reflectorizing bead tank with a calibrated rod.

The paint shall not bleed, curl, or discolor when being applied to the roadway surface. If bleeding, curling or discoloration occurs, the unsatisfactory areas shall be given additional coats of paint to correct the problem. In the event that the additional coats are not sufficient, the Engineer will determine what method of correction may be used. Such corrections will be at the Contractor's expense.

The paint shall not be applied over the decorative design in the median.

If a seal is required, sufficient drying time, minimum forty-eight (48) hours, shall be allowed before applying any pavement markings.

After the forty-eight (48) hour drying time has passed and the seal remains tacky, or excessive oil has risen to the roadway surface, a sand blotter shall be applied to absorb the excess oil. If the seal remains tacky, no pavement markings shall be applied.

If a sand blotter is applied after the installation of pavement markings, then all markings affected shall be removed and re-applied at the Contractor's expense.

(E) Tolerances for Placing Paint, Beads, and Primer:

The length of painted segment and gap shall not vary more than 6 inches in a 40-foot cycle.

The finished line shall be smooth, aesthetically acceptable and free from undue waviness.

Painted lines shall be 4.0", 8.0", or 12.0" wide as shown on the plans with a tolerance of plus or minus 1/8 inch and shall be placed at a minimum rate of 16 gallons per mile for a solid 4.0 inch line and 4 gallons for a broken 4.0 inch line, based on a 10 foot stripe and a 30 foot gap (40 foot cycle).

New pavement striping shall not vary more than 1/2 inch in 50 feet from the striping plans. Existing pavement markings requiring re-stripe shall be re-striped to completely cover existing markings within

¼ inch and be within a longitudinal tolerance of 6 inches at the beginning and at the end of each stripe.

Glass reflectorizing beads shall be applied on the wet paint at a minimum rate of 6 lbs. to each gallon of paint.

Wet thickness shall not be less than 15 mils.

461.4 Method of Measurement:

Pavement marking paint will be measured by the linear foot along the centerline of the pavement stripe. Skips in dashed lines will not be included in the measurement. Length of pavement markings will be based on 4-inch wide stripe. Measurement for striping with a plan width greater or less than the basic 4 inches as shown on the plans or requested by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

Symbols, legends, painted medians, painted curbing, and painted islands will be measured by each unit applied. Each legend, regardless of the number of letters, will be considered as a single unit.

No separate measurement will be made for cleaning and preparing the pavement surface, including abrasive sweeping and high-pressure air spray. The cost of disposal of excess materials, cleaning fluids, and empty material containers, will be considered as included in contract items

461.5 Basis of Payment:

Pavement striping of the type specified, measured as provided above, will be paid for at the contract price per linear foot for the total length of painted line applied to the nearest foot, which price shall be full compensation for the work complete, including cleaning and preparing the pavement surface and glass beads, as described and specified herein and on the project Plans.

Pavement symbols, legends, painted medians, painted curbing, and painted islands measured as provided above, will be paid for at the contract price for each painted symbol or legend, which price shall be full compensation for the work complete, including cleaning and preparing the pavement surface, and glass beads, as described and specified herein and on the project Plans.

SECTION 462

THERMOPLASTIC PAVEMENT MARKINGS

462.1 Description:

The work under this section shall consist of cleaning and preparing pavement surfaces and furnishing and applying either white or yellow hot-sprayed thermoplastic reflectorized stripes or pavement markings to the prepared pavement at the locations and in accordance with the details shown on the project plans and the requirements of these specifications and the Special Provisions.

Screed or extrusion application of thermoplastic may be allowed, if approved by the Engineer, for short application work such as intersections.

The Contractor shall furnish all materials, supervision, labor, equipment, tools, transportation and supplies required to complete the work according to the striping plans, these specifications and the Special Provisions.

462.2 Materials:

462.2.1 General Requirements

The thermoplastic reflectorized material shall consist of a solid mixture of heat-stable resins, white or yellow pigment, inter-mixed glass beads, filler, and other materials in granular or block form specifically compounded for reflectorized pavement markings to be applied to the pavement in a molten state. The characteristics of the liquefied material shall be such that complete and even coverage of specified areas to the required thickness is provided by the required application method and rate. Upon cooling to normal pavement temperature, this material shall produce an adherent reflectorized marking capable of resisting deformation and wear in the roadway.

Certificates of Compliance conforming to the requirements of Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction Section 106.05 shall be submitted for each lot or batch of thermoplastic reflectorized material prior to its use.

Only thermoplastic materials currently shown on the Arizona Department of Transportation's Approved Products List shall be used. The current Approved Products List is available from the Engineering Records Office, 1655 West Jackson, Phoenix, AZ 85007, Phone (602) 255-8216.

462.2.02 Composition: The thermoplastic composition shall conform to the following requirements:

	Percent by Weight	
	White	Yellow
Binder	18 - 26	18 - 26
Titanium dioxide	8 - 15	-----
Basic lead chromate	-----	4 - 10
Reflective glass spheres	30 - 40	30 - 40
Calcium carbonate or equivalent filler	20 - 40	25 - 45

The ingredients of the thermoplastic composition shall be thoroughly mixed and in a free flowing granular form. The material shall readily melt into a uniform mixture and be free from all skins, dirt, foreign objects or any other ingredient which would cause bleeding, staining or discoloration when applied to the bituminous or concrete pavement.

The thermoplastic shall be one of the following two types based on the binder composition:

Hydrocarbon: Shall consist mainly of synthetic petroleum hydrocarbon resins with appropriate fillers and pigments.

Alkyd: Shall consist mainly of maleic modified glycerol ester of tall oil resin for the binder.

(A) Reflective Glass Beads:

In addition to incorporating glass beads in the thermoplastic mix, glass beads shall be applied to the surface of the molten material at a uniform minimum rate of 10 pounds of glass beads per 100 square feet of line (300 feet of 4-inch stripe).

(B) Filler: The filler shall be a white calcium carbonate or equivalent filler with a compressive strength of at least 5.0 ksi.

(C) Titanium Dioxide:

Titanium Dioxide shall conform to the requirements of ASTM D 476 for Type II (92 percent).

(D) Lead Chromate Pigment:

The lead chromate pigment shall be silica encapsulated heat resistant lead chromate pigment.

462.2.03 Physical Characteristics of the Composition:

(A) General Requirements:

The thermoplastic material shall not exude fumes which are toxic, injurious, or require specialized breathing apparatus when heated to the temperature range specified by the manufacturer for application. The material shall remain stable when held for four hours at this temperature, or when subjected to four reheatings, not exceeding a total of four hours, after cooling to ambient temperature. The temperature viscosity characteristics of the plastic material shall remain constant throughout the reheatings and shall show like characteristics from batch to batch. There shall be no obvious change in color of the thermoplastic material as a result of reheating, and the color of the material shall not vary from batch to batch.

(B) Color:

The thermoplastic material, after heating for four hours \pm five minutes at 425° F \pm 3° F and cooled to 77° F \pm 3° F, shall meet the following:

White: Daylight reflectance at 45 degrees - 0 degrees shall be 75 percent minimum.
The color shall match Federal Test Standard Number 595, Color Chip No. 17925.

Yellow: Daylight reflectance at 45 degrees - 0 degrees shall be 45 percent minimum.

The color shall match Federal Test Standard Number 595, Color Chip No. 13538.

(C) Retroreflectance:

The white and yellow thermoplastic materials shall have the following minimum retroreflectance values at 86.5 degrees illumination angle and 1.5 degrees observation angle as measured by a Mirolux 212 portable retroreflectometer 30 days after application to the roadway surface:

Product	Retroreflectance (Millicandelas)
White	200
Yellow	150

(D) Water Absorption and Specific Gravity:

The thermoplastic material shall not exceed 0.5 percent by weight of retained water when tested in accordance with the requirements of ASTM D 570.

The specific gravity of the material, as determined by Section 11 of AASHTO T 250, shall be between 1.85 and 2.3.

(E) Bond Strength:

After heating the thermoplastic material for four hours \pm five minutes at 425° F \pm 3° F, the bond strength to Portland cement concrete shall be not less than 0.18 ksi. The bond strength shall be determined in accordance with the procedures specified in Section 7 of AASHTO T 250.

(F) Cracking Resistance at Low Temperature:

After heating the thermoplastic material for four hours \pm five minutes at 425° F \pm 3° F, applying to concrete blocks, and cooling to 15° F \pm 3° F, the material shall show no cracks when observed from a distance exceeding 1 foot. Testing for low temperature crack resistance shall be in accordance with the procedures specified in Section 8 of AASHTO T 250.

(G) Impact Resistance:

After heating the thermoplastic material for four hours \pm five minutes at 425° F \pm 3° F and forming test specimens, the impact resistance shall be not less than 10 inch-pounds when tested in accordance with Section 9 of AASHTO T 250.

(H) Softening Point:

After heating the thermoplastic material for four hours \pm five minutes at 425° F \pm 3° F and testing in accordance with ASTM D 36, the thermoplastic materials shall have a softening point of 215° F \pm 15° F.

(I) Flowability:

After heating the thermoplastic material for four hours \pm five minutes at 425° F \pm 3° F, and testing for flowability in accordance with Section 6 of AASHTO T 250, the white thermoplastic shall have a maximum percent residue of 18 and the yellow thermoplastic shall have maximum percent residue of 21.

(J) Yellowness Index:

The white thermoplastic material shall not exceed a yellowness index of 0.12 when tested in accordance with Section 4 of AASHTO T 250.

(K) Flowability (Extended Heating):

After heating the thermoplastic material for eight ± one-half hours at 425° F ± 3° F, with stirring the last six hours, and testing for flowability in accordance with Section 12 of AASHTO T 250, the thermoplastic shall have a maximum percent residue of 28.

(L) Abrasion Resistance:

The abrasion resistance of the thermoplastic material shall be determined by forming a representative lot of the material at a thickness of 1/8 inch on a 4" by 4" square monel panel (thickness 0.05 inch ± 0.001 inch), on which a suitable primer has been previously applied, and subjecting it to 200 revolutions on a Taber Abraser at 77° F, using H-22 calibrated wheels weighted to 0.55 lbs. The wearing surface shall be kept wet with distilled water throughout the test.

The maximum loss of thermoplastic material shall be 0.0011 lbs.

(M) Flash Point:

The thermoplastic material shall have a flash point not less than 475° F when tested in accordance with the requirements of ASTM D 92.

(N) Storage Life:

The materials shall meet the requirements of this specification for a period of one year from the date of manufacture. The thermoplastic must also melt uniformly with no evidence of skins or unmelted particles for this one-year period. Any material which does not meet the above requirements, or which is no longer within this one year period at the time of application, shall be replaced by the Contractor at no additional cost to the County

(O) Primer Sealer:

Primer Sealers for use on Portland cement concrete or hot mix asphaltic concrete surfaces prior to application of the thermoplastic material shall be either as recommended by the thermoplastic material manufacturer or especially compounded for use with the specified thermoplastic material.

462.2.4 Physical Requirements for Glass Beads: Inter-mix and drop-on reflective glass beads shall conform to the requirements of Section 461.2.2, except as noted herein.

The inter-mix beads shall conform to AASHTO M 247-81 (1986), type I, and may be coated or uncoated as recommended by the manufacturer. If uncoated beads are used, the thermoplastic formulation shall be configured to minimize settling of the intermix beads when the material is heated and applied.

462.3 Construction Requirements:

462.3.1 Equipment:

The equipment used to install hot applied thermoplastic material shall be constructed to provide continuous uniform heating to temperatures exceeding 400°F while mixing and agitating the

material. The heating mechanism of the kettle shall be equipped with a heat transfer medium consisting of oil or air. The burner flame shall not directly contact the material vessel surface. The mixing and agitating mechanism shall be capable of thoroughly mixing the material at a rate which ensures constant uniform temperature distribution. The kettle shall be equipped with two temperature gauges: one to indicate the temperature of the oil or air heat transfer medium, and the other to indicate the temperature of the thermoplastic material. The kettle shall also be equipped with an automatic thermostatic control device that allows for positive temperature control to prevent overheating or underheating of the material.

The conveying portion of the equipment, between the main material reservoir and the line dispensing device, shall be configured to prevent accumulation. All parts of the equipment which will come in contact with the material shall be constructed for easy accessibility for cleaning and maintenance. The equipment shall operate so that all mixing and conveying parts, including the line dispensing device, will maintain the material at the plastic temperature. The use of pans, aprons or similar appliances which the dispenser overruns will not be permitted. The equipment shall provide for varying traffic marking application widths.

All melting and application equipment shall have functioning and calibrated temperature sensing devices to verify that temperature requirements are being met. Upon request of the Engineer, the Contractor shall provide proof that the temperature sensing devices and verification thermometers are fully functional.

The application equipment to be used on roadway installations shall consist of either truck-mounted units, motorized ride-on equipment or manually pushed equipment, depending on the type of marking required. The truck-mounted or motorized ride-on units for center lines, lane lines and edge lines shall consist of a mobile self-contained unit carrying its own material capable of operating at a minimum speed of five miles per hour while applying striping. The hand applicator equipment shall be longitudinally and transversely.

The application equipment to be used on roadway long line installations shall consist of either truck-mounted units or motorized ride-on equipment. The truck-mounted or motorized ride-on units used for center lines, lane lines, gore lines, and edge lines shall consist of a mobile self-contained unit carrying its own material capable of operating at a minimum speed of five miles per hour while applying striping, and shall be sufficiently maneuverable to install curved and straight lines, both longitudinally and transversely.

The truck shall be equipped with high pressure air spray jets in front of the pavement marking material applicators to remove loose matter from the pavement surface where the marking material is to be applied.

Hand applicator equipment, to be used for all other roadway installations, shall be either self-contained melter application units or reservoir application units that are filled from a separate melter unit. Both types of units shall be equipped to maintain and measure the required application temperatures. The hand applicator equipment shall be sufficiently maneuverable to install symbols and legends, and curved and straight lines, both longitudinally and transversely.

The application equipment shall be so constructed as to assure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off square stripe ends and shall provide a method of applying "skip" lines. The equipment shall be constructed so as to provide varying widths of traffic markings. The application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment operator shall be located in such a position as to enable full visibility of the striping apparatus.

A glass bead top dressing shall be applied to the completed thermoplastic stripe by an automatic glass bead dispenser attached to the striping machine in such a manner that the beads are applied to the molten thermoplastic material immediately after it has been applied. The bead dispenser shall utilize pressure type spray guns which will embed the beads into the stripe surface to at least one-half of the bead diameter. The bead dispenser shall be equipped with an automatic cut-off synchronized with the cut-off of the thermoplastic material.

A special kettle shall be provided for uniformly melting and heating the thermoplastic material. The kettle must be equipped with an automatic thermostat control device and material thermometer for positive temperature control to prevent overheating or underheating of the material.

The heating kettle and application equipment shall meet the requirements of the National Fire Underwriters and the National Fire Protection Association and of the state and local authorities. Thermoplastic melting units, trucks or trailers, shall be equipped with foam-type fire extinguishers suitable for application to thermoplastic material that is at the flash point. If screed or extrusion application of thermoplastic is allowed by the Engineer for short applications, the screed/extrusion application method shall be utilized wherein one side of the shaping die is the pavement and the other three sides are contained by equipment suitable for heating or controlling the flow of material. The equipment utilized shall form an extruded line which shall be uniform in shape having clear and sharp dimensions.

For handliner applications, a gravity bead dispenser may be allowed by the Engineer if it properly gauges and dispenses the correct amount of glass spheres.

462.3.2 Application:

(A) Placement Locations:

Pavement markings shall be positioned as defined on the plans and in the specifications. The Engineer may revise individual marking locations as necessary.

Thermoplastic pavement markings shall not be applied to any new asphalt-rubber pavement surface within the first 30-days after pavement placement. Temporary painted markings complying with Section 461 may be used prior to placement of the thermoplastic markings.

The Contractor shall spot mark the entire project at 10-foot intervals in conformance with the striping plans. Upon completion of the spot marking, the Contractor shall notify the Engineer that the project is ready for inspection. County will conduct an inspection after the spot marking is completed, within three working days from notification of Contractor.

Approval of the spot marking shall not relieve the Contractor from obtaining a final inspection. Upon final inspection, if the Engineer decides that more than one coat is required, it will be done at the Contractor's expense.

The final striping inspection will be made by the Engineer within three working days after all pavement markings and markers have been installed.

The Striping in the field may exceed the construction project limits in order to match and tie into the existing striping. Contractor shall perform a field inspection and determine if the striping exceeds the construction project limits.

If a conflict exists between actual field conditions and the pavement marking plans, the Contractor shall

cease work and notify the Engineer immediately.

(B) Materials Selection and Compatibility:

All thermoplastic material, drop-on glass beads, and primer-sealer will be inspected and approved by the Engineer prior to their application. The Contractor shall also provide samples of said materials if requested by the Engineer.

All materials shall be properly packaged and stored. Each container to be used on the project shall be clearly labeled to indicate the following information:

- Nature, type, and formulation of the material, including whether it is an alkyd or hydrocarbon;
- Manufacturer, batch number, and date of manufacture;
- Application requirements and constraints; and
- Compatibility requirements and constraints, particularly those pertaining to equipment, storage, and other materials to be used.

Preparation and application equipment shall be in accordance with the plans and specifications, and shall conform to the recommendations of the materials manufacturer.

Incompatible materials shall not be used together. The Contractor shall not combine alkyd and hydrocarbon materials in preparation or application equipment. The Contractor shall completely clean preparation and application equipment when materials are changed.

The Contractor shall dispose of excess materials, cleaning fluids, and all empty material containers at a site in conformance with the state and federal requirements.

(C) Equipment Inspections and Deficiencies

The Contractor shall make daily maintenance and operation inspections of all application equipment to ensure that it is operable within the requirements of the specifications. The Contractor shall inform the Engineer of any equipment breakdowns, intermittent malfunctions, or other conditions that may impact the proper application of specified markings. Any equipment judged to be unsuitable by the Engineer shall be repaired or replaced.

(D) Pavement Surface

The Contractor shall remove all dirt, grease, oil or other detrimental material from the road surface prior to application of the thermoplastic stripes, arrows, legends or symbols. Any area that cannot be satisfactorily cleaned shall be scrubbed with a biodegradable chemical called Citrus Solv Plus or approved equal.

The method of cleaning the surface is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. The method of surface preparation shall also be in accordance with the recommendations of the thermoplastic material manufacturer. Loose material including all grindings and obliterated markings shall be removed from the pavement surface and disposed of properly.

When thermoplastic markings are to be applied to new Portland cement concrete pavement, any curing compound present shall be removed by means of a high-pressure water jet or sandblasting, followed by sweeping and high-pressure air spray. The curing compound shall be removed at least two inches beyond the entire perimeter of each marking to be installed.

At the time of application of primer-sealer and thermoplastics, the road surface shall be absolutely dry with no detectable or measurable surface or near-surface dampness. If precipitation or other surface wetting is imminent, all marking operations shall be stopped. If any surface dampness is detected during marking activities, marking operations shall be stopped until the pavement dries. If the hot-applied thermoplastic marking blisters upon application, marking operations shall be stopped until the cause, potentially including subsurface moisture, is determined and corrected.

(E) Primer Application

On both old and new Portland cement concrete pavement, a primer-sealer shall be used if recommended by the thermoplastic manufacturer. The primer-sealer shall be applied at the manufacturer's recommended application rates prior to placing the thermoplastic material. The primer-sealer shall be allowed to set up for the manufacturer's specified cure or evaporation time, and shall be free of solvent and water when the thermoplastic is applied.

The thermoplastic material shall be applied to primed pavement surfaces within the working time specified by the primer-sealer and thermoplastic materials manufacturers. If the primed surfaces are not marked within these time limits, the Contractor shall re-prime the surfaces as required by the manufacturer at no additional cost to the Department. If an epoxy primer is used, the thermoplastic application shall be completed before the epoxy has cured.

Improper primer-sealer application may result in bond failure between the thermoplastic and the pavement surface and may cause the thermoplastic surface to pinhole or blister. Should these conditions occur, all application operations shall stop until the cause is determined and corrected. All such defective markings shall be removed and replaced at no additional cost to the Department.

(F) Pavement Temperatures

The air and road surface temperature at the time of application shall not be less than 55°F, and the pavement surface shall be absolutely dry. If at any time during marking operations the air or pavement temperature falls below these requirements, all marking operations shall stop. To insure optimum adhesion, the thermoplastic material shall be installed in a melted state at a temperature from 400° F to 440° F.

The Contractor shall measure pavement surface temperatures one half hour prior to the start of the striping installation activities and as deemed necessary by the Engineer until the end of the application period. For elevation changes greater than 1000 feet temperature readings at the highest elevation shall govern unless otherwise requested by the Engineer. The lowest temperature so measured shall govern, unless otherwise requested by the Engineer. The temperature measurements shall be recorded in a log book and provided to the Engineer when required. The pavement surface temperature shall be measured with a standard surface temperature thermometer or a non-contact infrared thermometer.

After installing the asphaltic concrete roadway surface, a cooling down period of at least 12 hours shall allowed prior to the installation of the pavement markings.

(G) Thermoplastic Application

The thermoplastic pavement marking material shall be extruded or sprayed on to the pavement surface at a material temperature between 400° F and 440° F, depending on manufacturer's recommendations, ambient air and pavement temperatures, and the nature of the pavement surface. The Contractor shall verify temperature requirements with a non-contact infrared thermometer where determined by the Engineer.

The alkyd and hydrocarbon thermoplastic material temperatures shall not exceed 450°F. Material temperatures exceeding 440° F shall be allowed for short periods of time; however, in no case shall the material be held for more than four hours at temperatures above 440° F. Total heating time for any batch of material shall not exceed six hours. The Contractor shall note in the temperature log the time when each batch of thermoplastic material is first heated. The start of heating time shall also be marked on the side of the kettle to which it applies.

Specified temperature requirements shall be maintained at all times during application. The Contractor shall monitor material temperature at thirty-minute intervals, unless otherwise requested by the Engineer, and maintain a log of temperature readings taken. Readings shall be taken at the melting kettle or the application outlet point, as determined by the Engineer.

The Contractor shall minimize the thermoplastic material remaining in the kettle at the end of the work day and shall blend a minimum of 80 percent fresh material the start of each day. During project delays, the Contractor may transfer heated thermoplastic material into approved containers for later re-use, subject to specified limits on total acceptable heating time for each batch.

Drop-on glass beads shall be mechanically deposited, at the specified rate, into the thermoplastic material immediately after the thermoplastic marking is applied. The bead dispenser shall evenly distribute the beads such that they embed in the surface of the thermoplastic to a depth of between 50 and 60 percent of the bead diameter. If the glass beads do not adhere to the thermoplastic marking, operations shall be stopped until the problem has been corrected. All markings which do not meet the requirements of Section 461.2.3(C), as determined by the Engineer, shall be removed by the Contractor and replaced at no additional cost to the Department.

Unless otherwise specified, thermoplastic pavement markings crosswalks, stop bars, railroad markings, chevrons, painted hatching, legends, symbols and arrows shall be installed at a thickness of 90 mils. Longitudinal markings, such as lane lines, edge lines, centerlines, taper lines, holding bars, and bike lane legends, symbols and arrows shall be installed at a thickness of 60 mils. The thermoplastic thickness shall be uniform and consistent throughout the total length of the marking project.

The Contractor shall perform periodic spot checks of thermoplastic material to verify that the required thickness has been attained. Random spot checks of the thermoplastic thickness will be made by the Engineer to ensure conformance with the required criteria. Suggested spot check procedures include the following:

Wet: Thickness can be field tested immediately after the thermoplastic marking is applied by inserting a thin, graduated machinist rule or similar instrument into the molten thermoplastic to the depth of the pavement surface. The thickness is then determined visually by noting on the scale the depth of the penetration or coating of the instrument.

Dried: Thickness can be field tested by placing a small flat sheet of metal with a known thickness immediately ahead of the striping apparatus. After striping, remove the sample and use a suitable measuring device, such as a caliper or micrometer, to determine the thickness of the dried marking.

Longitudinal lines shall be offset at least 12 inches clear from construction joints unless otherwise requested by the Engineer.

The finished thermoplastic line shall have well defined edges and be free from waviness. Lateral deviation of the thermoplastic stripe shall not exceed 1.0 inches in 100 feet. The longitudinal deviation of a painted segment and gap shall not vary more than 6 inches in a 40-foot cycle. The actual width of stripe shall be within the limits specified in the following table, according to the width of stripe called for on the plans:

Plan Width	Actual Width
4 inches	4 to 4½ inches
8 inches	8 to 9 inches
Over 8 inches	± 1.0 inches

If a preservative or fog seal is required, sufficient drying time, minimum of forty-eight (48) hours, shall be allowed before applying any pavement markings.

After the forty-eight (48) hour drying time has passed and the seal remains tacky, or excessive oil has risen to the roadway surface, a sand blotter shall be applied to absorb the excess oil. The Contractor shall sweep the roadway surface free of sand prior to pavement marking applications.

If a seal or blotter is applied after the installation of thermoplastic pavement markings, any pavement markings affected by the seal or blotter shall be removed and re-applied at the Contractor's expense.

After application and sufficient drying time, the thermoplastic marking shall show no appreciable deformation or discoloration under local traffic conditions in an air and/or road temperature ranging from -10° F to 180° F. The drying time shall be defined as the minimum elapsed time, after application, when the thermoplastic pavement markings shall have and shall retain the characteristics required herein and after which normal traffic will leave no impression or imprint on the newly applied marking. When applied at a temperature range of 412.5° F ± 12.5° F and thickness of 60 to 90 mils, the material shall set to bear traffic in not more than two minutes when the air and road surface temperature is approximately 50° F ± 3° F, and not more than ten minutes when the air and road surface temperature is approximately 90° F ± 3° F. The Engineer may conduct field tests in accordance with ASTM D 711 to verify actual drying times.

The thermoplastic shall not be applied over the decorative design in the median.

462.4 METHOD OF MEASUREMENT:

Thermoplastic pavement markings, longitudinal and transverse lines, such as edge lines, lane lines, gore lines, cross-walks and stop bars, will be measured by the linear foot along the center line of the pavement stripe and will be based on a 4 inch wide stripe. Measurement for striping with a plan width greater or less than the basic 4 inches as shown on the plans or requested by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

No measurement will be made of the number of linear feet of skips in the dashed line.

Double marking lines, consisting of two 4-inch wide stripes will be measured as two individual marking lines. Crosswalk lines, stop bars, stop lines, gore lines, cross hatch lines, chevron lines and railroad marking transverse lines will be measured for centerline length and adjusted for widths other than 4 inches as defined above.

Thermoplastic pavement symbols and legends will be measured by each unit applied. Each pavement symbol and each legend, as shown on the Plans, will be considered a unit.

No separate measurement will be made for cleaning and preparing the pavement surface, including abrasive sweeping and high-pressure air spray. The cost of disposal of excess material, cleaning fluids, and empty material containers will be considered as included in the contract items.

Removal of curing compound from new Portland cement concrete pavement and the application of primer-sealer, which is to be applied to both old and new Portland cement concrete pavement, prior to application of thermoplastic striping or marking, shall be measured by the linear foot or unit each, respectively, depending on the nature of the work to be done, and in accordance with the items of work established in the bid schedule,

462.5 BASIS OF PAYMENT:

The accepted quantities of thermoplastic pavement markings of the type specified in the bidding schedule, measured as provided above, will be paid for at the unit price, complete in place, including pavement surface preparation and glass beads.

The accepted quantities for removal of curing compound from new Portland cement concrete pavement and the application of primer-sealer, measured as provided above, will be paid for at the contract unit price per each, respectively, under the items of work established in the bid schedule.

Pavement marking stripes will be paid for at the contract unit price per linear foot complete in place for the total length of painted lines applied to the nearest foot, including surface preparation. If the Engineer determines that additional striping beyond the project limits are is required in order to tie into and meet the existing striping, then this striping will be paid for at the contract unit bid price for the total length of lines applied.

Part 400 add the following new Section:

SECTION 463

RAISED PAVEMENT MARKERS

463.1 Description:

The work under this section shall consist of cleaning and preparing the pavement surface; furnishing all materials, equipment, tools and labor; and placing raised pavement markers of the type specified at the locations and in accordance with the details shown on the plans and the requirements of these specifications.

463.2 Materials:

463.2.1 General:

Certificates of Compliance for raised pavement markers and adhesive conforming to the Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction Section 106.05, shall be submitted to the Engineer at least 10 days prior to use. A minimum of one sample per lot per type of marker shall be taken by the Engineer. The pavement marker samples shall be tested to determine conformance to the applicable standard drawings and these specifications. The pavement marker samples shall be tested to determine conformance to the applicable standard drawings and these specifications.

The base of the pavement markers shall be free from glass glaze or from substances which may reduce its bond to the adhesive. The base shall be flat and its deviation from a flat surface shall not exceed 0.05 inches.

463.2.2 Reflective Pavement Markers:

The Contracting Agency requires that all reflective markers be Stimsonite 911 brand and shall be non-adhesive with an adhesive surface.

Reflective pavement markers shall be of the following type:

Type D	Yellow, two-way
Type G	Clear, one-way
Type H	Yellow, one-way
Type 911-A	Blue, two-way

Reflective pavement markers shall be of the prismatic reflector type consisting of a molded methyl methacrylate or suitably compounded acrylonitrile butadiene styrene (ABS) shell filled with a mixture of an inert thermosetting compound and filler material. The exterior surface of the shell shall be smooth and shall contain one or two prismatic reflector faces of the color specified.

When illuminated by an automobile headlight, the color of the reflectors shall be an approved clear, yellow, or red as designated. Reflectors not meeting the required color may be rejected.

Permanent reflective pavement markers will be tested for compressive strength, abrasion resistance and specific intensity. Permanent reflective pavement markers shall have thin untempered glass or other abrasion resistant material bonded to the prismatic reflector face to provide an extremely hard and durable, abrasive resistant reflector surface.

The area covered by the glass, or other abrasion resistant surface, shall not be less than 3 square inches.

The strength by compressive loading shall be at least 2,000 lbs. for both permanent and temporary reflective pavement markers.

The original specific intensity of each reflecting surface for both temporary and permanent reflective markers shall not be less than the following:

Reflectance	Specific Intensity: candelas/foot-candle		
	Clear	Yellow	Red
0 Degrees Incidence	3.0	1.8	0.75
20 Degrees Incidence	1.2	0.72	0.30

Permanent reflective pavement markers shall be subject to an abrasion resistance test as follows:

Steel Wool Abrasion Procedure: Form a 1.0 inch diameter flat pad using No. 3 coarse steel wool per Federal Specification FF-W1825. Place the steel wool pad on the reflector lens face. Apply a force of 50 lbs. and rub the entire lens surface 100 times. After the lens surface has been abraded, the specific intensity of each clear and yellow reflective surface shall be not less than that required above for the original specific intensity.

463.2.3 Non-Reflective Pavement Markers and Reflectorized Dagmars:

Non-reflective pavement markers shall be, Type A - white

Reflectorized Dagmars shall be of the following types:

Type J	white
Type JY	yellow

Non-reflective pavement markers and reflectorized dagmars shall consist of a heat-fired, vitreous ceramic base and a heat-fired, opaque glazed surface which will produce the required properties. Markers shall be produced from any suitable combination of intimately mixed clays, shales, flints, feldspars, or other inorganic material which will meet the properties herein required. Markers shall be thoroughly and evenly matured and free from defects which will affect appearance or serviceability.

The top surface of the marker shall be in reasonably close conformity with the configuration shown on the plans. Markers shall be convex and the radius of curvature shall be between 3.5 inches and 6.0 inches, except that the radius of the ½ inch nearest the edge may be less. All edges shall be rounded and any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations.

Non-reflective pavement markers and dagmars shall meet the following requirements:

Glaze Thickness, minimum, inches	0.005
Moh Hardness, minimum	6
Directional Reflectance (White Only), minimum Glazed Surface Body of Marker	75 70
Yellowness Index (White Only), maximum Glazed Surface Body of Marker	0.07 0.12
Color (Yellow Only) Purity, percent, range Dominant Wave Length, mu, range Total Lumious Reflectance (Y valve), minimum	75 - 96 579 - 585 0.41
Compressive Strength, pounds, minimum	1,500
Water Absorption, percent, maximum	2.0
Autoclave	Glaze shall not spall, craze or peel

Reflectorized dagmars shall have encapsulated lens reflectors conforming to standard manufacturing practices.

463.2.4 Bituminous Adhesive:

Stimsonite Corporation
7542 N. Natchez Avenue
Niles, Illinois 60648

or

Crafco, Incorporated
6975 West Crafco Way
Chandler, Arizona 85226

Materials by manufacturers other than those listed above may be used but must be approved by the Engineer prior to use.

463.3 Construction Requirements:

Raised pavement markers shall be installed after the permanent pavement striping has been completed and approved.

The portion of the highway to which the markers are to be attached shall be free of dirt, existing painted lines, curing compound, grease, oil, moisture, loose or unsound layers and any other material which could adversely affect the bond of the adhesive. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. On Portland cement concrete pavement and old asphalt concrete pavements, cleaning shall be accomplished by sandblasting, followed by sweeping and/or air blowing. Newly placed asphalt concrete pavement need not be sandblasted unless, in the opinion of the Engineer, the surface is contaminated with materials that would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface in an amount sufficient to result in complete coverage of the area of contact of the markers, with no voids present and with a slight excess after the markers have been placed. The markers shall be placed in position and pressure applied until firm contact is made with the pavement. The markers shall be protected against impact until the adhesive has set to the degree acceptable to the Engineer.

Excess adhesive on the pavement and on the exposed surfaces of the markers shall be immediately removed. Thinners or solvents which may be detrimental to either the markers or the bond provided by the adhesive shall not be used in removing excess adhesive.

Markers shall not be installed when the temperature of the pavement surface or the atmosphere is less than 40° F, when the relative humidity is 80 percent or higher or when the pavement surface is not dry.

All markers shall be installed to the line approved by the Engineer and in such manner that the reflective face of the markers is perpendicular to a line parallel to the roadway centerline. No pavement markers shall be installed over longitudinal or transverse joints of the pavement surface.

463.4 Method of Measurement:

Pavement markers will be measured as a unit for each marker furnished and placed.

463.5 Basis of Payment:

The accepted quantities of pavement markers, measured as provided above, will be paid for at the contract unit price for the type designated in the bidding schedule, complete in place, including adhesive and surface preparation.

Part 400 add the following new Section:

SECTION 464

ROADSIDE SIGN SUPPORTS

464.1 Description:

The work under this section shall consist of furnishing and installing square perforated tube sign post, U-channel sign post, and foundations.

Sign post and foundations shall conform to the requirements of MCDOT Standard Details.

464.2 Materials

464.2.1 General:

Certificates of Analysis conforming to the requirements of Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction Section 106.05 shall be submitted for all square perforated tube sign posts and U-channel sign posts.

Excessive damage to the finish of the posts during shipping, handling, or installation will result in rejection of the damaged posts.

464.2.2 Perforated Sign Posts:

Single and telescoping perforated posts shall be square tube fabricated from 0.105 inch cold-rolled sheet carbon steel conforming to the requirements of ASTM A 366/A 366M. Posts shall be welded directly in the corner by high frequency resistance welding or equal. The outside edges of the posts shall be externally scarfed to agree with standard corner radii of 5/32 inch \pm 1/64 inch. Bolts, nuts and washers shall conform to the requirements of ASTM A 307, Grade A.

Perforated posts shall be galvanized after fabrication in accordance with the requirements of ASTM A 525M, Coating Designation 275. Bolts, nuts and washers shall be zinc coated in accordance with the requirements of ASTM A 153 or cadmium plated in accordance with the requirements of ASTM B 766.

The diameter of holes on perforated sign post shall be 7/16 inch \pm 1/64 inch on 1.0 inch centers, on four opposite sides for the entire length of the post. Holes shall be on the centerline of each side on true alignment and opposite to each other. All material cuts must be centered between hole patterns and at a 90-degree angle to the length of material.

The finished sign posts shall be straight and have a smooth uniform finish. All consecutive sizes of posts shall be freely telescoping for not less than 120 inches of their length without the necessity of matching any particular face to any other face.

464.2.3 U-Channel Sign Posts:

U-channel sign post shall be used for temporary signing only.

U-channel posts shall be fabricated from rerolled rail steel conforming to the requirements of ASTM A 499 or hot-rolled carbon steel bars.

Prior to rerolling the rail steel, the rail nominal weight shall be 91 pounds per yard and shall meet

the requirements of ASTM A 1 pertaining to quality assurance.

Yield Point of the steel shall be 80,000 psi minimum.

The cast heat analysis of the steel shall conform to the following requirements:

Element	Composition (Percent)
Carbon	0.67 - 0.82
Manganese	0.70 - 1.10
Phosphorus, max.	0.04
Sulphur, max.	0.05
Silicon	0.10 - 0.25

Posts shall be a uniform, modified, flanged channel section as shown in MCDOT Standard Detail 2059. Weight of the posts shall be 2.00 lbs. per lineal foot, plus or minus five percent. The post shall be punched with continuous 3/8-inch diameter holes on 1.0-inch centers. The first hole shall be 1.0 inches from top and bottom of post.

The post shall consist of two parts, a sign post and a base post. The sign post lengths shall be supplied in 6-inch increments up to 12.0 feet as required for the installation location. The base posts shall be 3.5 feet in length, pointed at one end, and have at least eighteen holes in the base post, starting 1.0 inches from the top and continuing at 1.0-inch increments.

Posts shall be machine straightened to have a smooth uniform finish, free from defects. All holes and edges shall be free from burrs. Permissible tolerance for straightness shall be within 1/16 inch in 36 inches.

Posts shall be galvanized after fabrication in accordance with the requirements of ASTM A 123. Bolts, nuts, washers and spacers shall be cadmium plated in accordance with the requirements of ASTM B 766 or zinc plated in accordance with the requirements of ASTM B 633.

U-channel base posts shall be driven into the ground to a minimum depth of 36 inches.

464.2.4 Concrete:

Concrete for perforated sign post foundations shall be Class B and conform to Section 725.

464.3 Construction Requirements:

Foundations for perforated sign posts and U-channel posts shall be constructed to the details and dimensions shown on the plans.

Sign posts shall be erected plumb.

464.4 Method of Measurement:

Perforated sign posts and U-channel sign posts shall be measured by the foot, to the nearest inch for each post furnished and installed. The total length of all posts of the same type will be rounded to the nearest foot. Telescoping post members will be considered as one post after installation and will not be measured separately. The length of Perforated sign post will be measured from the top of the

concrete post foundation to the top of the post. The length of U-channel sign posts shall not include the U-channel base post.

Perforated sign post foundations shall be measured by the unit each.

U-channel base post installations shall be measured by the unit each.

464.5 Payment:

The accepted quantities of perforated sign posts, U-channel sign posts, Perforated sign post foundations, and U-channel base post installations measured as provided above, will be paid for at the contract unit prices.

The contract unit prices paid shall include full compensation for furnishing all labor, excavation, materials, tools, equipment and incidentals, and for doing all the work involved in constructing foundations, furnishing and erecting the sign posts including galvanizing and furnishing all metal plates and hardware, as shown on the plans and as specified herein, complete in place.

Part 400 add the following new Section:

SECTION 465

SIGN PANELS

465.1 Description:

The work under this section shall consist of furnishing and installing sign panels in accordance with the details shown on the plans and the requirements set forth herein.

465.2 Materials:

465.2.1 General:

Certificates of Compliance conforming to the requirements of Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction Section 106.05 shall be submitted for all materials, including reflective sheeting, required for fabricating sign panels.

Shipment, storage, and handling of sign panels shall conform to the recommendations of the manufacturers of the sign panel components. Fabricated signs and overlay sheets shall be shipped on edge. Damage to the sign panel or legend resulting from banding, crating or stacking shall be cause for rejection of the signs.

465.2.3 Flat Sheet Aluminum Sign Panels with Direct Applied or Silk Screened Characters:

Panels shall be fabricated from 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B 209M.

Panel facing shall be prepared and covered with retroreflective sheeting in accordance with the recommendations of the sheeting manufacturer. Color and type of sheeting shall be as specified or shown on the plans.

All surfaces not covered shall be etched to reduce glare from reflected sunlight.

The retroreflective sheeting and color shall conform to the requirements of Arizona State Department of Transportation Standard Specifications for Road And Bridge Construction 2000 edition, section 1007. Splicing of retroreflective sheeting shall not be allowed on sign panels having a minimum dimension up to and including 4 feet.

Messages on these sign panels shall be reflectorized white or, if called for in the plans, opaque black and produced by silk screening or direct applied characters or lettering.

465.2.4 REFLECTIVE SHEETING:

Panels to be installed on Roadside Sign Supports shall be fabricated from flat sheet aluminum and shall be reflectorized as specified herein.

All surfaces of panels to be covered with retroreflective sheeting shall be prepared in accordance with the recommendations of the sheeting manufacturer.

(A) WARNING SIGNS:

Warning signs shall be reflectorized with yellow retroreflective Engineering grade sheeting or as

specified by the Traffic Engineer. The following will be the exceptions to this rule:

1. Stop Ahead symbol signs (W3-1a), Yield Ahead symbol signs (W3-2a), No Passing Zone pennant signs (W14-3), and Advanced Railroad Crossings signs (W10-1) shall be reflectorized with yellow Diamond grade retroreflective sheeting.
2. School Advanced Warning signs and supplemental plaques and School Crosswalk Warning Assembly signs shall be reflectorized with fluorescent yellow-green Diamond grade retroreflective sheeting.

(B) REGULATORY SIGNS:

Regulatory signs shall be reflectorized with silver-white retroreflective Engineering grade sheeting or as specified by the Traffic Engineer.

Reflectorized red signs shall be reflectorized with silver-white retroreflective Engineering grade sheeting. The red color shall be produced by silk screening.

Regulatory signs with reflectorized red circles and slashes shall be reflectorized with silver-white retroreflective Engineering grade sheeting as background. The red color shall be produced by silk screening.

All Stop Signs (R1-1), 4-Way plaques (R1-3), 3-Way plaques (R1-3a), All-Way plaques (R1-4), and Cross Traffic Does Not Stop signs (W16-1) shall be reflectorized with red/white/yellow Diamond grade retroreflective sheeting.

(C) ROUTE MARKERS:

Interstate route markers shall be cut to shape. The colors and legend shall conform to the plans and shall be reflectorized with silver-white retroreflective Engineering grade sheeting. The Interstate route colors shall be silk screened and the hue of the colors shall be within the limits established for the Interstate Route Marker sign color standards. The numerals may be silk screened or direct applied characters.

United States, State Route, and Cardinal Direction markers shall be reflectorized with silver-white retroreflective Engineering grade sheeting unless otherwise shown on the project plans.

(D) STREET NAME SIGNS:

Street Name Signs shall be reflectorized with green or blue retroreflective Engineering grade sheeting as background. The characters shall be direct applied lettering reflectorized with silver-white retroreflective Engineering grade sheeting or as requested by the Traffic Engineer. Street Name Signs fabrication and installation shall conform to the requirements of MCDOT Standard Detail 2054.

(E) METRO STREET NAME SIGNS:

Metro Street Name Sign panels shall be reflectorized with green retroreflective Diamond grade sheeting as background. The characters shall be direct applied lettering reflectorized with silver-white retroreflective Diamond grade sheeting or as requested by the Traffic Engineer. Metro Street Name Signs fabrication and installation shall conform to the requirements of MCDOT Standard Detail 4780. Internally illuminated Metro Street Name Signs shall comply with project special provision sections 470 and 477.

465.2.5 Silk Screened and Direct Applied Characters:

Silk screened letters, numerals, arrows, symbols, and borders, shall be applied on the retroreflective sheeting background of the sign by direct or reverse screen process. Messages and borders of a color darker than the background shall be applied to the reflective sheeting by direct process. Messages and borders of a color lighter than the sign background shall be produced by the reverse screen process.

Opaque or transparent colors, inks, and paints used in the screen process shall be of the type and quality recommended by the manufacturer of the retroreflective sheeting.

The screening shall be performed in a manner that results in a uniform color and tone, with sharply defined edges of legends and borders and without blemishes on the sign background that will affect intended use.

Signs after screening shall be air dried or baked in accordance with the manufacturer's recommendations to provide a smooth hard finish. Any signs on which blisters appear during the drying process will be rejected.

Direct Applied letters, numerals, symbols, borders, and other features of the sign message shall be cut from black opaque or retroreflective sheeting of the color specified and applied to the retroreflective sheeting of the sign background in accordance with the instructions of the manufacturer of the retroreflective sheeting and shall be applied by heat activation of the adhesive.

Retroreflective sheeting shall meet or exceed the minimum Specific Intensity Per Unit Area (SIA) requirements of AASHTO M 268.

465.3 Construction Requirements:

465.3.1 Fabrication:

Fabrication of the sign panels shall be in accordance with the details shown on the project plans and the requirements of these specifications. Panels shall be cut to size and shape and shall be free of buckles, warps, dents, cockles, burrs and defects resulting from fabrication. Sign panel colors, lettering, and symbols shall be in accordance with requirements established by the Manual of Uniform Traffic Control Devices (MUTCD).

Fabricated signs and overlay sheets shall be stored indoors and kept dry during storage. If packaged signs become wet, all packaging material shall be removed immediately and the signs allowed to dry. The signs may be repackaged using new dry materials. If outdoor storage is necessary, all packaging materials shall be removed. Signs shall be stored on edge, above ground, in an area where dirt and water will not contact the sign face. Materials used to support stored signs shall not contact sign faces.

465.3.2 Installation of Sign Panels:

The sign panels shall be installed on roadside sign supports in accordance with the details shown on the plans.

Minor scratches and abrasions resulting from fabrication, shipping and installation of panels may be patched; however, patching shall be limited to one patch per 54 square feet of sign area with the total patched area being less than five percent of the sign area. Panels requiring more patching than the specified limit will be rejected. Patches shall be edge sealed by a method approved by the retroreflective sheeting manufacturer.

The face of bolts on the panel face shall be anodized or painted to match the background or legend color in which they are placed. The zinc coated or cadmium plated washers on the panel face shall be the color of, or shall be painted to match, the background or legend color in which they are placed. The sign manufacturer's name and date of installation shall be placed on the back of each sign in black, one-inch block letters. Use of felt markers for this purpose will not be permitted. Bolts shall be tightened from the back by holding the bolt head stationary on the face of the panel. Twisting of the bolt head on the panel face shall not be allowed.

465.3.3 Permanent Road Closures using Type III Barricades:

Permanent Type III barricades shall be installed in accordance with MCDOT Standard Details 2057 Series as deemed appropriate to the field conditions.

465.3.4 Inspection:

An inspection of the completely installed sign panels will be made by the Traffic Engineer during the daytime and at night for proper appearance, visibility, color, specular gloss and proper installation.

Each sign panel face shall be cleaned thoroughly just prior to the inspection as recommended by the manufacturer. The cleaning solvent and cleaning material shall in no way scratch, deface or have any adverse effect on the sign panel components.

The Contractor at no additional cost to the County shall correct all apparent defects disclosed by the inspection. If color variations or blemishes between aluminum extruded sign panel increments are visible from a distance of 50 feet either during the day or at night, the panels shall be removed and replaced at the Contractor's expense.

465.4 Method of Measurement:

Sign panels will be measured by the square foot for each type or types of sign panels furnished and installed. The area of each sign panel, except for warning, regulatory and marker sign panels will be measured per Plans dimensions.

For warning, regulatory and marker sign panels, the area of each sign panel will be measured to the nearest 0.1 square foot. The areas of each rectangular, square or triangular sign panel will be determined from the dimensions shown on the project Plans. The area of irregular shaped signs, such as stop signs and route markers, will be determined by multiplying the maximum height in feet by the maximum width in feet, using the dimensions shown on the project Plans.

The total area of all sign panels of the same type will be rounded to the nearest square foot.

Metro Street Name Sign Installation shall be measured by the unit each for every installed and approved Metro Street Name Sign.

465.5 Basis of Payment:

The accepted quantities of each type of sign panel designated in the bidding schedule, measured as provided above, will be paid for at the contract unit price.

Payment will be made for the total rounded area of each type of sign panel.

The contract unit price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for performing all the work involved in furnishing and installing the sign panels, except for Metro Street Name Sign panels, complete in place, including furnishing and applying all retroreflective sheeting, all fastening hardware, all necessary sign support accessories, stringers and post ties, all as shown on the plans and as specified.

The contract unit price for Metro Street Name Sign Installation shall be full compensation for furnishing all labor, materials, tools, equipment, fastening hardware, all necessary sign support accessories, stringers, post ties and incidentals, and for performing all the work involved in installing the Metro Street Name Sign panels, complete in place, as shown on the plans and as specified.

Part 400 add the following new Section:

SECTION 470

GENERAL REQUIREMENTS FOR TRAFFIC SIGNAL AND INTERSECTION LIGHTING SYSTEMS

470.1 DESCRIPTION: It is the purpose of this section to provide general information necessary for completion of the installation of traffic signals and intersection lighting in accordance with the details shown on the Traffic Signal Plan and the Maricopa County Traffic Signal StandardMCDOT Details.

All electrical systems and appurtenances shall be complete, functional and in operating condition at the time of acceptance.

470.2 DEFINITIONS: The words defined in the following section shall for the purpose of these specifications have the meanings ascribed to them pertaining to signals and lighting.

470.2.1 Actuation:

The operation of any type of controller initiated by a detector.

470.2.2 Back Plate:

A thin metal strip extending outward parallel to the signal face on all sides of a signal housing to provide suitable background for the signal indications.

470.2.3 Controller:

That part of the controller assembly, which performs the basic timing and logic functions for the operation of the traffic signal.

470.2.4 Controller Assembly:

The complete assembly for controlling the operation of a traffic signal, consisting of a controller unit, and all auxiliary and external equipment housed in a weatherproof cabinet.

470.2.5 Coordinated Traffic Signal System:

A group of signals timed together to provide a specific relationship among signal phases.

470.2.6 Cycle:

A complete sequence of signal indications.

470.2.7 Detector:

A device for indicating the passage or presence of vehicles or pedestrians.

(A) Inductive Loop Detector:

A detector capable of sensing the passage or presence of a vehicle by a change in the inductance characteristics of the wire loop.

(B) Magnetometer Vehicle Detector:

A detector capable of being actuated by the magnetic disturbance cause by the passage or presence of a vehicle.

(C) Pedestrian Detector:

A detector for pedestrians, usually of the push button type.

(D) Video Detector:

Video Camera capable of detecting the presence or passage of vehicles or pedestrians.

470.2.8 Flasher:

A device used to open and close signal circuits at a repetitive rate.

470.2.9 Flashing Feature:

This feature, when operated, discontinues normal signal operation and causes a predetermined combination of flashing signal lights.

470.2.10 Interval:

The part or parts of the signal cycle during which signal indications do not change.

470.2.11 Luminaire:

The assembly, which houses the light source and controls the light emitted from the light source. Luminaires consist of a housing, lamp socket, reflector and glass globe or refractor when specified.

470.2.12 Manual Operation:

The operation of a signal controller unit by means of a hand-operated switch.

470.2.13 Mounting Assembly:

The framework and hardware required to mount the signal face(s) and pedestrian signal(s) to the pole.

470.2.14 Pedestrian Signal:

A traffic control signal for the exclusive purpose of directing pedestrian traffic at signalized locations.

470.2.15 Rretimed Controller Assembly:

A controller assembly for operating traffic signals in accordance with a predetermined fixed-time cycle.

470.2.16 Clearance Interval:

A clearance interval, which follows the yellow, change interval during which both the terminating phase and the next right-of-way phase display red.

470.2.17 Signal Face:

An assembly controlling traffic in a single direction and consisting of one or more signal sections. Circular and arrow indications may be included in a signal assembly. The signal face assembly shall include back plate and visors.

470.2.18 Signal Indication:

The illumination of a signal section or other device, or of a combination of sections or other devices at the same time.

470.2.19 Signal Section:

A complete unit for providing a signal indication, consisting of a housing, lens, reflector, lamp receptacle and lamp, or LED unit.

470.2.20 Traffic Phase:

A part of the time cycle allotted to any traffic movement or combination of movements receiving the right-of-way during one or more intervals.

470.2.21 Traffic-Actuated Controller Assembly:

A controller assembly for operating traffic signals in accordance with the varying demands of traffic as registered with the controller unit by detectors.

470.2.22 Vehicle:

Any motor vehicle normally licensed for highway use.

470.2.23 Yellow Change Interval:

The first interval following the green right-of-way interval in which the signal indication for the phase is yellow.

470.3 REGULATIONS AND CODES: All electrical equipment shall conform to the current standards of the National Electrical Manufacturers Association (NEMA), National Electric Safety Code (NEC), Underwriters' Laboratory Inc. (UL), when applicable. All material and workmanship shall conform to the requirements of the National Electric Code (NEC), Illumination Engineers Society (IES), Standards of the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the Traffic Signal Plan, these specifications, the special provisions, and to any other codes, standards, or ordinances which may apply. Whenever references are made to any of the standards mentioned, the reference shall be interpreted to mean the code, ordinance, or standard that is in effect at the time of the bid advertisement.

470.4 SOURCE OF SUPPLY: The Contractor shall furnish all traffic signal material and equipment required to complete the work, except Maricopa County Department of Transportation will furnish the controller cabinet for Maricopa County Department of Transportation contracted projects.

470.4.1 QUALITY REQUIREMENTS: Only materials and equipment conforming to the requirements of these specifications shall be incorporated into the work. Material and equipment

shall be new except as may be provided in the special provisions.

Maricopa County Department of Transportation reserves the right to reject proposed traffic signal material or equipment if, in the judgment of the Engineer any or all the following may apply:

1. The material or equipment is not in the best interest of Maricopa County Department of Transportation and the public.
2. The material or equipment past field performance has been unsatisfactory.
3. The material or equipment is not compatible with the material or equipment presently in use, which may cause the need to purchase additional spare parts, provide additional training, and/or long term maintenance problems.

In addition, Maricopa County Department of Transportation reserves the right to pre-approve traffic signal material and equipment by brand name model or part number which in the judgment of the Engineer meets the intended purpose of these specifications. Pre-approved items are posted on MCDOT's Procurement website: <http://www.mcdot.maricopa.gov/procurement/mcdot/aml.pdf> Deviations from the pre-approved materials list, if any, will be listed in the project special provisions or bid package construction plans. Bidders seeking to provide equipment and materials, which have not previously been approved, shall submit an approval request to the Engineer prior to the date of bid opening. Rejection or pre-approval of traffic signal material and equipment by the Engineer shall be final.

470.4.2 APPROVAL OF MATERIAL AND EQUIPMENT: All traffic signal materials and equipment shall be approved by the Engineer prior to incorporation in the work. Any work in which materials or equipment not previously approved are used shall be performed at the Contractor's risk and may be considered as unauthorized and unacceptable and not subject to the payment provisions of the contract. Such materials or equipment may be subject to removal at the discretion of the Engineer.

Before ordering or installing any material or equipment, the Contractor shall submit four (4) copies of each proposed material and/or equipment list, including shop drawings to the County at the pre-construction conference for approval by the Engineer. To be acceptable, the list shall be complete and contain all items supplied on the project by the Contractor, including pre-approved items. MCDOT reserves the right to reject an incomplete or unclear material submittal. All items on the list shall be identified by manufacturer's part number, model, specification or other pertinent catalogue information. The materials from any catalog cuts shall be clearly indicated by the contractor. One (1) copy will be returned to the Contractor for further action.

All equipment or material specified or shown on signal plans, or other drawings, by brand name, part number, or model number is intended to be descriptive of the type and quality of material or equipment desired. Another equal brand name, part number, or model number may be substituted so long as it is in accordance with these specifications and is equal in form, fit, function, performance, reliability, and is approved by the Engineer.

The contractor shall provide complete wiring diagrams for controller assemblies and auxiliary controller cabinets at the time of delivery for testing. A mylar original and four sets of prints shall be provided with each controller assembly. The wiring diagram shall illustrate all circuits and components in detail. All components shall be identified by name or number so as to be clearly noted in the drawings.

470.4.3 WARRANTIES AND GUARANTIES: In addition to the requirement of Section 108.8 manufacturers warranties and guaranties furnished for material and equipment used in the work, shall be delivered to the Engineer prior to acceptance of the project.

470.5 MARICOPA COUNTY FURNISHED MATERIAL AND EQUIPMENT: Traffic signal material and equipment furnished by Maricopa County Department of Transportation or tested by Maricopa County Department of Transportation will be made available to the Contractor as specified in the Special Provisions. All specified items will be available at the following address:

The Contractor shall call (602) 506-4885 forty-eight hours prior to pick-up of in stock items.

The cost of handling and placing all material and equipment, after delivery to including pick-up by the Contractor, shall be considered as are included in the contract price for the bid item in connection with which they are used.

The Contractor will be held responsible for all material and equipment delivered received by the Contractor. The cost to make good any shortages or deficiencies, from any cause whatsoever and for any damage which may occur after delivery receipt will be deducted from any monies due or becoming due to the Contractor.

470.6 REMOVAL AND SALVAGE OF EXISTING FACILITIES: All removals shall be done in accordance with Section 350, and as shown on the Traffic Signal Plan. Any item noted on the Traffic Signal Plan that is to be removed and salvaged shall be delivered to the County warehouse or as directed by the Engineer. The Contractor shall notify the Engineer forty-eight hours in advance of the intended date of delivery. The address for the County warehouse is:

Maricopa County Department of Transportation Warehouse
2222 South 27th Avenue
Phoenix, Arizona 85009-6357

470.6.1 METHOD OF MEASUREMENT: The cost of the removal, salvaging and delivery of existing facilities will be measured on a lump sum basis.

470.6.2 BASIS OF PAYMENT: Removal and salvaging of existing facilities, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place, as specified and described herein, and as shown on the project plans.

470.7 INSTALLATION OF TRAFFIC SIGNALS AND RELATED ITEMS

470.7.1 GENERAL: The Contractor shall furnish labor and supervision with experience in the construction of the traffic signals and all materials, equipment, tools, transportation and supplies required to complete the work in an acceptable manner; within the time specified, and in full compliance to these specifications, terms of the contract, the Traffic Signal Plan and special provisions.

The contractor shall have on the work site at all times a competent supervisor capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the construction of traffic signals. Unless waived by the special provisions, the Contractor's supervisor shall possess an International Municipal Signal Association (IMSA) Level II Traffic Signal Electrician Certification.

470.7.2 TRAFFIC SIGNAL PLAN: The Traffic Signal Plan graphically describes the location of signal component parts, the equipment and materials to be used, and the way the traffic signal is to be constructed. The plans shall be supplemented by the Traffic Signal Standard MCDOT Details or other drawing(s) deemed necessary for the acceptable completion and control of the work.

Where dimensions on the plans are given or can be computed from other given dimensions, they shall govern over scaled dimension.

After completion of the project the Contractor shall provide the Engineer with a set of as-built drawings on clean prints of the original drawings. The as-built drawing shall indicate in a neat and accurate manner all changes and revisions in the original design. As-built drawings shall be submitted before final payment for completed work will be made.

470.8 CONSTRUCTION STAGING & CONTRACTOR'S CONSTRUCTION SCHEDULE:

The following requirements shall apply in addition to the provisions of Section 108.4 and 108.5. When the underground part of an existing traffic signal re-construction is a part of a roadway widening contract, the Contractor shall schedule the construction and completion of traffic signal conduit and foundations and any other required work such that County forces will have 20 working days to complete the traffic signal re-construction, after notification of approved completion of the Contractor's intersection related work. This requirement shall apply for each signal re-construction. During these 20 working days, the Contractor shall schedule no work within or adjacent to the intersection without approval of the Engineer.

SECTION 471

ELECTRICAL UNDERGROUND INSTALLATION

471.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing and installing electrical conduit, and pull boxes for traffic signals and intersection lighting including jacking, drilling, excavating placing and compacting backfill material in accordance with the locations shown on the Traffic Signal Plan, requirements of these specifications, and MAG specifications.

471.2 MATERIALS:

471.2.1 ELECTRICAL CONDUIT: All conduit and conduit fittings shall be listed by UL, and conform to NEC standards. Except as specified below, all conduit to be installed underground or in concrete structures shall be rigid polyvinyl chloride (PVC) rigid nonmetallic type conforming to the requirements of UL 651 for Rigid Nonmetallic Conduit. PVC conduit and conduit fittings shall be Schedule 40, heavy wall, manufactured from high impact material and shall be rated for use at 90° C.

All exposed conduit and conduit fittings to be installed above ground shall be rigid metallic type manufactured of galvanized steel conforming to requirements of UL 6 for Rigid Metallic Conduit and to NEC standards.

471.2.2 CONDUIT WARNING TAPE: Conduit warning tape shall be a four (4) mil inert plastic film specially formulated for prolonged use underground and shall be a minimum of 3 inches wide. All tape shall be highly resistant to alkalis, acids, and other destructive agents found in the soil.

Tape shall have a continuous printed message warning of the location of underground conduits. The message shall be in permanent ink formulated for prolonged underground use and shall bear the words, 'CAUTION--ELECTRIC LINE BURIED BELOW' in black letters on a red background.

471.2.3 PULL BOXES: Pull boxes, pull box covers and pull box extensions shall be constructed of polymer concrete with reinforced heavy-weave fiberglass in accordance with Traffic Signal StandardMCDOT Details 4711 and 4712. Pull boxes and covers shall be concrete gray color and rated for no less than 8,000 lbs. over a 10" x 10" area and be designed and tested to temperatures of -55° F. Material compressive strength shall be no less than 1584 ksf. Covers shall have a minimum coefficient of friction of 0.5. Pull boxes shall be stackable for extra depth. Covers shall be secured with two (2) 3/8 inch corrosion resistant metallic hex bolts with corrosion resistant metallic washers. The bolts shall be in accordance with the requirements of Traffic Signal StandardMCDOT Detail 4711.

The words "TRAFFIC SIGNAL" shall be cast in the pull box covers in 1-inch high letters.

At the request of the Engineer the Contractor shall furnish pull box plans and specifications.

Chipped or cracked pull boxes, covers and extensions will not be accepted.

471.2.4 METAL JUNCTION BOXES: Metal junction boxes and covers for installation in concrete structures shall be fabricated from a minimum of 59 mils thick type 304 stainless steel. All seams shall be continuously welded and shall conform to the dimensions and details called out for or shown on the project plans. A neoprene gasket with a thickness of 1/8 inch shall fit between the box and the cover. The cover shall be made to fit securely and shall be held in place with a minimum of four stainless steel machine screws. Tabs for ease of installation may be attached to

the junction box at the option of the contractor.

471.3 CONSTRUCTION REQUIREMENTS:

471.3.1 INSTALLATION OF ELECTRICAL CONDUIT:

(A) GENERAL REQUIREMENTS: Conduit shall be furnished and installed at the locations and of the sizes shown on the Traffic Signal Plan. Unless changes are necessary to avoid underground obstructions all underground conduit shall be installed in a straight line from pull box to pull box and/or from foundation to pull box and shall be of one continuous size. Any change in conduit routing must be approved by the Engineer and documented by the Contractor on as-built traffic signal plans.

All PVC conduit shall be stored and handled in an approved manner to minimize ultraviolet deterioration due to exposure to sunlight.

The PVC conduit shall be cut square and trimmed to remove all rough edges. PVC conduit connections shall be of the solvent weld type. Purple primer conforming to the requirements of ASTM F 656 shall be applied to the joined surfaces prior to use of cement. The joint cement shall be the gray PVC cement conforming to the requirements of ASTM D 2564. Where a connection is made to rigid metallic conduit, the coupling used shall be a PVC female adapter.

Expansion joint fittings shall not be installed in PVC conduit runs between pull boxes unless specified. Expansion joint fittings shall be installed in conduit runs in which both ends of the conduit are fixed in place, such as conduit runs between two foundations. Expansion joint fittings shall be installed in conduit runs which cross a concrete structure expansion joint. Approved expansion fittings shall allow for a linear thermal expansion of up to 6 inches.

Conduit embedded in concrete structures shall be securely attached to the reinforcing steel at intervals of approximately 12 inches. Expansion fittings shall be installed where conduit crosses expansion joints in the structure. Where bonding is not continuous, expansion fittings shall be provided with a bonding jumper of number 6 AWG flexible wire. Where it is not possible to use expansion fittings, sleeves of sufficient size shall be installed to provide a minimum ½ inch clearance between the conduit and the inside wall of the sleeve. The sleeve shall be discontinuous at the expansion joints.

All existing conduits and conduit embedded in concrete structures shall be cleaned out with a mandrel and blown out with compressed air.

Field PVC conduit bends shall be made without crimping or flattening, using the longest radius practical but not less than specified by the NEC. Collapsed conduit, no matter how small, is not acceptable. The number of bends between pull boxes or between pull box and foundations shall not contain more than equivalent of two quarter bends (180 degrees, total), including the bends at the pull boxes or foundations, unless authorized by the Engineer.

PVC conduit entering a pull box or foundation shall be fitted with a factory made 90 degree elbow with a minimum sweep radius per the table below:

PVC Size	Radius
2 inches	10 inches
3 inches	13 inches

Conduit entering pull boxes shall terminate a minimum of 3” inside the box wall. The conduit shall

be between 2" and 4" above the bottom of the pull box and shall be sloped to facilitate the pulling of conductors. Conduit entering through the bottom of a pull box shall be located near the sides and ends and extend no more than 4" above the bottom of the pull box including the length of the conduit bell end in order to leave the major interior portion clear. At all outlets, conduits shall enter from the direction of the run and allow for expansion and contraction.

Conduit for future use shall have a ¼ inch nylon rope or a No. 8 AWG bare copper wire installed as called for on the bidding schedule which extends 24 inches beyond each end of the PVC conduit run. This pull rope or bond wire shall be coiled and inserted into the conduit so as to be easily recovered from either end. Conduit ends shall be capped with conduit end cap fittings after the pull rope is installed. Conduit end cap shall remain in place until wiring is started. When end caps are removed, PVC ends shall be provided with an approved conduit end bell. End bells shall be installed prior to the installation of the conductors. Approved insulated grounding bushings shall be used on steel conduit ends.

The Contractor shall place warning tape (as specified in Section 471.2.2) in all open trenches in which conduit is placed. All warning tape shall be buried at a depth of 6" to 8" below final grade.

Where conduit is to be installed under existing roadway pavement by jacking or drilling methods, the jacking and/or drilling pits shall be kept 2 feet clear of the edge of the pavement.

Conduit stub-outs under curbs or roadway edges for loop detection lead-in conductors shall conform to the requirements of Traffic Signal Standard MCDOT Details 4758 and 4759. Loop detection conduit stub-outs shall not be installed until completion of curb and gutter work. A 3-inch "X" shall be chiseled into the curb directly over conduit located under curbs.

Installation of conduit for underground electrical service shall be in accordance with the Standard Details, as shown on the Traffic Signal Plan and in accordance with the requirements of the utility company providing electrical service. Conduit installed in railroad right-of-way shall be installed in accordance with the requirements of the railroad company.

(B) CONDUIT DEPTH REQUIREMENTS: Conduits installed in protected areas such as behind curbs, under side-walks, etc., that are not subject to any vehicular traffic shall be at a minimum depth of 24 inches below final grade. Conduits installed under roadways, driveways, or any open area where there is the possibility of vehicular traffic, shall be installed at a minimum depth of 36 inches below final grade. When conduit cannot be installed at the minimum depth, it shall be completely encased in 3" of class C concrete in accordance with Section 725.

(C) TRENCHING, BACKFILLING AND COMPACTION: Trenches shall not be excavated wider than necessary for the proper placement of conduit and pull boxes. Trenching shall be done in accordance with MAG Section 601. Backfilling, compaction and bedding of conduit runs shall be in accordance with MAG Section 601.4.9.

Open trench excavation across any existing paved areas, shall have two (2) parallel cuts made at a distance not to exceed 16 inches. All removal and replacement of existing paved areas shall be in accordance with Section 336.

Open trench excavation across an existing Portland concrete area shall have two (2) parallel cuts made at a distance not to exceed 16 inches. All removal and replacement of existing Portland concrete areas shall be done in accordance with Section 336.

After each excavation is complete and materials in place, the Contractor shall notify the Engineer for inspection, and under no circumstances shall any underground material or equipment be covered with fill without proper approval.

471.3.2 INSTALLATION OF PULL BOXES: Pull boxes of the type specified on the Traffic Signal Plan shall be furnished and installed at the locations shown on the Plan. Pull boxes shall be installed in accordance with the Traffic Signal Standard MCDOT Detail 4713. All relocation of pull boxes to avoid driveways and/or other structures shall be approved by the Engineer and documented by the Contractor on the as-built traffic signal plans.

Pull boxes shall be set and adjusted so that they are flush at curb or sidewalk grade. When no grade is established pull boxes shall be set as requested by the Engineer.

All pull box covers shall be secured with the required bolts and washers before final acceptance of the project.

All pull boxes shall be left in a clean condition, free of dirt and debris upon completion of the work.

471.4 METHOD OF MEASUREMENT:

Conduit will be measured by the linear foot for each diameter size.

Pull boxes will be measured as a unit for each pull box size.

471.5 BASIS OF PAYMENT:

The accepted quantities of conduit, measured as provided above, will be paid for at the contract unit price per linear foot, which shall be full compensation for the item, COMPLETE IN PLACE, including excavation, backfill, warning tape, pull rope or bond wire and any incidentals necessary to complete the work. No direct payment will be made for rigid metal conduit bends or rigid non-metallic conduit bends at pull boxes, expansion fittings and coupling fittings, the cost being considered as included in the contract price for the conduit items.

The accepted quantities for pull boxes, measured as provided above, will be paid for at the contract unit price, each, which shall be full compensation for the item, COMPLETE IN PLACE, including any excavating, backfilling and landscaping necessary to complete the work.

SECTION 472

TRAFFIC SIGNAL FOUNDATIONS

472.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing all materials and constructing all traffic signal foundations including signal poles, cabinet and electrical service pedestal foundations for the traffic signals and intersection lighting system in accordance with the locations and details designated on the Traffic Signal Plan, MAG Specifications, and the requirements of these specifications.

Traffic signal pole foundations shall include all conduit, conduit elbows, anchor bolts, re-bar cages, grounding electrode, and forms required for construction of the foundation. The traffic signal pole foundations shall conform to the requirements of the Traffic Signal StandardMCDOT Details, 4720 and 4721.

The cabinet and service pedestal foundations shall conform to the requirements of Traffic Signal StandardMCDOT Details 4723 and 4724.

472.2 MATERIALS:

472.2.1 EXCAVATION AND BACKFILL: Trenches shall not be excavated wider than necessary for the proper placement of conduit and pull boxes. Trenching, backfilling and compaction shall be done in accordance with Section 601.

All excavations within the roadway shall be backfilled and compacted in accordance with Section 211.

472.2.2 CONCRETE: Concrete used for all foundations shall be class 'A' concrete and shall be in accordance with the requirements of Section 725.

472.2.3 ANCHOR BOLTS: All anchor bolts shall be in accordance with Traffic Signal StandardMCDOT Details 4725 and 4726.

All anchor bolts shall be threaded at the top and shall conform to the plans.

472.2.4 REBAR CAGE: All rebar cages shall be in accordance with Traffic Signal StandardMCDOT Detail 4721.

472.2.5 ELECTRICAL CONDUIT: All electrical conduit and conduit fittings shall be in accordance with these specifications.

472.2.6 GROUNDING ELECTRODE: The grounding electrode shall be in accordance with these specifications and Traffic Signal StandardMCDOT Details 4720, 4721, 4723 and 4724.

472.3 CONSTRUCTION REQUIREMENTS: The excavations required for the installation of foundations and other items shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping and other improvements. Any damage by the contractor's operation shall be replaced or reconstructed where determined by the Engineer at the expense of the contractor. The trenches shall not be excavated wider than necessary for the proper construction of the foundations and other equipment. Excavation shall not be performed until immediately before construction of foundations. The material from the excavation shall be placed in a position that will minimize obstructions to traffic and interference with surface drainage.

All surplus excavated material shall be removed and properly disposed of within 48 hours by the contractor, as directed by the Engineer. After each excavation is completed, the contractor shall notify the Engineer for inspection, and under no circumstances shall any underground materials or equipment be covered with fill without the approval of the Engineer.

Excavation and backfill shall be in accordance with the requirements of Section 105.12. At the end of each working period, all excavations shall be barricaded or covered, or both, to provide safe passage for pedestrian and vehicular traffic.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted at any time, unless otherwise provided in the Special Provisions.

Sidewalk and pavement excavations shall be kept well covered and protected to provide safe passage for pedestrian and vehicular traffic until permanent repairs are made.

The elevation of signal and lighting pole foundations shall be set as follows unless otherwise noted within the construction plans or special provisions. Signal and lighting pole foundations shall be set flush with the existing or new curb and sidewalk when sidewalk is present, or flush with the finished grade. Where curb exists without sidewalk, the foundations shall be set flush with a surface defined by a 1.5% upward slope from the top of curb. Where there is no curb or sidewalk, except in sloped areas pole foundations they shall be as shown on the project plans. The dimensions and locations of foundations shall be as specified on the project plans; however, the Engineer may direct that changes be made in locations due to obstructions or other existing conditions. Any change in locations shall be documented by the contractor on as-built traffic signal plans. The contractor shall verify top of foundation elevations with the Engineer prior to foundation construction.

Concrete shall be placed in holes which have been augured against undisturbed earth. If the material in the bottom of the hole is not firm and stable, it shall be compacted or treated as directed by the Engineer. The walls and the bottoms of the holes shall be thoroughly moistened prior to placing concrete.

If the soil is not stable, a deeper foundation than specified may be required or forms shall be used as determined by the Engineer. The forms shall be of the proper size and dimensions and shall be rigid and securely braced.

Foundation forming material shall extend no more than 20 inches below the foundation final grade and shall be removed after placement and curing of concrete.

Anchor bolts shall be oriented such that the bolt pattern sides are both parallel and perpendicular to the roadway centerlines unless otherwise specified on the Traffic Signal Plan. A 25-foot coil of No. 4 AWG bare copper conductor shall be installed in accordance with Traffic Signal Standard MCDOT Details. Anchor bolts, conduit and rebar cage shall be centered within the foundation, set at the specified height and plumb within $\pm 1/2$ degree. During placement of concrete, anchor bolts shall be securely held in proper alignment, position, and height with a suitable template.

After excavations are completed and anchor bolts and conduit installed, the Contractor shall notify the Engineer for inspection. Under no circumstances shall concrete be placed without approval of the Engineer.

The concrete pour shall be continuous and consolidated by means of vibrators. All exposed surfaces of the foundation shall receive a finish that is smooth, level, and free of form marks.

Type 'A' and 'SB' pole foundations, type 'P' cabinet foundation, and type 'SP' service pedestal

foundation shall set for a minimum of three (3) days prior to installation of poles and/or cabinets. Type 'E', 'F', 'J', 'Q', 'K' and 'R' pole foundations shall set for seven (7) days prior to installation of poles.

Before the concrete for the cabinet foundation has set, depressions shall be made around the anchor bolts for adjustment of the cabinet leveling nuts in accordance with Traffic Signal Standard MCDOT Detail 4723.

472.4 METHOD OF MEASUREMENT: Foundations for traffic signals and intersection lighting system will be measured as a unit for each type of foundation constructed.

472.5 BASIS OF PAYMENT: The accepted quantities of foundations for traffic signal and intersection lighting system, measured as provided above, will be paid for at the contract unit price each, for the type of foundations designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described including excavations, backfill and incidentals necessary to complete the work.

No measurement or direct payment will be made for anchor bolts or re-bar cages, the cost being considered as included in the unit price paid for foundations.

Part 400 add the following new Section:

SECTION 473

DETECTORS

473.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing and installing vehicular and pedestrian detectors at the locations shown on the Traffic Signal Plan and in accordance with the requirements of these specifications.

473.2 MATERIALS:

473.2.1 LOOP DETECTOR SENSOR: Loop detector sensors shall be of the size and type specified on the Traffic Signal Plan and shall conform to the requirements of Traffic Signal StandardMCDOT Detail 4757. The conductors for inductive loop detection and the loop detector lead in cable shall be as specified by Section 478.2.1.

Roadway loop detector sensor wire shall conform to IMSA specification 51-5, or be number 14 AWG stranded copper with USE XLPE cross-linked polyethylene insulation and installed in accordance with the requirements of these specifications and Traffic Signal StandardMCDOT Details 4757, 4758, and 4759 and 4760.

473.2.2 (A) HOT APPLIED RUBBERIZED SEALANT: The saw cut loop sealant shall be a hot applied rubberized asphalt formulated specifically for use as a loop sensor saw cut sealant. The sealant shall be non-tracking during application and relatively stiff but flexible after application at low pavement temperatures. At application temperatures the sealant shall be a thin, free flowing fluid which penetrates the saw cut, encapsulating the loop conductors and self-levels permitting uniform and easy application.

The sealant shall be applied using a pressure feed melter/applicator equipped with a heated hose and handgun control.

When heated in accordance with ASTM D3407 the sealant shall meet the following physical properties:

SPECIFICATIONS

TEST PARAMETER	LI MI TS	TEST METHOD
Cone Penetration, TIF 150g, 5 sec; .004 inch	35 max	ASTM D 3407, Sec. 5
Flow, 140F, SM; inch	0.2 max	ASTM D 3407, Sec. 6
Resilience, TIF	30% min	ASTM D 3407, Sec. 8
Softening Point	180 °F min	ASTM D 2398
Ductility, TIF 2"/min	12" min	ASTM D 113
Mandril Bend	Pass	SEE NOTE BELOW

Pour Temperature	379 °F	
Safe Heating Temperature	410 °F	

NOTE: A sample of sealant is poured in a 0.12 inch thick by 1.0 inch wide and 4.0 inches long configuration on a glycerin coated brass plate using appropriate molds. The specimen is removed from the molds, placed in a freezer maintained at 0°F ±2°F for one (1) hour. To test, remove the specimen from the freezer and immediately bend over a 1-inch diameter mandril through a 180-degree arc in five (5) seconds at a uniform rate. To pass the test, the sample shall not show any cracks.

473.2.2(B) OPTIONAL COLD APPLIED EMULSION SEALANT: As an alternative sealant, the loop sealant shall be a single component asphaltic emulsion sealant designed to fill and seal inductive loop saw cuts. Loop sealant shall be “Tri-American TA-500” or approved equal.

SPECIFICATIONS

TEST PARAMETER	LIMITS	TEST METHOD
Residue by evaporation, weight percent	70 min	ASTM D 2939
Ash content, weight percent	50 min	ASTM D 2939
Firm set time, hours	4 max	ASTM D 2939
Brookfield viscosity, Poise RVT Spindle #3, 10 RPM at 75 ± 2 ° F	50 to 125 °F	
Tensile strength, psi,	20 min	ASTM D 2523
Elongation, %	2.0 min	ASTM D 2523
Flexibility	No full depth cracks	ASTM D 2939 SEE NOTE BELOW
Resistance to water	No blistering, re-emulsification or loss of adhesion	ASTM D 2939, Alternative B

NOTE: Flexibility: Except air-dry specimens to constant weight at 75° ± 5° F and 50° ± 10° F relative humidity. Condition the mandril and specimens for 2 hours at 75° ± 2° F before test.

473.2.3 PEDESTRIAN DETECTORS: All pedestrian push buttons shall be in accordance with the Americans with Disabilities Act Accessibility Guidelines (latest revision). The pedestrian detector shall be a push-button switch mounted inside an approved push-button housing. The switch shall be the phenolic-enclosed SPST-type with momentary contacts. The contacts shall be rated at 15 amps and 125 volts AC. The switch shall have screw-type terminals and shall have a rated life of not less than one million operations. The switch shall operate in the normally open position.

The housing of the push-button station shall be of substantial tamper-proof construction made of cast aluminum. The assembly shall be weather-proof and so constructed that it will be impossible to receive any electrical shock under any weather conditions. The housing shall be shaped to fit the curvature of the pole to which it is attached and shall provide a rigid installation. The housing body shall contain a direct push-type actuator button, microswitch-type or approved equal. The housing cover shall contain the push-button sign as described below.

Pedestrian push-button signs shall be made with porcelain enameled 20-gage sheet steel, 9.5 inches by 12 inches in size. Corners of the sign shall be finished round for safety and neat appearance. Each hole shall be provided with a brass grommet. Instructions on the signs shall be black enameled letters or symbols on a white enamel background. The legend shall be as shown on the plans or Detail 4797-1.

473.2.4 VIDEO DETECTORS: Video detectors for signalized intersections shall comply with the specification as set forth in Section 485.

473.3 CONSTRUCTION REQUIREMENTS:

473.3.1 VEHICULAR LOOP DETECTOR SENSORS:

(A) GENERAL: Vehicular loop detector sensors of the size and type specified on the Traffic Signal Plan shall be installed in accordance with the locations shown on the Traffic Signal Plan and the requirements of these specifications. Any change in loop detector sensor location or deviation in loop detector sensor installation not in accordance with these specification must be approved by the Engineer and documented by the Contractor on as-built signal plans. The installation of the detectors shall be such that the operation shall not be affected by temperature changes, water, ice, rain, snow, chemicals, or electromagnetic noise.

(B) LOOP DETECTOR SENSOR CONDUCTOR INSTALLATION: The loop detector sensor conductors shall be installed in accordance with Traffic Signal StandardMCDOT Detail 4757. All saw cuts shall be made with an abrasive type saw. The sawed slot shall extend to the curbside PVC conduit for each loop sensor. Separate lead-in sawed slots extending from the loop to the stub-out conduit shall be cut for each loop sensor. To insure that all saw cuts are true and straight a loop sensor layout shall first be made on the pavement surface.

All corner and diagonal points shall be cored drilled at full depth.All diagonal and corner saw cuts shall overlap such that the sawed slot is at full depth at turn points.

The sawed loop sensor slot shall be flushed clean of all debris with a high-pressure stream of water and completely dried by means of an air stream prior to installation of loop sensor conductors.

After the sawed slot is dry and free of debris, wind the specified number of wire turns into the sawed slot in accordance with the details shown on the Traffic Signal StandardMCDOT Detail 4757. Wind loops which are in close proximity in opposite directions, (i.e. No. 1 clockwise, No. 2 counter clockwise, etc.). This may be accomplished by reversing loop "start-finish" lead-in conductors at the curb-side pull box.

The lead-in conductors from the loop sensor to curb-side pull box shall be continuous and twisted a minimum of six turns per foot in the lead-in saw cut and under curb stub out conduit.

(C) SAWCUT SEALANT: The loop sensor conductors shall be permanently anchored in the sawed slot using the hot applied rubberized asphalt or cold applied single component emulsion sealant as specified. The sealant shall completely surround the loop sensor conductors and fill the sawed slot to within 1/8 inch of the pavement surface. Surplus sealant shall be removed from the road surface without the use of solvents.

(C.1) Hot Application: The sealant shall be applied with a sealant melter/applicator which melts the sealant and pressure applies the sealant at 379° F via a heated hose and applicator handgun control. The handling of the sealant melter/applicator and the filling of the saw slot shall be in accordance with the directions of the melter/applicator manufacturer.

(C.2) Cold Application: The emulsion sealant shall be thoroughly mixed per the manufacturer's recommendations. The emulsion sealant may be poured directly from container or any other suitable applicator, applied into sawcuts.

(D) LOOP DETECTOR SENSOR CONNECTION: Each pair of loop sensor conductors entering the curb-side pull box shall be identified as to which loop it represents (i.e. inside lane, outside lane, through lane, or left turn lane). Each conductor pair shall also be marked to signify its winding direction, "S" for start and "F" for finish. Marking identification tags shall be in accordance with Section 478.2.1.

The loop sensor conductors shall be spliced to the detector lead-in cables in the adjacent curb-side pull box. Detector lead-in cable shall run continuous and unspliced from curb-side pull box to the controller cabinet in accordance with Traffic Signal Standard Detail 4760.

Unless otherwise specified or requested, the maximum number and size of loop detector sensors connected to a detection channel shall be as follows:

LOOP SIZE	LEAD-IN LENGTH	LOOP S PER CHANNEL	LOOP CONNECTION	LOOP USE
6.0 ft. x 6.0 ft.	500 ft. or less	2-3	Series	Advance detection
6.0 ft. x 6.0 ft.	500 ft. or greater	1	N/A	Advance detection
6.0 ft. x 40.0 ft.	200 ft. or less	2-3	Series	Call detection
6.0 ft. x 40.0 ft.	200 ft. or greater	1-2	Series	Call detection
6.0 ft. x 50.0 ft.	As required and greater	1	N/A	Left turn detection

All detector wire splices will be made by the MCDOT Signal Shop at time of acceptance of the detectors

(E) LOOP DETECTOR SENSOR FIELD TEST: Before and after sealing the saw cut the Contractor shall perform an insulation resistance to ground test. The insulation resistance to ground shall be at least 50 mega-ohms measure at a voltage between 400 and 500 volts D.C. Any loop detector sensor not meeting the above insulation test or fails to tune when connected to a loop

detector amplifier unit shall be replaced by the Contractor at no cost to Maricopa County Department of Transportation.

473.3.2 VIDEO DETECTORS:

Video detectors for signalized intersections shall comply with the specification as set forth in Section 485.

473.4 METHOD OF MEASUREMENT: Vehicular and pedestrian detectors will be measured as a unit for each type of detector furnished and installed.

473.5 BASIS OF PAYMENT: The accepted quantities of detectors measured as provided above, will be paid for at the contract unit price each for the type detector designated on the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described and specified herein and on the signal plan.

Part 400 add the following new Section:

SECTION 474

TRAFFIC SIGNAL POLE INSTALLATION

474.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing and installing traffic signal poles, mast arms, and modifying multi-use poles in accordance with the Traffic Signal Plan, the Traffic Signal Standard MCDOT Details, the special provisions, and these requirements of this specifications.

Standard poles for traffic signals shall include a shaft, base, anchor bolts, mast arms (if required), and other hardware required to support the traffic signal apparatus.

474.2 GENERAL STANDARD: Steel poles for traffic signals and highway lighting shall include pole shafts, mast arms, and pole bases.

Material standards for traffic signal and lighting supports shall be in conformance with the current edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. All pole supports shall be designed to withstand 80 mph winds.

All welding design, fabrication and inspection of welding for structural steel shall be performed in accordance with the requirements of the latest edition of the American Welding Society (AWS) Structural Welding Code AWS D1.1-Steel, and the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. In the event of any conflict, the latter specifications shall govern.

The use of electro-slag welding process on structural steel will not be permitted.

474.3 TYPES OF POLES: Types of poles to be furnished are as follows:

1. Type 'A', Standard Detail 4738
2. Type 'E', Standard Detail 4740
3. Type 'F', Standard Detail 4741-1
4. Type 'J', Standard Detail 4742
5. Type 'Q', Standard Detail 4743
6. Type 'SB', Standard Detail 4745
7. Type 'K', Standard Detail 4748
8. Type 'R', Standard Detail 4749-1
9. Type 'PB' Standard Detail 4750

(A) Pole Shafts: The tapered pole shafts shall be fabricated from sheet steel of weldable grade which shall meet or exceed the minimum strength requirements of ASTM A 36 for all poles except the Type K and the Type R poles. The Type K and Type R poles shall be constructed from sheet steel that has a minimum yield stress after fabrication of 48 ksi. A tapered rate of 1/8 inch change in diameter per linear foot shall be required unless otherwise specified. Pole shafts shall be fabricated according to the thickness requirements shown on the Standard Details.

Standard pipe pole shafts for Type A poles shall be fabricated from standard weight structural steel which conforms to the minimum strength requirements of ASTM A 53, Grade B and an outside diameter in inches as indicated on the Standard Details. Each section shall be fabricated from not more than two pieces of sheet steel. When two pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded, seams shall be directly

opposite one another. When the sections are butt-welded together, the longitudinal welded seams on adjacent sections shall be placed to form continuous straight seams from base to top of pole. Pole shafts shall be straight, with a permissive variation not to exceed 1-inch measured at the midpoint.

Pole shafts shall be galvanized in accordance with the requirements of ASTM A 123. The visual appearance of the galvanized finish shall be uniform. Discoloration of the galvanized finish such as dark areas, dark streaks, dark rings or transportation handling marks, which are considered excessive by the Engineer, shall not be allowed. Pole shafts that have a finish unacceptable to the Engineer shall either be repaired or replaced to the satisfaction of the Engineer at no additional cost to the Department.

Hand holes in the base of the poles shall conform to the details shown on the Standard Details. All welds shall be continuous and any exposed welds, except fillet welds, shall be ground flush with the base metal.

A metal tag shall be permanently attached to the pole above the hand hole stating the manufacturer's name, pole type per the Department's plan, pole drawing number, shaft length and inches of material thickness.

(B) Standard Bases: Poles shall have standard bases fabricated from structural steel plates, as per the Traffic Signal StandardMCDOT Details, and conform to the minimum strength requirements of ASTM A 36. Exposed surfaces shall be finished smooth and all exposed edges shall be neatly rounded to a 1/8 inch radius. Standard bases shall be galvanized in accordance with the requirements of ASTM A 123.

(C) Anchor Bolts: All anchor bolts shall be threaded at the top and shall conform to the plans.

High strength anchor bolts, washers and nuts shall be fabricated from steel which meets or exceeds the minimum requirements of ASTM A 325 and shall be electro-galvanized in accordance with the requirements of ASTM B 633. Welding shall not be performed on any portion of the body of these anchor bolts. Certificates of Analysis conforming to the requirements of Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction Section 106.05 shall be submitted for high strength anchor bolts, washers and nuts.

(D) Mast Arms: The tapered mast arms shall be fabricated from sheet steel conforming to the requirements of ASTM A 36. The mast arms for the Type K and Type R poles shall be constructed of sheet metal with a minimum yield stress of 48 ksi after fabrication. Mast arms shall be fabricated according to the thickness requirements shown on the Traffic Signal StandardMCDOT Details. A tapered rate of 1/8 inch change in diameter per foot shall be required unless otherwise specified. All bolts, washers and nuts for mast arms shall be fabricated from steel conforming to the requirements of ASTM A 325 and shall be electro-galvanized in accordance with the requirements of ASTM B 633.

Mast arms shall be galvanized in accordance with the requirements of ASTM A 123. The visual appearance of the galvanized finish shall be uniform. Discoloration of the galvanized finish such as dark areas, dark streaks, dark rings or transportation handling marks which are considered excessive by the Engineer shall not be allowed. Mast arms that have a finish unacceptable to the Engineer shall either be repaired or replaced to the satisfaction of the Engineer at no additional cost to the County.

Mast arms shall be bent to the dimensions and curvature shown on the Traffic Signal StandardMCDOT Details.

A metal tag shall be permanently attached on the side of the mast arm near the base stating the manufacturer's name, pole type per the Department's plan, mast arm or pole drawing number, length and material thickness.

(E) Luminaire Mast Arms: The tapered mast arms for the luminaires shall be fabricated from sheet steel conforming to the requirements of ASTM A 36. Mast arms shall be fabricated according to the thickness requirements shown on the Traffic Signal StandardMCDOT Details. A tapered rate of 1/8 inch change in diameter per foot shall be required unless otherwise specified. All bolts, washers and nuts for mast arms shall be fabricated from steel conforming to the requirements of ASTM A 325 and shall be electro-galvanized in accordance with the requirements of ASTM B 633.

Luminaire mast arms shall be galvanized in accordance with the requirements of ASTM A 123.

Mast arms shall be bent to the dimensions and curvature shown on the Traffic Signal StandardMCDOT Details.

A metal tag shall be permanently attached on the side of the mast arm near the base stating the manufacturer's name, pole type as required on the plans, mast arm or pole drawing number, length and thickness in inches.

474.4 WARRANTIES: Each type 'A', 'E', 'F', 'J', 'Q', 'SB', 'K', 'R' and 'PB' signal pole shall be warranted by the manufacturer against all defects in material and workmanship for a period of twelve (12) months and in accordance with the requirements of Section 108.8.

474.5 CONSTRUCTION REQUIREMENTS:

474.5.1 Base Plates and Poles:

High strength bolts, nuts, and washers for bases shall be assembled as specified in the Standard Details and shall be torqued as required by the Standard Details. Anchor bolts, washers, and nuts required for relocating existing poles shall be furnished by the contractor.

Poles shall be drilled and tapped for mounting hardware as shown on the Standard Details.

Sidewalks, curbs, gutters, pavement, base material, lawns, plants, and any other improvements removed, broken, or damaged by the contractor's operations shall be replaced or reconstructed with materials in accordance with these specifications. The replaced or reconstructed improvements shall be left in a serviceable condition satisfactory to the Engineer, and shall conform to these specifications where applicable.

Where existing pole installations are to be modified, materials and equipment shall be used, salvaged, or disposed of as specified in the Special Provisions and as directed by the Engineer.

Existing poles shall be either relocated or used in place as specified in the project plans. The contractor shall inspect the poles and provide the materials and work necessary to recondition the poles so they can be reused. Holes left in the shafts of existing poles, due to removal of items such as signal mounting assemblies, shall be repaired and painted with a zinc galvanized paint.

If any poles are damaged by the contractor's operations, such repairs or replacements shall be at no additional cost to the Department.

New poles that are damaged by improper drilling of holes will be rejected.

474.5.2 SIGNAL POLES AND MAST ARMS: Poles and mast arms shall be of the type shown on the Traffic Signal Plan and shall be installed in accordance with the Traffic Signal StandardMCDOT Details.

Poles shall be drilled and tapped for mounting of hardware. The use of a welding torch is not authorized.

All poles shall be plumbed to the vertical with all mast arms, signal heads, and luminaires installed. When mast arms are bolted to the pole shaft, the mast arm end over the roadway shall adjust to the horizontal.

474.6 METHOD OF MEASUREMENT:

Poles for traffic signals will be measured as a unit for each type pole installed, COMPLETE IN PLACE. The poles furnished, including signal and luminaire mast arms, base plates and all materials required shall be furnished by the contractor unless otherwise indicated, COMPLETE and installed IN PLACE.

474.7 BASIS OF PAYMENT: The accepted quantities of poles, measured as provided above, will be paid for at the contract unit price each, for the type of pole designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described including all incidentals necessary to complete the work.

Part 400 add the following new Section:

SECTION 475

ELECTRICAL POWER SERVICE AND CONTROLLER CABINET INSTALLATION

475.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing and installing electrical power service equipment in accordance with the location and details on the Traffic Signal Plan, Traffic Signal StandardMCDOT Details, and the requirements of these specifications, and the specifications of the utility company serving the location, and the picking up, installing and wiring of the controller cabinet assembly in accordance with the type and location as designated on the Traffic Signal Plan and the requirements of these specifications

475.2 MATERIALS:

475.2.1 ELECTRICAL SERVICE PEDESTAL: The underground service meter pedestal (TESCO catalog number 26-000 or pre-approved equal) consisting of the meter socket, circuit breaker panel, test bypass facilities, pedestal locking device and necessary fittings all of which shall conform to the material requirements specified by Traffic Signal StandardMCDOT Details 4731 and 4798.

Electrical service equipment wiring and wiring devices shall be in conformance with NEMA, the NEC, Traffic Signal StandardMCDOT Details and the specifications of the utility company providing electrical service.

(A) BREAKERS: All circuit breakers shall have an interruption capacity of 10,000 amperes and supplied as follows:

- 20 amp -- Luminaire circuit
- 30 amp -- 2 phase signal circuit
- 50 amp -- 4 and 8 phase signal circuits

(B) METER LOOP ASSEMBLY: The meter loop assembly shall be bonded and grounded in accordance with the requirements of these specifications.

(C) CONDUCTORS: Conductor size and color shall be as specified on the Traffic Signal Plan conductor schedule and in accordance with the requirements of these specifications. All electrical apparatuses shall be UL listed.

475.2.2 CONTROL CABINET ASSEMBLY: The Controller Cabinet Assembly shall include a weatherproof cabinet furnished by Maricopa County Department of Transportation.

Cabinet types and configurations shall be supplied as specified on the Traffic Signal Plans, Standard Details, and in accordance with of these specifications.

475.2.3 BATTERY BACKUP SYSTEM: The battery backup system (Alpha Technologies catalog number UPE-6 or pre-approved equal generally consisting of a ground mount enclosure, gel-cell batteries, and power supply module, shall conform to the material requirements specified by MCDOT Detail 4732, the Traffic Signal Plans, these specifications, and the project special provisions.

475.3 CONSTRUCTION REQUIREMENTS:

475.3.1 ELECTRICAL SERVICE PEDESTAL: The electrical service meter pedestal shall be

assembled and installed on a concrete foundation at the location shown on the Traffic Signal Plan and in accordance with the Traffic Signal Standard MCDOT Detail 4724.

475.3.2 CONTROL CABINET ASSEMBLY: The Contractor shall notify the Engineer five (5) days in advance of the intended date the Contractor is to pick up the Control Cabinet Assembly. The wired cabinet shall be in accordance with the requirements of these specifications.

The Control Cabinet Assembly shall be picked up at the following address:

Maricopa County Department of Transportation
Traffic Signal Operations
2909 W. Durango Street
Phoenix, Arizona 85009-6357

Contractor shall install the control cabinet assembly. After the installation and leveling of a 'P' cabinet an approved non-shrink type grout shall be placed between the cabinet and foundation.

475.3.3 BATTERY BACKUP SYSTEM: Each battery backup system shall be assembled and installed on a concrete foundation at the location shown on the Traffic Signal Plan and in accordance with MCDOT Detail 4725.

475.4 METHOD OF MEASUREMENT:

Electrical power service equipment will be measured as a unit for each service furnished and installed.

Controller cabinet assemblies will be measured as a unit for each type installed.

Battery backup system will be measured as a unit for each battery backup system installed and accepted.

475.5 BASIS OF PAYMENT:

The accepted quantities of the electrical power service equipment, measured as above, will be paid for at the contract unit price, as designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described.

The accepted quantities for the installation of the controller cabinet assemblies, measured as above, will be paid for at the contract unit price each, for the type controller cabinet assembly designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described and specified herein and on the Signal Plans.

The accepted quantities of the battery backup system equipment will be paid for at the contract unit price, as designated in the bidding schedule, COMPLETE IN PLACE.

Part 400 add the following new Section:

SECTION 476

SIGNAL INDICATIONS AND MOUNTINGS

476.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing and installing vehicular and pedestrian traffic signal indications and mounting assemblies in accordance with the types and locations shown on the Traffic Signal Plan, Traffic Signal StandardMCDOT Details 4773, 4774, 4775, 4776, 4778-1, 4778-2, 4794, and 4795 and the requirements of these specifications. Signals, except pedestrian type, for newly signalized intersections shall be of the same manufacturer and of the same material.

476.2 MATERIALS:

476.2.1 VEHICULAR TRAFFIC SIGNAL HEADS: Vehicular traffic signal heads shall be assembled of standard 12 inch lens size signal sections with the number of sections or combination of sections specified on the Traffic Signal Plan, Traffic Signal StandardMCDOT Detail 4773 and the requirements of the Manual on Uniform Traffic Control Devices.

The optical performance and design of signal heads shall conform to the requirements of the Institute of Transportation Engineers Standards for Vehicular Traffic Control Signal Heads (ITE Publication No. ST-008B), the Traffic Signal Plan and the provisions of these specifications.

(A) HOUSING: A standard 12 inch signal section shall be a one (1) piece housing with hinged door for housing all optical and electrical components.

Both the one (1) piece signal section housing and door shall be fabricated of corrosive resistant die cast aluminum conforming to Institute of Transportation Engineers Standards. The top and bottom of the housing shall have openings to accommodate standard 1½ inch pipe fitting. Each opening shall have a locking "Shurlock" boss integrally cast into the housing section.

A snap-in, swing-out cast aluminum reflector ring, supported by stainless steel hinge pins shall be provided. The hinge pins shall be supported by mounting lugs integrally cast on the left side of the housing.

The housing door shall be hinged to the signal section housing by stainless steel roll pins and hinge lugs integrally cast in the door and housing. The door shall be latched by means of integrally cast door latch slots, housing hinge bolt lugs and stainless steel hinge bolts and wing nuts. The 12-inch sections require two (2) latching bolts.

A gasket groove on the inside of the door shall accommodate a neoprene gasket to form a positive seal between the door and signal housing when the door is closed and latched. Four (4) quick change type lens clips and four (4) stainless steel screws shall be provided for securing the lens and lens gasket in the door lens opening. Four (4) stainless steel washer head type screws shall be provided to secure the signal visor.

Signal section housings shall be fastened together by two (2) cadmium plated, (clover leaf type) clamping washers and three (3) carriage bolts and lock washers. Each complete signal head assembly shall be pre-drilled for mounting of signal backplates.

All signal sections and the outside surfaces of visors shall be painted gloss black. The inside of the visor shall be painted dull black. All painting shall be done by the manufacturer.

(B) VISORS: Each signal section shall have a tunnel type visor with a 5 to 7 degree downward tilt. Unless otherwise specified the 12-inch signal sections shall be furnished with 12-inch by 12-inch long visors. All visors shall be retained to the housing section door with stainless steel washer head type screws.

(C) BACKPLATES: Louvered backplates and backplate mounting hardware shall be furnished with each vehicular signal head assembly. The backplate shall be fabricated of anodized sheet aluminum. The 5.0 inch border backplates shall be provided for the 12-inch signal head assemblies. All backplates shall be painted dull black. All painting shall be done by the manufacturer.

(D) MOUNTING ASSEMBLIES: An elevator plumbizer conforming to the requirements of Traffic Signal StandardMCDOT Detail 4778-2 shall be installed with all mast arm mounted 12 inch signal heads, as shown on the Traffic Signal Plan. The plumbizer elongated bolt hole shall be positioned to align with the bolt hole drilled 2 3/8 inches from the end of the tenon on the mast arm. The plumbizer shall be held in place with a 3/8 inch bolt with a nut and two (2) washers as per the Traffic Signal StandardMCDOT Detail 4778-2. The plumbizer signal head mounting position shall be in accordance with the requirements of Traffic Signal StandardMCDOT Detail 4778-1.

Pole top and sidemount mounting assemblies shall consist of 1 7/8" outside diameter (1 1/2" nominal size) standard pipe and fittings. All members shall be so fabricated that they shall provide plumb, symmetrically arranged and securely fabricated assemblies.

Terminal Compartments – A terminal compartment shall be assembled in the mounting brackets as shown in the Standard Details and as called for on the plans. The terminal compartment shall be manufactured of bronze.

Each terminal compartment shall be fitted with a 12 position, 24 terminal block. Each type of mounting assembly shall be supplied with wiring from the terminal block through the support arm which holds the signal. This wiring shall be in the form of color-coded wire leads with spade terminals for connecting to signal head, and soldered ends for connecting to terminal strips in the terminal compartment. The wiring shall be color-coded as follows:

White	-	Common to all heads
Red	-	Red lens head
Yellow	-	Yellow lens head
Green	-	Green lens head

The leads shall be minimum number 16 stranded AWG Type THW with 30 mil thermoplastic insulation. Leads shall be of sufficient length to extend from the center section of the signal head to the top of the terminal compartment.

Terminal compartment wire hookup shall be as follows:

Top terminal	-	Phase A Red
Next terminal	-	Phase A Yellow
Next terminal	-	Phase A Green
Next three terminals	-	Phase B, R-Y-G
Bottom terminal	-	Common – White

A rainproof cover shall be provided for all terminal compartments which will provide ready access to the internal terminal block wiring.

The types of mounting assemblies used, and the methods of mounting them, shall be as shown on the Traffic Signal Plan and shall conform to the requirements of Traffic Signal Standard MCDOT Details.

476.2.2 OPTICAL SYSTEM:

(A) LENSES: The lens shall be standard red, yellow, and green conforming to the specifications of the Institute of Transportation Engineers Standards. Circular lens may be made of ultraviolet stabilized polycarbonate or glass conforming to the specifications of ASTM D2473. All arrow lenses shall be glass. Polycarbonate lens shall not show any discoloration or distortions due to heat from a 150 watt signal lamp.

The lens shall fit into a slotted silicon rubber or ethylene propylene diene monomer synthetic rubber lens gasket. The lens and lens gasket shall be secured to the housing door lens opening with the door lens clips and screws provided on the housing door.

(B) REFLECTOR: The reflector shall be a one-piece formed aluminum parabolic "alzak" finished reflector conforming to the requirements of ITE (Publication 1 No. ST-008B). A gasket shall be furnished to fit the outer periphery of the reflector. The reflector and lamp receptacle shall be retained within the snap-in swing-out reflector ring by a bail wire and spring.

With the signal section housing door closed the lens gasket shall seal against a lip on the front edge of the reflector ring to exclude contaminants from entering the optical assembly.

476.2.3 ELECTRICAL:

(A) LAMP RECEPTACLE: The lamp receptacle shall have a heat-resistant molded phenolic housing designed to fit into the hole at the rear of the reflector such that the lamp filament will be positioned at the design focal point. The lamp receptacle shall be designed so that it may be rotated to provide proper lamp filament orientation. A gasket shall be fitted between the lamp receptacle and reflector to exclude contaminants from entering the optical assembly.

(B) WIRING: Each lamp receptacle shall be provided with two color-coded leads with quick disconnect type terminal lugs. A terminal block with the required number of positions for the signal head configuration shall be placed in the yellow section. One side of the barrier-type terminal block shall be used to attach the quick disconnect lead lugs from the lamp receptacle leaving the opposite side for field wiring.

(C) LAMPS: Lamps to be used in vehicular traffic signal heads shall conform to the standards set forth in the Institute of Transportation Engineers publication "Standards for Traffic Signal Lamps" and the requirements of these specifications.

TRAFFIC SIGNAL LAMP TABLE

Lamps shall be clear and have an aluminum reflector disc. Projection type filaments shall be used, and supported at seven (7) points. The filament type shall be C-11V. Name of manufacturer, wattage, voltage, and user-hours shall be etched on lamps. The amount of krypton gas shall be not less than 80 percent of the total fill gas of the lamp. If requested by the Engineer, the lamp manufacturer shall provide a report by an independent testing laboratory certifying the beam lumens and composition of the fill gas.

476.2.4 LED SIGNAL LAMPS

(A) General:

LED traffic signal modules shall be designed to fit traffic signal housings that meet MCDOT specifications. The module shall be weather tight and shall fit securely in the housing and shall have wire leads long enough for easy connection to the traffic signal head wire terminal block. The wire shall have crimped on terminal connectors. The LED signal module shall be a single, self-contained device. The power supply shall be integral to the sealed LED module.

(B) Module Identification:

The Contractor shall ensure that the date of installation is filled in on the module label on each LED module.

(C) Physical and Mechanical Requirements:

The LED lamp unit shall be a single self-contained device, not requiring on site assembly for installation. The assembly and manufacturing process for LED Traffic Signal Lamp unit assembly shall be such as to withstand mechanical shock, and vibration caused by winds up to 80 mph.

Signal lens shall be convex to minimize sunlight reflectance.

(D) Optical and Light Output Requirements:

The LED shall be manufactured using AllnGaP Technology or other LEDs with low susceptibility to temperature degradation (AlGaS LEDs will not be allowed).

The LED signal lamps will shall be provided in two three colors: red, yellow, and green. Multiple color modules shall not be used.

Each LED traffic signal lamp shall meet the minimum laboratory light intensity values, color (chromatically), and light output distribution as described in ITE Standards as shown in Section 11.04, Table 1 and Section 8.04, Figure 1 of the Vehicle Traffic Control Signal Head Standard. Each LED traffic signal lamp shall meet the minimum requirements for light output for the entire range of allowed voltage.

(E) Electrical: Each unit shall incorporate a regulated power supply engineered to electrically protect the LEDs and maintain a safe and reliable operation. The power supply shall provide capacitor filtered DC regulated current to the LEDs per the LEDs manufacturer's specification. MCDOT does not require the unit be dimmable.

The LED traffic signal lamp shall operate on a 60Hz AC line voltage ranging from 80 volts RMS to 135 volts RMS. The Circuitry shall prevent flickering over this voltage range. Nominal rated voltage for all measurements shall be 117 volts RMS.

The LED traffic signal lamp unit shall be operationally compatible with controllers and conflict monitors used by MCDOT.

The LED lamp units shall contain a disconnect that will show an open switch to the conflict monitor when less that 60% of the LEDs in the unit are operational.

Two, captive, color coded, 3 feet long, 600 V, 18 AWG minimum jacketed wires, conforming to the NEC, rated for service at 105° C, are to be provided for an electrical connection.

One Schematic diagram shall be provided for each LED lamp unit along with any necessary installation instructions.

LEDs shall be arranged in no less than 6 loaded circuits.

The LED shall operate with a minimum 0.90 power factor.

Total harmonic distortion (current and voltage) induced into an AC power line by a signal module shall not exceed 20 percent.

LED modules shall have female quick-disconnect type terminals.

476.2.5476.2.3 PEDESTRIAN SIGNAL HEAD: The pedestrian signal head shall include an aluminum housing with swing down door frame, a plug-in sealed LED message module, and visor. The pedestrian signal shall be energy efficient with a power consumption of less than 10 watts at 120 volts.

Optically, the pedestrian signal head shall display brightly and uniformly, the alternate symbol messages "HAND" in Portland orange and "WALKING PERSON" in lunar white under all ambient light conditions. The message symbols shall not be seen (blank-out) when the message symbol is not energized.

The HAND-WALKING PERSON symbol shall be a minimum of 11 inches high and 7 inches wide conforming to the requirements of the Manual of Uniform Traffic Control Devices, Institute of Transportation Engineering Standards for Pedestrian Traffic Control Signal Indications, the Signal Plan and the requirements of these specifications.

(A) HOUSING AND DOOR FRAME: The housing and door frame shall be a one piece corrosion resistant aluminum die casting. The maximum overall dimensions of the pedestrian unit signal housing including door and visor shall be 18 inches wide, 16 inches high, and 9 inches deep. The top and bottom of the housing shall have openings to accommodate standard 1½ inch pipe size fittings. The bottom opening shall have a locking "Shurlock" boss integrally cast into the housing. The distance between the mounting surfaces of the upper and lower opening shall be 15.75 inches.

The housing door frame shall be hinged to the housing by stainless steel pins and hinge lugs integrally cast in the housing and door frame. The swing down door shall be latched by two integrally cast housing hinge bolts lugs, two door latch slots and two stainless steel hinge bolts with wing nuts.

The housing shall be dust proof and weatherproof with the plug-in LED module installed and the door closed and latched. The housing and door shall be painted gloss black by the manufacturer.

(B) LED MESSAGE MODULE: The lunar white and Portland orange LED, solid state controls, and transformers for energizing the LED shall be encased in a plug-in module. The HAND and WALKING PERSON symbol message lens shall be ultraviolet stabilized polycarbonate.

The rear of the module shall have three male quick disconnect lugs for connection of the AC+HAND signal and AC+WALKING PERSON signal. The HAND and WALKING PERSON power consumption shall be less than 10 watts.

476.2.6476.2.4 WARRANTIES: All LED signal lamps and heads shall be warranted for five (5) years against defects in workmanship and materials and the requirements of Section 108.8.

476.3 METHOD OF MEASUREMENT: Vehicular and pedestrian signal indications completely (including wiring and mounting assemblies) will be measured as a unit for each type of signal installed.

476.4 BASIS OF PAYMENT: The accepted quantities of vehicular and pedestrian signal indications and mounting assemblies, measured as provided above, will be paid for at the contract unit price each, for the type signal indication and mounting assembly designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described and specified, including visors, louvered backplates, LED's and all hardware necessary to provide a complete, and functional signal installation.

Part 400 add the following new Section:

SECTION 477

INTERSECTION LIGHTING

477.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing and installing luminaires for intersection lighting in accordance with the location shown on the Traffic Signal Plan and the requirements of these specifications.

477.2 MATERIALS:

477.2.1 GENERAL: Intersection lighting materials shall conform to the type and location of the luminaire as indicated on the Traffic Signal Plan. All luminaires shall be supplied with lamps.

The luminaire shall be 250 watt, high pressure sodium with an internal ballast and shall be capable of operating on primary voltages of 110 and 220 volts, 60 Hz AC. The luminaire shall be of the horizontal cut-off type. The light distribution pattern shall be Type III medium cut-off unless otherwise specified and shall conform to the Illumination Engineering Society Standards (IES).

Each luminaire shall be furnished with an instruction sheet which clearly shows installation procedures and instructions for adjusting the lamp socket. This instruction sheet shall include complete information on all socket positions and the IES light distribution produced from each setting.

477.2.2 LUMINAIRE HOUSING: The luminaire housing shall be fabricated from a corrosive resistant metal material and have a baked on enamel finish. The housing shall be composed of three (3) sections, an upper housing section and two (2) lower housing sections. The upper housing section retains the reflector, lamp socket, and when specified the photo electric control receptacle. One (1) of the lower housing sections is the lens door frame and shall retain the 90-degree cut-off type flat glass lens. The other lower housing section shall be the ballast module door. The ballast module door shall contain the major electrical components.

The ballast module door shall be lowered by loosening a single stainless steel captive screw. After lowering, the ballast module door shall be removed by unplugging a quick-disconnect electrical plug and lifting the module off its hinges. The hinged lens door housing shall be latched to the upper housing by a spring loaded, single-action latch.

The housing shall have a slipfitter for mounting on a 2-inch mast arm tenon and shall be adjustable for leveling ± 3 degrees from the horizontal.

477.2.3 LUMINAIRE OPTICAL ASSEMBLY AND GASKETS: The optical assembly shall incorporate a snap-on high specular, anodized reflector and shall contain a filter which effectively absorbs gaseous contaminants or particulate matter. The flat glass lens of the optical assembly shall be manufactured of high quality, heat resistant glass.

A gasket of an approved neoprene material that will maintain a watertight and dust-tight seal throughout the temperature ranges inherent with high intensity discharge (HID) lamps, shall be securely fastened to the reflector. The gasket between the lamp socket and the reflector shall be polyester fiber that will maintain a dust-tight seal throughout the above specified temperature ranges.

The lamp socket shall be of rugged, high grade porcelain securely mounted on a support bracket

which is adjustable in both the vertical and the horizontal directions. Each adjustment shall be clearly and permanently coded for each light distribution setting. The coding shall directly relate to the instruction sheet furnished with each luminaire.

477.2.4 LUMINAIRE BALLAST: The ballast shall be pre-wired to the lamp socket and terminal board. The ballast shall be mounted on the ballast module door and rated to the circuit voltage and size of the lamp specified. The ballast shall be a regulator type capable of starting lamps at -20 degrees Fahrenheit and operating them within the limits specified by the lamp manufacturer. The ballast shall limit lamp wattage variations to a maximum of five (5) percent even when the ballast voltage input varies ten (10) percent from the normal values. At the rated line voltage, the ballast shall have a minimum power factor of 90 percent. The starting amperes shall be less than operating amperes. The ballast shall provide the lamp voltage shown in the lamp table of Section 477.2.5.

477.2.5 LUMINAIRE LAMPS: The lamps shall be universal burning, clear, high pressure sodium type. Each lamp shall be clearly and permanently marked, giving the wattage and the American Standard Association number or the manufacturer's reference number. Lamps of the wattage specified shall conform to the following:

Watt age	Lamp Voltage	Minimum Lumens	Initial	Rated Life
250	100	30,000		24,000 hr.

477.2.6 PHOTO ELECTRIC CONTROL:

REMOTE MOUNTED PEC: The remote mounted photo electric control (PEC) shall be rated at 120 volt, 60 Hz AC 3000 volt-ampere. The operating temperature range shall be from -65° F to +158° F and 100 percent relative humidity. The PEC shall be a conventional glass-faced hermetically sealed ½” cell. A time delay shall be incorporated into the PEC circuit to prevent cycling at night by transient lights which might be focused on the PEC.

The PEC shall turn-on at 1.0 ±0.2 foot candles and turn-off at 1.8 foot candles. The PEC shall be UL listed for rain-tight applications. A built-in surge protector shall be provided to protect the PEC from lightning induced and line voltage transients.

The PEC shall be mounted on the controller cabinet with a ½” diameter threaded fitting. PEC shall be (Tork 2105) or approved equal.

The PEC and a luminaire test switch shall be wired in accordance with Traffic Signal StandardMCDOT Detail 4737.

477.3 CONSTRUCTION REQUIREMENTS: Luminaires of the size specified shall be furnished and installed at the locations shown on the Signal Plan. Unless otherwise specified the luminaire shall be adjusted to the horizontal. Field adjustment of the lamp socket shall not be made unless specified on the signal plan or approved by the Engineer. The lamp socket shall be adjusted at the factory to achieve the light distribution as specified herein. All wiring shall be in compliance with the NEC, the requirements of Traffic Signal StandardMCDOT Detail 4737 and as shown on the plans. The intersection lighting circuit shall not be connected to the same service leg to which the controller cabinet assembly is connected.

477.4 METHOD OF MEASUREMENT: Luminaires will be measured as a unit for each luminaire furnished and installed.

477.5 BASIS OF PAYMENT: The accepted quantities of luminaires measured as provided above, will be paid for at the contract unit price bid, for the types of luminaires designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described and specified herein and on the Signal Plan.

Part 400 add the following new Section:

SECTION 478

ELECTRICAL CONDUCTORS

478.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing and installing electrical conductors for traffic signals and intersection lighting in accordance with the Traffic Signal Plan, requirements of these specifications, and MAG specifications

478.2 MATERIALS

478.2.1 ELECTRICAL CONDUCTORS: The wire shall be annealed copper and shall be uncoated unless otherwise specified. The wire shall be solid for number 10 AWG and smaller, conforming to the requirements of ASTM B 3 for annealed bare copper wire. Conductors for sizes number 8 AWG and larger shall be stranded and shall conform to ASTM B 8 for Class B stranding, unless otherwise specified, the conductors shall be insulated with THW grade thermoplastic compound and shall meet the requirements of UL 83. Insulation colors shall be permanent and an integral part of the insulation and shall not be applied as a surface treatment or coating. The insulation thickness shall conform to the requirements of the NEC. Conductor insulation shall be a solid color unless otherwise specified. The color shall be continuous over the entire length of the conductor.

Wire and cable shall be UL listed and rated at 600 volts. The UL label shall be present on each reel, coil or container of wire or cable. When requested the Contractor shall submit to the Engineer the manufacturer's written certification that the product conforms to the requirements of these specifications.

All single conductors shall have plain, distinctive and permanent markings on the outer surface throughout their entire length showing the manufacturer's name or trademark, insulation type, conductor size, voltage rating and the number of conductors in the cable. Insulation colors shall be permanent and an integral part of the insulation and shall not be applied as a surface treatment or coating.

Conductor colors and sizes for use in traffic signal and intersection lighting shall be as specified on the Traffic Signal Plan conductor schedule, and Traffic Signal Standard MCDOT Details 4799-1 and 4799-2.

(A) LOOP DETECTOR LEAD-IN CABLES: Loop detector lead-in shielded cables shall be two conductor, stranded, twisted pair, tinned copper, polyethylene insulated cable with a polyethylene jacket, rated at 600 volts and 140 degrees Fahrenheit and shall be in conformance with IMSA Specification 50-2.

(B) WIRE TAGGING: Individual conductors for each vehicular and pedestrian phase group shall be secured together by two layers of plastic electrical tape and tagged with an approved wire I.D. marker (3M Scotchcode Wire Marker Tape or approved equal). Cables for each vehicular and pedestrian phase group shall be wrapped with two layers of plastic electrical tape and tagged with an approved wire I.D. marker (Scotchcode Wire Marker Tape or approved equal). Wires and cables shall be marked in all cabinets and in pull boxes.

When IMSA cable is specified, wire insulation color assignment shall be in accordance with Traffic Signal Standard MCDOT Details 4799-1 and 4799-2.

(C) IMSA CABLES: IMSA cable shall be used when specified on the plans. IMSA cables shall

be polyethylene insulated copper conductors, polyvinyl chloride jacketed, rated at 600 volts for use in underground conduit or as aerial cable conforming to IMSA Specification 19-1.

The IMSA 19-1 cable shall be provided with the number and size of conductors as specified on the plans. The colors and tracers shall be permanent and an integral part of the insulation and shall not be painted, surface coated or adhered to surface. Ink strips are unacceptable. Conductor insulation colors shall be standard IMSA colors (as shown by the following table). Cable conductor color, phase and interval assignments shall be in accordance with Traffic Signal Standard MCDOT Details 4799-1 and 4799-2.

(D) TELEPHONE COMMUNICATION CABLE: Telephone communication cable shall be used when specified on the plans. Telephone communication cable shall be in accordance with IMSA Specification 40-2. Cable shall be 19 AWG, 25 conductor, solid, twisted pair, polyethylene jacketed, with a rating of 300 volts.

Conductor Number	Insulation Color	Stripe Color	Conductor Number	Insulation Color	Stripe Color
1	Black	---	11	Blue	Black
2	White	---	12	Black	White
3	Red	---	13	Red	White
4	Green	---	14	Green	White
5	Orange	---	15	Blue	White
6	Blue	---	16	Black	Red
7	White	Black	17	White	Red
8	Red	Black	18	Orange	Red
9	Green	Black	19	Blue	Red
10	Orange	Black	20	Red	Green

478.3. WIRING PROCEDURES:

478.3.1 GENERAL REQUIREMENTS: All wiring shall be in conformance with the NEC and the requirements of these specifications. All wire nuts and other wiring devices shall be UL listed. Conductor sizes and colors shall be as specified on the Traffic Signal Plan conductor schedule. Conductors shall be pulled into runs in a smooth continuous manner, avoiding contact with sharp objects that might damage the insulation. Approved lubricants shall be used for inserting conductors in conduit. Before installation, conductors' ends shall be taped for moisture protection until connections are made. Splices are permitted in pull boxes, pedestals and cabinets.

Conductors shall have a minimum of 36 inches of slack from the conduit end bell in the pull box.

All phase wiring shall be boxed at the intersection, terminated and spliced in the number seven (# 7) pull boxes.

478.3.2 CONDUCTOR SPLICES: Splices shall be made utilizing wire nut connectors (Ideal model numbers 451, 452 and 454, or approved equal). Wire stripping length and wire size combinations shall be in accordance with the manufacturer's instructions supplied with the wing nut connector. Soldered connections will not be permitted. All phases shall be spliced in all pull boxes and unused phase wiring shall be spliced to the ground rod in the controller cabinet.

A minimum of three coats of liquid waterproof splicing compound (3M Scotch Kote or approved equal) shall then be applied to the splice. The finished splices shall be such that their electrical and mechanical characteristics and insulation quality are equal to those of the original cable.

478.3.3 BONDING AND GROUNDING: All metallic enclosures such as cabinets, pedestals, poles, conduit and cable sheaths shall be bonded to form a continuous grounded system. Non-metallic portions of the system, such as PVC conduit, shall have a No. 8 AWG bare copper bond wire installed with suitable connections to form a continuous grounded system.

At each service disconnect, cabinet foundation, or where otherwise specified, an approved copper-plated ground rod shall be installed. Each ground rod shall be a one-piece solid rod of the copper weld type or approved equal and shall be a minimum of 5/8 inch in diameter and 10.0 feet long. The rod shall be driven vertically into the ground to a minimum 9.0 feet below the surface. If the rod cannot be driven vertically it shall be installed in accordance with article 250-83 of the NEC. The ground rod may be located in a pull box. The service equipment neutral (grounded conductor) and the system grounding conductor (No. 8 AWG bond) shall be connected to the ground rod with a copper-plated bolt or a brass bolt on the ground clamp.

The grounding electrode system shall be in accordance with articles 250-81 and 250-83 of the NEC.

Pole foundations shall have 25 feet of number 4 AWG bare copper conductor coiled and placed at the bottom of the excavation before concrete is poured. Pole foundation grounding electrodes shall be connected to the pole grounding screw in the hand hole with an approved lug connector.

A ground resistance test shall be performed for each installed ground rod prior to final connection of the utility service. Pole foundation coil grounds shall be tested as determined by the Engineer in the field.

The ground resistance shall be measured with a three terminal, fall of potential, direct reading, battery powered earth tester with a 0.50 to 500 ohm scale or digital read-out. The 25 ohm reading shall be approximately at mid scale.

The test shall be performed according to the manufacturer's instructions and OSHA requirements. Two auxiliary copper clad ground rods shall be driven into the ground a minimum of 3 feet. The lateral spacing for each test rod shall be given in writing on the test report form and the spacing shall be approved by the Engineer.

All tests shall be performed in the presence of the Engineer and the test results shall be written down, dated and given to the Engineer for approval.

Each ground rod or foundation ground shall be isolated with the bond wires disconnected when the test is being performed. The resistance to ground shall be 25 ohms or less. If it is not, additional ground rods shall be installed as required at least 15 feet from the original ground and shall be bonded to it. The test shall then be repeated for multiple grounds as necessary to achieve proper grounding below 25 ohms. As many additional ground rods shall be installed as is necessary to achieve proper grounding of 25 ohms or less.

The test shall be performed when the soil is dry. The contractor shall not add any chemical, or salt solutions to any portion of the grounding system. All grounding rods and foundation grounds to be tested shall be installed a minimum of ten days prior to testing unless otherwise determined by the Engineer in the field.

478.4 METHOD OF MEASUREMENT: Conductors for traffic signals and intersection lighting will be measured on a lump sum basis.

478.5 BASIS OF PAYMENT: Conductors, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the item, COMPLETE IN PLACE

SECTION 480

INTELLIGENT TRANSPORTATION SYSTEM GENERAL REQUIREMENTS

480.1 DESCRIPTION: It is the purpose of this section to provide general information necessary for completion of the installation of Intelligent Transportation System (ITS) field devices, such as fiber optic cable and infrastructure, closed circuit television cameras (CCTV), dynamic message signs (DMS), and video image detectors (VID).

All field devices, appurtenances, and associated communication and electrical systems shall be complete, functional and in operating condition at the time of acceptance.

480.2 MATERIAL AND EQUIPMENT REQUIREMENTS

480.2.1 ENVIRONMENTAL: Except when otherwise stated, all electronic equipment installed in the field shall meet the minimum environmental requirements of NEMA Standards Publication No. TS-2, Section 2, Environmental Standards and Test Procedures, including, but not limited to:

- Power Interruption;
- Temperature and Humidity;
- Transients, Power Service and Input Terminals;
- Nondestruct Transient Immunity;
- Vibration; and
- Shock.

All equipment exposed to the environment shall be corrosion resistant and designed to withstand 80 mph winds with a 30% gust factor, and withstand the effects of sand, dust, and hose-directed water per the hose down test described in the latest edition of the NEMA Standards Publication 250. All connections shall be watertight.

480.2.2 GROUNDING: Grounding Electrodes shall meet the requirements of Section 472.2.5 except as modified herein.

Electrolytic grounding may be used in lieu of ground electrodes for the cabinet grounding system. Electrolytic grounding systems shall be 480% self-activating, sealed and maintenance free. Electrolytic ground systems shall hydroscopically extract moisture from the air to activate the electrolytic process without addition of chemicals or water. Hazardous material shall not be used to improve the performance of the electrolytic ground. Electrolytic systems shall be UL listed and have a minimum life expectancy of 30 years.

Following installation, the Contractor shall verify the resistance to ground of the cabinet grounding system is less than 5 ohms using the 3 terminal fall of potential method. If the tested resistance is greater than 5 ohms, install as many ground electrodes as is necessary to meet the requirement.

480.2.3 POWER: Electronic equipment shall meet the minimum requirements of NEMA Standards Publications No. TS-2, Section 2 Environmental Standards and Test Procedures.

Provide step-up/step-down transformers and AC to DC power conversion as needed to match the power requirements of each component.

480.2.4 CONTROL OF MATERIAL AND EQUIPMENT

480.2.4A SOURCE OF SUPPLY: The Contractor shall furnish all material and equipment required to complete the work, except the controller cabinet which will be furnished by Maricopa County Department of Transportation.

480.2.4B QUALITY REQUIREMENTS: Only materials and equipment conforming to the requirements of the specifications shall be incorporated into the work. Material and equipment shall be new except as may be provided in the special provisions.

Maricopa County Department of Transportation reserves the right to reject proposed traffic signal material or equipment if, in the judgment of the Engineer, any of the following apply:

- 1) The material or equipment is not in the best interest of Maricopa County Department of Transportation and the public.
- 2) The material or equipment has a demonstrated history of failing to meet similar contract specifications on past installations past field performance has been deemed unsatisfactory.
- 3) The material or equipment is not compatible with the material or equipment presently in use, which may cause the need to purchase additional spare parts, provide additional training, and/or long term maintenance problems.

In addition, Maricopa County Department of Transportation reserves the right to pre-approve traffic signal material and equipment by brand name model or part number which in the judgment of the Engineer meets the intended purpose of the Specifications. Pre-approved items will be listed in the special provisions or bid package. Bidders seeking to provide equipment and materials, which have not previously been approved, shall submit an approval request to the Engineer at least one week prior to the date of bid opening. Rejection or pre-approval of traffic signal material and equipment by the Engineer shall be final.

480.2.4C REGULATIONS AND CODES: All electrical equipment shall conform to the current standards of the National Electrical Manufacturers Association (NEMA), National Electric Safety Code (NESC), Underwriters' Laboratory Inc. (UL), when applicable. All material and workmanship shall conform to the requirements of the National Electric Code (NEC), Illumination Engineers Society (IES), Standards of the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the Traffic Signal Plan, these specifications, the special provisions, and to any other codes, standards, or ordinances which may apply. Whenever references are made to any of the standards mentioned, the reference shall be interpreted to mean the code, ordinance, or standard that is in effect at the time of the bid advertisement.

480.2.5 APPROVAL OF MATERIAL AND EQUIPMENT: All materials and equipment shall be approved by the Engineer prior to incorporation in the work. Any work in which materials or equipment not previously approved are used shall be performed at the Contractor's risk and may be considered as unauthorized and unacceptable and not subject to the payment provisions of the contract. Such materials or equipment may be subject to removal at the discretion of the Engineer.

Before ordering or installing any material or equipment, the Contractor shall submit four (4) copies of each proposed material and/or equipment list, including shop drawings and warranty information to the County at the pre-construction conference for approval by the Engineer. To be acceptable, the list shall be complete and contain all items supplied on the project by the Contractor, including pre-approved items. MCDOT reserves the right to reject an incomplete or unclear material submittal. All items on the list shall be identified by manufacturer's part number, model, specification or other pertinent catalogue information. The materials from any catalog cuts shall be clearly indicated by the contractor. One (1) copy will be returned to the Contractor for further action.

All equipment or material specified by brand name, part number, or model number is intended to be descriptive of the type and quality of material or equipment desired. Another equal brand name, part number, or model number may be substituted so long as it is in accordance with the specifications and is

equal in form, fit, function, performance, reliability, and is approved by the Engineer.

The contractor shall provide complete wiring diagrams for controller assemblies and auxiliary controller cabinets at the time of delivery for testing. A mylar original and four sets of prints shall be provided with each controller assembly. The wiring diagram shall illustrate all circuits and components in detail. All components shall be identified by name or number so as to be clearly noted in the drawings.

480.2.6 CERTIFICATE OF COMPLIANCE: When required by the Specifications, submit an original or copy of a Certificate of Compliance along with required equipment lists and supporting material, include warranty information with equipment submittal, information to the Engineer for approval.

If requested by the Engineer, furnish laboratory results or independent certifications that substantiate compliance with the stated requirements. Materials or equipment covered by the certificate may be sampled and tested at any time, and, if found not in conformity with the requirements of the plans or specifications, will be subject to rejection, whether in place or not.

Certificate of Compliance shall contain the following information:

- A description of the material or equipment supplied;
- Means of material identification, such as label, lot number, or marking;
- Statement that the material complies in all respects with the requirements of these Specifications. When identified in the Specifications, Certificates shall state compliance to specific cited standards, such as RUS 1755.900, NEMA TS-2, etc. and specific required tests, such as burn-through testing for fiber optic conduit;
- Clearly state any exceptions to the requirements of the Specifications; and
- The name, title, and signature of a person having legal authority to bind the manufacturer or the supplier of the material. The date of the signature shall also be given. The name and address of the manufacturer or supplier of the material shall be shown on the certificate. A copy or facsimile reproduction (FAX) will be acceptable. However, the original certificate shall be made available upon request. The person signing the certificate shall be in one of the following categories:
 1. An officer of a corporation.
 2. A partner in a business partnership or an owner.
 3. A general manager
 4. Any person having been given the authority in writing by one of the three listed above.

480.2.7 MARICOPA COUNTY FURNISHED MATERIAL AND EQUIPMENT: Field Devices material and equipment furnished by Maricopa County Department of Transportation will be made available to the Contractor as specified in the Special Provisions. All specified items will be available at the following address:

The Contractor shall call (602) 506-4885 forty-eight hours prior to pick-up.

The cost of handling and placing all material and equipment, after transfer to the Contractor, shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor shall be held responsible for all material and equipment delivered to the Contractor. The cost to make good any shortages or deficiencies, from any cause whatsoever and for any damage which may occur after transfer will be deducted from any monies due or becoming due to the Contractor.

480.3 METHOD OF CONSTRUCTION:

480.3.1 CABLE MANAGEMENT AND LABELING: Provide labeling for all Contractor installed cables. Labeling shall be done in a neat, professional manner using permanent methods and products specifically designed and approved by the Engineer for each label scenario. At a minimum, provide the following labeling:

- Label trunkline and branch cables at pull boxes, cabinets, racks, and other points of entry with the appropriate cable identification number. Use permanently marked, removable cable sleeves;
- Label both ends of jumper cables and pigtails; and
- Sequentially label the jumper cable (front) side of patch panels in a consistent manner throughout the project.

Provide cable routing and management in a neat and professional manner. Group and neatly tie cables to the sides of racks when applicable. Slack or excess cables shall be neatly coiled, tied, and stowed. Strain relief shall be provided for fiber optic cable, jumpers, and pigtails.

480.3.2 LABOR AND SUPERVISION: The Contractor shall furnish labor and supervision with experience in the construction of the ITS field devices and communications encompassed by the project, all materials, equipment, tools, transportation and supplies required to complete the work in an acceptable manner; and in full compliance with the Specifications, terms of the contract, the Plans and Special Provisions.

The Contractor shall have on the work site at all times a competent supervisor capable of reading and thoroughly understanding the plans and specifications and be experienced in the construction of ITS field devices and communications encompassed by the project. When construction involves traffic signals, the Contractor's supervisor shall possess an International Municipal Signal Association (IMSA) Level II Traffic Signal Electrician Certification.

480.3.3 PLANS: The Plans graphically describe the location of signal component parts, the equipment and materials to be used, and the way the traffic signal and ITS facilities are to be constructed. The plans shall be supplemented by Standard Drawings or other drawing(s) deemed necessary for the completion and control of the work.

Where dimensions on the plans are given or can be computed from other given dimensions, they shall govern over scaled dimension.

After completion of the project the Contractor shall provide the Engineer with a set of as-built drawings on clean prints of the original drawings. The as-built drawing shall indicate in a neat and accurate manner all changes and revisions in the original design. As-built drawings shall be submitted before final payment for completed work will be made.

480.3.4 TESTING: Demonstrate that the equipment and the systems furnished and installed under the contract function in full compliance with the requirements of the contract documents. Furnish and maintain all required test equipment. Conduct tests in the presence of the Engineer using approved test procedures and submit the test results to the Engineer using approved test data forms. The Engineer will review the test results for conformance with the requirements of the contract documents. If the equipment or systems fail any part of the test, make necessary corrections and repeat the entire test.

Notify the Engineer of the time, date and place of all tests at least 14 calendar days prior to the date on which a test is planned. If requested by the Engineer, postpone any test up to seven calendar days in order to accommodate the schedules of the Engineer and his representatives. Postponement of tests is not grounds for extension of the Contract, or for additional compensation.

The Engineer may waive the right to witness certain tests. Neither the witnessing of tests by the Engineer or his representatives, nor the waiving of the right to do so, will relieve the Contractor of the responsibility to furnish and install the work in accordance with the contract documents. Such actions by the Engineer or his representative or approval of any test results by them will not be deemed as acceptance of the equipment or systems tested until successful completion of the System Acceptance Test (SAT).

The Contractor shall ensure that all equipment to be tested is ready for testing prior to the performance of, and Engineer's witnessing of the tests. Costs for transportation, meals, and lodging for the Engineer and his representatives that are associated with delays in the testing will be deducted from monies due, or to become due, or owed to the Contractor.

All test data forms shall be signed by the Contractor or authorized representative. When tests are witnessed by the Engineer, obtain the witnessing Engineer's signature on the test data form.

The contract period will not be extended for time loss or delays related to testing.

Failure of any item to meet the requirements for any test will be counted as a defect and the equipment under test will be subject to rejection by the Engineer. Rejected equipment may be re-tested provided all areas of non-compliance have been corrected and evidence thereof is submitted to the Engineer by the Contractor.

For equipment that has failed and subsequently been repaired or modified, the Contractor shall prepare and deliver a report to the Engineer that describes the nature of the failure and the corrective action taken. Re-design and modification of failed equipment shall be done at no additional cost.

Conduct or support tests in the following stages of implementation:

- Design Approval Test (DAT);
- Factory Demonstration Test (FDT) (when required);
- Factory Acceptance Test (FAT);
- Stand-Alone Test;
- Subsystem Test (SST);
- Systems Integration Test (SIT) (when required); and
- System Acceptance Test (SAT).

DAT verify that certain design parameters are satisfied prior to going to production. FDT are performed on a production unit and verify that the equipment meets the functional requirements. FAT verify that each unit of equipment as it comes off the production line operates as specified. Stand-alone tests verify that after installation but prior to interconnection, the equipment operates as specified. SSTs verify that units forming a subsystem continue to operate as specified when they are interconnected. The SIT is performed when previously untested hardware or software is developed and/or added to an existing system to verify that all system interfaces perform properly prior to final acceptance. The duration of the SIT shall be based on the complexity of the design. The SAT verifies that all the interconnected subsystems operate together as one system. Upon successful completion and acceptance of the SAT, the project will advance to the warranty and operational support period.

480.3.4(A) DESIGN APPROVAL TESTS (DAT): A DAT shall be conducted when required by the Specifications. The Contractor shall provide certification from the manufacturer for the following:

1. Certify that the equipment has been laboratory tested and meets or exceeds the environmental requirements of the Specifications. Specifically list test results and passing criteria for each required test.

2. Certify the equipment meets the functional requirements stated in the Specifications, and is suitable for the intended application.

State any requirements that are not met or have not been laboratory tested. Test procedures and results, or independent laboratory certification shall be made available upon request.

DAT certification shall meet the requirements stated in Section 480.2.6 for Certificates of Compliance. If a DAT and a Certificate of Compliance is required for the same equipment, both requirements may be satisfied by a single Certificate of Compliance.

Submit DAT certification with the equipment submittal data for Engineer's approval.

The Engineer may waive the DAT requirement for equipment that has been previously tested by the Maricopa County Department of Transportation (MCDOT) or certified for use in prior projects where the application is consistent and results deemed favorable. The Contractor should contact MCDOT for information regarding the DAT or certification status of a particular device.

480.3.4(B) FACTORY DEMONSTRATION TESTS (FDT): A FDT shall be conducted when required by the Specifications. A FDT shall be conducted on a prototype model before going to production. The FDT requirement for models of equipment previously tested and/or certified by the MCDOT for the types of applications required in the project may be waived by the Engineer.

To gain a waiver, submit certification from the manufacturer that states that the equipment has been tested and meets all the project requirements. State any exceptions or requirements not covered by testing. Provide supporting information such as test procedures, data, and results.

Costs for lodging and transportation for the Engineer and his representatives to witness the FDT, will be borne by MCDOT, for one visit lasting for up to 5 consecutive days. In the event, the FDT requires multiple visits by the Engineer or lasts longer than five consecutive days, the Contractor shall be responsible for the added cost of transportation and lodging beyond what is covered by the County.

480.3.4(C) FACTORY ACCEPTANCE TESTS (FAT): A FAT shall be conducted on each unit of equipment. The FAT shall verify proper operation of all required functions. Submit FAT results for approval. Do not deliver equipment until FAT results have been received and approved by MCDOT.

480.3.4(D) STAND-ALONE TESTS: Conduct approved stand-alone tests (non-network) on each unit of equipment after installation on-site. Furnish all necessary test equipment and test software.

480.3.4(E) SUBSYSTEM TESTS (SST): A subsystem is defined as a logical grouping of field devices and/or central equipment that when interconnected and communicating, is capable of performing the function for which it was designed (i.e. – CCTV cameras, communications to/from the cameras, central control and display of the video images). Conduct approved SST for the field equipment and related equipment at the hubs and the Traffic Operations Center (TOC) once they are completed. Conduct SST on the groups of equipment as identified in the project Special Provisions after the equipment has been installed and interconnected.

Subsystem tests shall not be considered successful until all equipment being tested is operational without failure for 72 consecutive hours.

480.3.4(F) SYSTEM INTEGRATION TEST (SIT): Begin the SIT upon completion of all the SSTs. The Contractor is responsible to keep the installed equipment operational during the system final integration as determined by the Engineer. The Contractor shall identify the SIT in the project schedule. The Contractor shall work with the Engineer to troubleshoot all problems related to non-specification compliant equipment and interfaces.

480.3.4(G) SYSTEM ACCEPTANCE TEST (SAT): The SAT may commence upon completion of the SIT. The SAT consists of a 30-day test period demonstrating that the total system (hardware, software, materials and construction) is properly installed, is free from identified problems, exhibits stable and reliable performance, and complies with the contract documents.

Demonstrate all system functions using live control equipment. Test all normal and backup functions of redundant system equipment. Include in the SAT, any emergency conditions for which the equipment is designed to respond.

Troubleshoot, diagnose, identify, and isolate hardware and software problems and inconsistencies. Formulate possible solutions and implement all corrections needed for Contractor installed equipment.

Make available on-site, key technical personnel familiar with the design and construction of each major system component within 48 hours of notification of a problem.

Correct all system documentation errors, omissions, and changes discovered and resulting from the SAT and previous testing. System acceptance will not be complete until corrected documentation is submitted.

In the event of a failure of a single piece of equipment during the SAT, replace or repair the equipment and restart the 30-day test only for that piece of equipment. If the failure of the single piece of equipment prevents the proper operation of other equipment (i.e. – failure of the CCTV terminal server prevents CCTV control for several cameras), all devices affected by the failure will have the test extended by however many days they were out of service.

The following conditions constitute a minor system failure and will result in a suspension of time during the 30-day SAT. After satisfactory remedial action, the 30-day test will be resumed and extended one additional day:

- Interference with project operations due to vandalism, traffic accident, power failure, or lightning for which lightning protection devices as specified are not sufficient protection;
- Failure to complete the objective of any test scenario due to lack of adequate documentation for equipment supplied by the Contractor. Re-test using revised documentation; and
- Intermittent hardware, software, communication, or operation control malfunctions.

The following constitutes a major system failure. Any one of the following conditions shall result in re-initialization of the SAT from day zero:

- Failure of 5% of any hardware or performance item within a 14-day period; and
- Failure to correct any problem that adversely impacts the safety of the traveling public, the Engineer, or his representatives within four hours of notification.

480.3.4(H) TEST PROCEDURES, SOFTWARE, AND DATA FORMS: Prepare test procedures, software (when needed) and data forms for all required DAT, FDT, FAT, stand-alone, SST, and SAT procedures.

Submit test procedures, software, and data forms to the Engineer for approval at least 45 calendar days before the scheduled testing. The Engineer will review the submitted procedures, software, and data forms and return them within 14 calendar days after receipt. If approved, tests may be conducted as scheduled. If rejected, reschedule the test, revise the submittal accordingly and resubmit for another review. Highlight the portions of the submittal that have changed to aid the

Engineer's re-review of the material. Extension of the schedule will not be granted for rejected test procedures, software, and data forms.

As a minimum, prepare test procedures and data forms that include the following:

- A step-by-step outline of the test sequence to be followed, showing a test of every function of the equipment or system to be tested;
- A description of the expected operation, pass/fail criteria, and test results;
- A data form to be used to record all data and quantitative results obtained during the test; and
- A description of any special equipment, setup, manpower, or conditions required for the test.

Except as modified in this section, the requirements and process for submittal data identified in Section 480.2.5 shall also apply for test procedures, software, and data forms.

480.4 WARRANTIES AND GUARANTIES: Meet the requirements of Section 180.8 except as modified herein:

Specific warranty requirements, if any, are listed under specific equipment requirements of the Specifications. The cost of warranties and repairs are included as an incidental inpart of the contract unit price.

Within 60 days following approval of material and equipment, submit a preliminary Warranty

Administration Plan (WAP) to the Engineer for approval. In the WAP, address how the warranty

period shall be administered, including the following requirements:

- Provide a 24 hour, seven day a week telephone number for MCDOT initiated warranty requests;
- Repair or replace failed items that prevent normal operation of the system or any of the subsystems within 5 calendar days after notification. Respond to all other warranty requests within 14 calendar days;
- Track each repair performed during the warranty period by serial number. Account for removals, replacements, and repaired items put back in service or into the spare inventory. Reset the warranty period for all repaired or replaced items. Establish a new warranty period for all new items;
- Perform routine maintenance during the warranty period per vendor recommendations.
- Provide a summary of all routine maintenance activities required, whether or not they fall within the one-year warranty period;
- When used, replenish spare equipment inventory within 2 weeks, or stated vendor lead-time, whichever is greater;
- Provide a complete list of equipment and vendor warranty periods, including spare equipment. Use Figure 480.1 or similar approved form; and
- Provide copies of all warranty paperwork.

Submit a final WAP to the Engineer for approval at least 45 days prior to final acceptance. An approved WAP is required prior to final acceptance.

Within 90 days of the end of the one-year warranty period, submit the following to the Engineer for approval:

480.5 DOCUMENTATION: Deliver a minimum of ten sets of maintenance manuals to the COUNTY for all furnished equipment. The manuals shall be supplied in durable, loose-leaf, three ring binders or appropriate size. All volumes shall be permanently titled and have pages numbered and indexed for easy and efficient removal and replacement. In addition, an electronic copy of all manuals shall be provided for all equipment and software.

Format maintenance manuals in two volumes that include the following material for all furnished equipment and components:

Volume 1

- Description for each type of equipment and its components.
- Description of operation.
- Troubleshooting procedures at system and device levels.
- Preventative maintenance and adjustment procedures.
- “As-built” drawings including block diagrams, signal path, and detailed device and system connection diagrams.
- Equipment source reference including manufacturer and nearest authorized service centers along with associated addresses and telephone numbers.
- Final warranty administration plan.

Volume 2

- Manufacture’s operation and installation.
- Manufacture’s service and repair guides.

480.6 TRAINING: When required, training shall be provided in two sessions.

The first training session shall be for maintenance and troubleshooting. This session shall be a minimum of four hours in length for each type of field device installed, including communications. This session shall be oriented for the County maintenance staff.

The second training session shall be for operations. This session shall be a minimum of four hours in length for each type of field device installed. This session shall be oriented for the County Traffic Operations Center staff.

Part 400 add the following new Section:

SECTION 481

FIBER OPTIC CONDUIT AND PULL BOXES:

481.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing, installing, and testing fiber optic conduit, warning tape, duct plugs, and pull boxes.

481.2 MATERIALS

481.2.1 FIBER OPTIC CONDUIT: Conduit or innerduct that is either occupied or designated for installation of fiber optic cable shall meet the requirements of Section 471.2 and the following:

Bends used for fiber optic conduit runs shall exceed the following requirements:

Conduit Size	Min. Radius
2"	24"
2½"	30"
3"	36"
4"	48"

481.2.2 MULTIDUCT CONDUIT: Multiduct conduit (multiduct) shall be manufacturer-assembled conduit sections consisting of an outerduct, 4 factory-installed innerducts, coupling bodies, and spacers.

Bends used for multiduct conduit shall have a minimum radius of 4' and shall be available from the multiduct manufacturer in increments of 11.25°, 22.5°, 45°, and 90°.

Multiduct conduit shall be marked with a longitudinal print line with the wording "Install This Side Up" or equivalent to assure proper innerduct/conduit orientation and alignment. Male ends of multiduct conduit shall have circumferential insertion depth marks to provide a visual indication that proper insertion is achieved.

481.2.2(A) MULTIDUCT CONDUIT WITH OUTERDUCT: Multiduct with outerducts shall meet the following requirements:

Outerducts shall be constructed of metal, fiberglass, or polyvinyl chloride (PVC).

- Metal outerducts shall be Schedule 40 and galvanized. Male and female ends shall be threaded.
- Fiberglass outerducts shall have a minimum wall thickness of 0.7", with an integral coupling of 5" minimum length.
- PVC outerducts shall be Schedule 40 with an integral coupling of 5" minimum length. PVC outerducts shall comply with NEMA TC-2 and ASTM F512.

Innerducts shall be fabricated using either High Density Polyethylene (HDPE) or PVC for straight sections, and either HDPE or nylon66 for bends. Innerducts shall contain, or be factory treated with a friction reducing material that is dry-to-the-touch. Innerducts shall meet the requirements of Bellcore GR-356.

- Innerducts shall have a nominal inside diameter of 1.2". HDPE innerducts shall have a minimum wall thickness of 0.1". PVC innerducts shall have a minimum wall thickness of 0.06".

- Each length of multiduct shall have one white and three gray colored innerduct. Colors as indicated above shall be oriented in a clockwise direction when viewing the male end of the multiduct. Innerducts shall be aligned in the outerduct with the white innerduct located directly below the outerduct longitudinal print line.
- Bends may utilize the same color for all innerducts, provided that the bend does not terminate in a junction box. Colors shall be impregnated within the innerducts and shall be consistent throughout the Project.
- Innerducts shall be held together in a square configuration by a system of spacers that provides a rigid internal system to hold the innerducts in formation, without twists and sags. Spacing of the spacers shall not exceed 5’.

Coupling bodies shall be incorporated in all lengths of multiduct, bends, and fittings to seal between the outerduct and innerducts. Coupling bodies shall facilitate field assembly of the multiduct sections without the use of lubricants. Sealing components within the coupling bodies shall be of an anti-reversing design to keep the multiduct conduits together without the use of cement. Coupling bodies shall allow for innerduct movement due to expansion/contraction without affecting the innerduct sealing.

Multiduct terminations used at end of multiduct runs at junction boxes, cabinets, etc. to seal the innerduct to the outerduct shall be durable and fabricated from no metallic parts except nuts, bolts, washers and fasteners which shall be stainless steel. Terminations shall provide a watertight and airtight seal of at least 20 psi.

481.2.2(B) MULTIDUCT WITH NO OUTERDUCT: Multiduct with no outerduct shall consist of multiple PVC, HDPE or metal conduits locked together in formation using spacers no more than 5’ apart.

PVC and metal conduit that comprise the multiduct shall be Schedule 40. HDPE shall be SDR 13.

481.2.3 CONDUIT AND INNERDUCT PLUGS: Conduit plugs, caps, or sealing fittings for sealing empty conduit and occupied conduit shall be durable, easily removable, reusable, and produce a watertight seal. Plugs, caps, and sealing fittings shall be designed for the diameter of the conduit and cable, shall cause no damage to the cable when installed, and shall have a rope tie on the inside end for connection of a pull rope. Plugs, caps, or sealing fittings used for fiber optic conduit shall provide a watertight and airtight seal of at least 20 psi. Plugs that seal conduits containing fiber optic cable shall be of the split design to allow installation and removal around in-place cables. Plugs, caps, or sealing fittings shall be approved by the Engineer.

481.2.4 CONDUIT SPACERS: Conduit spacers shall be dielectric and have sufficient strength to support the conduits in a straight line above the bottom of the trench.

481.2.5 FIBER OPTIC CONDUIT WARNING TAPE: Fiber optic conduit warning tape shall meet the requirements of Section 471.2.2 except the message shall bear the words “FIBER OPTIC CABLE BURIED BELOW” in black letters on an orange background, or approved equivalent. Fiber optic conduit warning tape shall connect into pull boxes.

481.2.6 FIBER OPTIC PULL BOXES: Pull boxes shall meet the requirements of Section 471.2.3 except as modified by the following:

Pull box covers shall have the message “MCDOT ATMS” cast in the pull box covers in 1” letters.

Pull boxes and covers shall sustain a minimum vertical test load of 12,000 lbs applied over a 10” square. Pull boxes shall be designed with a minimum 1.5 safety factor.

Furnish a minimum of two appropriately sized knockouts on each side of the pull box. Knockouts on opposite sides shall be aligned. If extensions are used, locate the knockouts on the deepest extension. Knockouts shall provide a minimum of 3" clearance between the conduit and the bottom of the pull box.

Pull boxes shall have provisions on the long sides for lashing coiled cable and installation of underground splice closures, subject to Engineer's approval.

481.3 CONSTRUCTION REQUIREMENTS

481.3.1 FIBER OPTIC CONDUIT: Installation of fiber optic conduit shall meet the requirements of Section 471.3.1 and the following requirements:

481.3.1(A) GENERAL REQUIREMENTS: When obstructions are encountered during installation and fiber optic conduit cannot be economically located elsewhere, the obstruction shall be bypassed by deflecting the conduit at a rate of at least 10:1. Minimum 4' radius, maximum 90° bends may be used to avoid obstructions at locations where 10:1 deflection is not possible, provided the least degree bend needed to clear the obstruction is used. Flexible bends may be utilized when needed to facilitate proper location of the fiber optic conduit, only at locations approved by the Engineer. Fiber optic conduit runs between any two pull boxes shall not employ more than 4 bends, or exceed an angular sum of 270°.

Fiber optic conduit shall enter fiber optic pull boxes through sidewall or endwall knockouts.

Conduit spacers shall be used to arrange multiple conduits in the trench to provide a minimum of ½" between conduits. The conduit spacers shall be used at intervals not exceeding 5' on-center, or the conduit manufacturer's recommendations. Conduit spacers shall remain upright and not collapse during backfilling, compaction, and pavement installation operations.

All empty and occupied fiber optic conduits and innerducts shall be sealed with a cap or plug at each end.

Fiber optic warning tape shall be installed above fiber optic conduit installed in open trenches. The message side shall face up. If electrical conduit shares the same trench, the conduit warning tape for the electrical conduit is not required.

Detectable tape/wire shall be installed in each non-metallic fiber optic multiduct to facilitate locating underground fiber optic cables. One pull tape/rope is needed required in each conduitinnerduct.

Pull tape/rope shall be attached to the plug, cap, or sealing fitting on each end of the conduit.

During shipping and while on the job site, the open ends of all runs of ducts, conduit, and multiduct conduit shall be sealed with removable caps, plugs, or sealing fittings to prevent the entry of rodents, dirt, sand and other foreign materials. These caps, plugs, or sealing fittings shall be removed only when the Contractor is in the act of joining sections together, testing, or pulling cable. The open ends shall be immediately recapped or resealed after completion of these activities. This requirement shall be met for all empty or occupied ducts, conduit, and multiduct conduit located anywhere on the Project site, including but not limited to those at equipment enclosures and pull boxes.

If temporary caps or seals are used, the methods and materials shall be approved by the Engineer. Temporary caps and seals shall be replaced with caps, sealing fittings, or plugs conforming to the requirements of the Specifications prior to acceptance.

481.3.1(B) MULTIDUCT CONDUITS: Multiduct conduit shall be installed in accordance with the Specifications and the manufacturer's recommended installation procedures.

Cutting of multiduct shall not be allowed, except to obtain proper lengths at bridge structures, junction boxes, and when needed for connection of bends at specific points along the multiduct runs.

Multiduct shall be joined in such a manner that colored innerducts match up.

Should connection of multiduct to existing multiduct be required, the joining multiduct shall be of the same manufacturer of multiduct as the stub out. This requirement does not preclude use of a different manufacturer of multiduct in areas where there are no existing multiduct or areas where multiducts meet at a pull box. At the Contractor's option, a pull box may be installed in order to meet the above requirement; however, the cost of furnishing and installing the pull box shall be included in the cost of the multiduct.

Field bending of multiduct shall not be permitted.

Terminations that provide a watertight seal between the innerduct and outerduct shall be installed for all multiduct ends terminated at junction boxes.

481.3.1(C) DEPTH REQUIREMENTS: Fiber optic conduit shall be installed at a minimum depth of 4' to the top of the conduit except at pull box locations.

481.3.1(D) CONDUIT BORING: Fiber optic conduit placed under an existing roadway or access shall be installed by jacking or boring. Fiber optic conduit may be installed in a steel sleeve or conduit specially designed for a jack/bore.

Installation shall be as per MCDOT Detail 4812 or 4813 as established by the plans.

Sleeves shall be installed by a method approved by the engineer.

Sleeves shall be black steel pipe.

Sleeves shall be 6" for one 4" conduit, and 10" for two 4" conduits.

The depth of the sleeve installation varies depending on conflicts with existing utilities and obstructions.

Sleeves shall be nominally sloped to drain, slope in super elevated sections may approximate the roadway cross section.

Expansion fittings shall be installed on all conduits at one end of the steel pipe if sleeve is less than 100' in length, and at both ends if the steel sleeve is 100' or greater in length. The expansion fittings shall be installed a minimum of 3' from the end of the steel pipe sleeve.

481.3.1(E) TRENCHING, BACKFILLING, AND COMPACTION: Trenching, backfilling, and compaction of trenches for fiber optic conduit shall be meet the requirements of Section 471.3.1(C).

Controlled Low Strength Material (CLSM) consisting of 150 psi. concrete shall be installed in the bottom 24" of the trench. The CLSM depth will vary at pull boxes to remain six inches clear of the finished grade. CLSM shall be placed in such a manner to avoid voids of segregation of material.

481.3.3 FIBER OPTIC PULL BOXES: Installation of pull boxes shall meet the requirements of Section 471.3.2, except as modified by the following:

#7 pull boxes used for ITS applications shall be encased in Class B concrete, have a reinforced lid, and the knock-outs shall be located at the bottom of the extension per MCDOT Standard Detail 4810.

Install pull boxes for fiber optic conduit runs that have the following internal dimensions based on the number of fiber optic splices:

No. of Splices	Width (min)	Length (min)	Depth (min)
36 or less	22"	34"	24"
More than 36*	28"	40"	24"

* Covers 40" and longer in length shall be two-piece to facilitate maintenance.

Following installation of fiber optic conduit, neatly seal the knockout area.

481.4 TESTING REQUIREMENTS: Meet the requirements of Section 480.3.4 and the following:

481.4.1 DESIGN APPROVAL TESTS (DAT): Furnish DAT certification for the following tests:

481.4.1(A) FIBER OPTIC CONDUIT: Bends for fiber optic conduit and innerduct shall conform to the requirements of the following tests for burn resistance and friction:

1. Burn resistance: Perform the burn resistance test on a 90°, 2' radius conduit bend or innerduct wrapped around and secured to a rigid form. Thread an appropriate length of 0.25" diameter braided polyethylene rope through the conduit/innerduct and sew the ends together to create a continuous loop. The loop of rope shall be wrapped around a powered capstan and drawn away from the innerduct at a rate of 480' per minute. The sample shall not burn through within 90 minutes.

2. Friction: Conduit and innerducts shall have a coefficient of friction of 0.09 or less when tested in accordance with Bellcore GR-356.

Coupling bodies, for multiduct, shall be tested for water tightness and air tightness at 73°F ± 4° with a relative humidity of 50 percent, in accordance with the following procedures:

1. Water tightness (outerduct): Two lengths of multiduct (one factory bell and one factory spigot end) shall be joined without the use of force other than that required by hand. The center of the section of the multiduct conduit containing the joint shall be enclosed within a housing suitable for containing water at or above a positive pressure of 20 psi or a water column of 12'. The enclosure shall be sufficiently filled with water to completely cover the conduit joint within. A regulated air pressure of 20 psi or a water column of 12' above the joint shall be applied to the interior of the enclosure by way of a sealed connection. The ends of the multiduct shall protrude through the sealed exterior of the housing in order to facilitate inspection for leakage of water to the inside. The multiduct assembly shall not show signs of leakage for a period of 24 hours.

2. Air tightness (innerducts): Two lengths of multiduct (one factory bell and one factory spigot end) shall be fully joined without the use of force other than that required by hand. One end of an innerduct shall be sealed with a plug. The opposite end of the same innerduct shall be fitted with a plug and hose assembly for application of air pressure. Air pressure shall be applied until the pressure within the test sample is 480 psi. The coupling assembly shall not allow more than a 20 percent air pressure drop in 2 minutes from the initial pressure of 480 psi. The above procedure shall be repeated on each remaining innerduct.

481.4.1(B) FIBER OPTIC PULL BOXES: Provide DAT certification that demonstrate pull boxes and covers comply with the loading requirements.

481.4.2 STAND-ALONE TESTS: Visually inspect each section of multiduct prior to installation and verify that the innerducts are straight and do not sag.

481.5 WARRANTY REQUIREMENTS: All equipment furnished under this section shall meet the one year warranty requirements identified in Section 480.4.

481.6 SPARE PARTS: Prior to final acceptance, furnish an inventory of the following spare parts. The spare parts inventory shall include the minimum quantity stated based on the total number of like parts supplied, or a minimum of one, whichever is greater:

* Provide for each type and size of fiber optic conduit.

** Provide for each size of pull box.

481.7 DOCUMENTATION: Provide maintenance manuals for multiduct conduit, plugs, pull boxes, and other equipment per the requirements of Section 480.5.

481.8 7 TRAINING: When required, meet the training requirements of Section 480.6.

481.9 8 METHOD OF MEASUREMENT: Fiber optic conduit and multiduct will be measured by the linear foot for each type and size.

The cost of testing, warranty, documentation, and training and spare parts are considered incidental included in the unit price of the item requiring the work.

481.10 9 BASIS OF PAYMENT: The accepted quantities of conduit, measured as provided above, will be paid for at the contract unit price bid, which price shall be full compensation for the item, COMPLETE IN PLACE, including any excavating, backfilling and landscaping necessary to complete the work.

Part 400 add the following new Section:

SECTION 482

FIBER OPTIC CABLE AND EQUIPMENT:

482.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing, installing, and testing underground and indoor fiber optic cable and related equipment, including trunkline cable, branch cable, jumper cable, pigtailed, connectors, patch panels, splice trays, splice units, termination units, splice and termination units, and underground splice closures.

482.2 MATERIAL REQUIREMENTS:

482.2.1 FIBER OPTIC CABLE: Unless otherwise stated, all fiber optic cable shall be single mode fiber optic (SMFO) cables that are of loose tube construction, filled with a water-blocking material, and constructed by a certified ISO 9001 or 9002 manufacturer.

Fiber optic cable shall be dielectric and comply with the requirements of US Department of Agriculture Rural Utility Services specification RUS 1755.900 except as modified by the Specifications. Indoor fiber optic cable shall also comply with the requirements of Article 770 of the NEC.

When plans or special provisions require signal interconnect with a non-fiber optic cable, the non-fiber optic cable shall be IMSA 39-2, 6 pair, shielded cable with PVC Jacket.

482.2.1(A) FIBER OPTIC CABLE PERFORMANCE AND CONSTRUCTION: Use fiber optic cable that complies with the following requirements:

Cladding diameter:	125 ± 1.0 μm
Core-to-cladding offset:	≤ 0.8 μm
Cladding non-circularity:	≤ 1.0%
Maximum attenuation:	≤0.4 dB/km at 1310 nm; ≤0.3 dB/km at 1550 nm
Microbend attenuation (1 turn, 32 mm diameter):	≤ 0.5 dB at 1550 nm
Microbend attenuation (480 turns, 75 mm diameter):	≤ 0.05 dB at 1310 nm
Attenuation uniformity:	No point discontinuity greater than 0.1 dB at either 1310 nm or 1550 nm.
Mode-field diameter (matched cladding):	9.3 ± 0.5 μm at 1310 nm; 10.5 ± 1.0 μm at 1550 nm
Maximum chromatic dispersion:	≤ 3.2 ps/(nm x km) from 1285 nm to 1330 nm and < 18 ps/(nm x km) at 1550 nm
Fiber polarization mode dispersion:	≤ 0.5 ps/(km) ^{1/2}
Fiber coating:	Dual layered, UV cured acrylate applied by the fiber manufacturer
Coating diameter:	245 μm ± 10 μm
Minimum storage temperature range:	-40°C to +70°C (-40°F to 158°F)
Minimum operating temperature range:	-20°C to +70°C (-4°F to 158°F)
Rated life:	Certify a 20 year life expectancy when installed to manufacturer's specifications
Ensure the change in attenuation for single-mode from -20°C to +70°C (-4°F to 158°F) does not exceed 0.2 dB/km at 1550 nm, with 80% of the measured values no greater than 0.1 dB/km at 1550 nm.	

Buffer Tubes: Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus,

electrically non-conductive, homogenous gel that is free from dirt and foreign matter. The gel shall allow free movement of the fibers, without loss of performance, during installation and normal operation including expansion and contraction of the buffer tubes. The gel shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z", stranding process. Use filler rods when needed in trunkline cable to lend symmetry to the cable section.

Central Strength Member: The fiber optic cable shall have a central strength member designed to prevent buckling of the cable.

Cable Core: The fiber optic cable shall use a dry water-blocking material to block the migration of moisture in the cable interstices.

Tensile Strength Members: The fiber optic cable shall have tensile strength members designed to minimize cable elongation due to installation forces and temperature variation.

Underground fiber optic cable shall withstand a 600 lb tensile load applied per EIA-455-33 where the change in attenuation does not exceed 0.2 dB during loading and 0.1 dB after loading. Use cable rated for an installed tensile service load of 200 lbs or more.

Cable Jacket: The fiber optic cable jacket shall be constructed of HDPE or medium density polyethylene (MDPE) jacket that has been applied directly over the tensile strength members and water-blocking material. The jacket shall have at least one ripcord designed for easy sheath removal.

Cable Markings: Provide cable with markings that include cable length markings (in feet) and the year of manufacture. In addition, provide cable with two color stripes, or similar marking approved by MCDOT, to distinguish between trunkline (between communication hubs) and branch cables (spliced to trunkline cables).

Environmental: Provide cable that is capable of withstanding the following conditions without damage or decrease in function:

- Cable operating temperature per EIA/TIA-455-03;
- Total immersion in water with natural mineral and salt contents;
- Salt spray or salt water immersion for extended periods; and
- Wasp and hornet spray.

482.2.1(B) CABLE LENGTH AND SHIPPING: Base the length of each fiber optic cable on field measurements. Include in the measurement, the required amount of slack cable at pull boxes, field cabinets, hubs, and equipment racks as required by the Plans.

Stencil, letter, or provide the following information on a weatherproof tag firmly attached to the reel:

- Factory order number;
- Job number;
- Ship date;
- Manufacturer's cable code;
- Type of cable (single mode, outdoor, indoor);
- Beginning and ending length markings; and
- Measured length and attenuation.

482.2.1(C) TRUNKLINE FIBER OPTIC CABLE: Trunkline fiber optic cable shall have a minimum of 36 fibers, with either 6 or 12 fibers per buffer tube.

482.2.1(D) BRANCH FIBER OPTIC CABLE: Branch fiber optic cable shall have factory installed male ST or SC connectors on one end for each fiber in the cable. Leave the other end of the branch cable bare for splicing to the trunkline fiber.

482.2.1(E) FIBER OPTIC JUMPER CABLE: Jumper cables shall meet the following requirements:

- 250 μm buffering of each fiber;
- 900 μm buffering of each fiber applied after the initial 250 μm buffering;
- Maximum factory measured insertion loss of 0.5 dB per EIA/TIA 455-171;
- Less than 0.2 dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg;
- Aramid yarn strength member;
- Rugged 0.12" (approximate) PVC sheathing;
- Minimum bend radius of 12" following installation, 25" during installation;
- Minimum tensile strength of 480 lbs; and
- ST or SC Connectors that are factory terminated with strain relief.

Use either single fiber or duplex jumper cables.

482.2.1(F) FIBER OPTIC PIGTAIL: Fiber optic pigtails shall meet the requirements for jumper cable, except as amended by this section. Pigtails that are totally contained within a fiber optic splice or termination unit, need not have a 0.12" PVC jacket. Pigtails shall have a factory installed male ST or SC connector on one end. The other end shall be left bare for splicing to fiber.

482.2.1(G) FIBER OPTIC CONNECTORS: Fiber optic connectors shall meet the following requirements:

- Pre-installed by the cable manufacturer;
- Designed for terminating single mode fiber with 125 μm cladding;
- Factory-measured – 40 dB or less from -10°C to +60°C;
- Factory-measured attenuation less than 0.5 dB; and
- Connector attenuation will not change more than 0.2 dB following 4800 re-matings.

Use connectorized cable with strain relief boots that can withstand an axial pull of 25 lbs with no physical damage to the connector or performance of the fiber.

482.2.2 FIBER OPTIC SPLICE AND DISTRIBUTION EQUIPMENT

482.2.2(A) FIBER OPTIC PATCH PANELS: Provide fiber optic patch panels with protective covers for all unused couplers.

482.2.2(B) SPLICE TRAYS: Splice trays shall be designed specifically for housing single-mode fusion splices protected by heat-shrink sleeves. Use splice trays that are easy to install and remove, and have provisions for a minimum entry of four buffer tubes.

482.2.2(C) FIBER OPTIC SPLICE AND TERMINATION UNITS: Fiber optic splice and fiber optic termination units shall be properly sized for the required number of splices and terminations subject to the minimum requirements stated for each configuration. Fiber optic splice and termination units shall meet the following requirements:

- Have provisions for minimum of 6 fiber optic cable entries;
- Rack mounted;

- Have front and rear doors or removable panels;
- Have a top, bottom, and 4 sides that fully enclose the interior and protect its contents from physical damage;
- Manufactured using 16 gauge aluminum or equivalent and corrosion resistant;
- Provisions for neatly routing cables, buffer tubes, and fan-out tubing;
- Have internal feed-through provisions that allow cables to be internally routed between two units installed adjacent to each other; and
- Have provisions for externally securing the fiber optic cable, sheath, and central strength member.

Fiber Optic Splice Units: Fiber optic splice units shall consist of a single housing with provisions for installation of multiple splice trays as required. The splice unit shall have provisions for future installation of 2 splice trays of minimum 12 splice capacity each, in addition to the required amount.

The splice unit shall have a pull-out shelf that allows easy access to the splice tray, buffer tube and fiber storage area that permits fusion splicing to be conducted at a minimum distance of 16 feet from the housing. Units with hinged shelves are not acceptable. The following permanent marking shall be provided on the door or front access panel: "Communication Fiber Optic Cable Splice Area Inside".

Fiber Optic Termination Units: Fiber optic termination units shall consist of a single housing with provisions for installation of one or more patch panels as required. Patch panels shall face to the front of the rack.

Fiber optic termination units shall have cable management brackets or rings, integral to the unit, that secure and support cables between patch panels or splice trays to the vertical rack members while maintaining a minimum 1.5" cable radius. Jumper cable troughs may be provided in lieu of this requirement.

The following permanent marking shall be provided on the front of the unit: "Communication Fiber Optic Cable Termination Area Inside".

Integrated Fiber Optic Splice and Termination Units: Integrated fiber optic splice and termination units shall consist of a single housing with provisions for patch panels and splice trays. Integrated splice and termination units shall meet the requirements stated herein for splice units and termination units.

The following permanent marking shall be provided on the door or front access panel: "Communication Fiber Optic Cable Termination and Splice Area Inside".

482.2.2(D) JUMPER CABLE TROUGHS: Jumper cable troughs shall be designed to secure, support, store, and horizontally route jumper cables and other fiber optic cables from vertical frame members on one side of the rack, to vertical frame members on the other side of the rack. Jumper cable troughs shall be designed to maintain the manufacturers minimum bend radius for jumper cables cable bend radius when transitioning from the trough to vertical frame member. The capacity of each cable trough shall exceed the number of jumpers it houses. The finish of the jumper cable troughs shall match the finish of the fiber optic termination equipment.

482.2.2(E) UNDERGROUND SPLICE CLOSURES: Underground splice closures shall be cylindrical, butt-end style, corrosion resistant, water-tight, and meet the requirements of GR-771-CORE. Underground splice closures shall seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices. Provide internal configuration and end cap with a minimum of two express ports for entry and exit of uncut trunkline cable and a minimum of three additional ports for branch cables.

Splice closures shall be designed to accommodate heat-shrink fusion splice trays in sufficient

quantities to perform the required number of splices. At a minimum, the splice closure shall accommodate up to 24 splices.

Splice closures shall have a reliable dual seal design with both the cable jackets and core tubes sealed, without the use of water-blocking material. Use splice closures that can be opened and completely resealed without loss of performance. Use splice closures are at least 12” shorter in length than the inside long dimension of the pull box.

482.3 CONSTRUCTION REQUIREMENTS

482.3.1 FIBER OPTIC CABLE: Install fiber optic cable continuous and without splices between allowable splice points as identified on the Plans and in the Specifications. Only splice fibers in splice closures and at fiber optic splice units that are housed at hub locations and/or the TMC. Perform all final length measurements and order cable accordingly.

Carefully handle fiber optic cable. Do not pull cable along the ground or over or around obstructions. Do not pull cable over edges or corners, over or around obstructions or through unnecessary curves or bends. Do not exceed fiber optic cable bend radius at any time. Use manufacturer approved pulling grips, cable guides, feeders, shoes and bushings to prevent damage to the cable during installation.

When removing cable from the reel prior to installation, place it in a “figure-eight” configuration to prevent kinking or twisting. Take care to relieve pressure on the cable at crossovers by placing cardboard shims (or equivalent method) or by creating additional “figure-eights”.

Furnish the Engineer with the cable manufacturer's recommended procedures, maximum pulling tension, a list of the cable manufacturer's approved pulling lubricants, and the lubricant manufacturer's procedures for use. Adhere to manufacturer's installation procedures when installing fiber optic cable. Use lubricants in quantities and in accordance with the procedures recommended by the lubricant manufacturer.

Furnish attachment hardware, installation guides, and other necessary equipment, not specifically listed herein, as necessary to install the fiber optic cable.

482.3.1(A) UNDERGROUND FIBER OPTIC CABLE: At each splice point, coil 150 ft of slack fiber optic cable per cable entry and stow it per the Plans. At each field cabinet, provide a minimum of 16 ft of slack for each fiber optic cable.

Underground fiber optic cable shall be installed only in fiber optic conduit, unless shown otherwise in the Plans. Do not direct bury underground fiber optic cable.

If the cable is pulled by mechanical means, obtain the Engineer's approval for the cable pulling equipment. Use pulling cable equipment that has a mechanism to ensure that the maximum allowable pulling tension is not exceeded at any time during installation.

482.3.1(B) INDOOR FIBER OPTIC CABLE: For indoor fiber optic cable installations, follow the requirements of local building codes and NEC Article 770, inclusive of the Fine Print Notes.

Splices for indoor fiber cable shall be housed in a rack-mounted fiber optic splice unit or integrated fiber optic termination unit. Coil 16’ of slack fiber optic cable and stow it in the rack.

482.3.1(C) FIBER OPTIC JUMPER CABLE: Install jumper cables only in field cabinets and indoor locations. Provide permanent markings on duplex jumper cables that provide a visual distinction between the two fibers. Provide strain relief for jumper cables at both ends and elsewhere as needed. Adhere to manufacturer recommended installation and minimum bend radius requirements.

482.3.1(D) FIBER OPTIC PIGTAILS: Install fiber optic pigtails only in enclosed fiber optic splice and termination units located in field cabinets and indoor locations. When splicing pigtails to individual fibers, match the color of single fiber pigtails with the color of the fiber. Alternatively, single fiber pigtails may be routed through colored fan-out tubing that matches the color of the fiber.

482.3.2 SPLICING AND TERMINATIONS: Only splice fibers at locations that are identified on the splice tables in the Plans. Splice tables in the Plans shall not be revised without approval from the Engineer. All splices shall be protected and stored in underground splice closures for outdoor installations, and in fiber optic splice units or integrated fiber optic splice and termination units for indoor installations.

For indoor installations, the fiber optic cable shall enter the rear of the fiber optic splice unit or integrated fiber optic splice and termination unit. The fiber optic cable sheath and central member shall be secured inside the unit prior to buffer tube fan-out. All entry holes not utilized shall be plugged. Buffer tubes with fiber designated for splicing shall be routed into and secured in a splice tray. Remaining buffer tubes shall be secured within the splice unit and not accessed.

482.3.2(A) SPLICING METHODS: All splices shall be accomplished by means of the fusion splice technique and that do not induce more than 0.1 dB attenuation is induced for each splice. Splices found to exceed 0.1 dB attenuation by the fusion splicing equipment's loss estimation algorithm shall be re-spliced, at no additional cost, until this requirement is met.

Each splice shall be packaged in a protective heat-shrink sleeve and secured in the splice tray. The heat-shrink sleeve shall be approved for use by the fiber optic cable manufacturer and installed in such a manner as to protect the fiber from scoring, dirt accumulation, moisture intrusion, and microbending.

Splice all fibers in a buffer tube within the same splice tray. When splicing to fiber optic pigtails, use spiral wrap (or similar approved method) to group and protect pigtails routed from each splice tray to the corresponding patch panel.

Fiber optic cable splices will fall into one of the following categories:

Mid-cable splices: Perform mid-cable splices when splices are not required for all fibers of a cable. Only fibers within a buffer tube that are designated for splicing shall be accessed, spliced, and secured neatly within the splice tray. The remaining fibers in the buffer tube that are not designated for splicing shall be secured neatly within the splice tray and not cut. Removal of the buffer tube to access the fibers shall be accomplished using equipment specifically designed for buffer tube removal without damaging the individual coated fibers (CorningSiccor OFT-000 or equivalent).

Full-cable splice: Perform full-cable splices when the distance exceeds the maximum length of fiber optic cable available on a reel. All fibers, including spares, shall be spliced together to provide a continuous optical path. All fibers shall be secured neatly within the splice trays.

482.3.2(B) TERMINATION METHODS: Use ST connectors for terminating fiber optic cables to equipment and patch panels in field cabinets. Use cables with SC type connectors for terminating fiber optic cables at patch panels located at hubs and the TMC.

Measured attenuation at each termination (inclusive of 2 connectors and coupler) shall not exceed 0.5 dB.

Fiber terminations shall be neatly, and permanently labeled on the connector module to designate transmit or receive (when appropriate) and the fiber optic strandstring number or other designation as determined by the Engineer. Spare fibers shall be terminated when called for by the Plans, and labeled as determined by the Engineer.

Protective covers shall be used on all optical connectors and terminations at all times until terminated.

Field Termination: Fan-out kits with 0.12" tubing shall be used for direct field termination of fiber optic cable. ST connectors with strain relief boots shall be attached to the fiber and fan-out tubing by using an epoxy-cured method. This method is only appropriate when terminating fiber directly to equipment or patch panels located in field cabinets.

Termination at Hubs and TMC: Termination of fiber optic cable at hubs and the TMC shall be accomplished by fusion splicing fiber to factory prepared, fiber optic pigtails with SC connectors terminated at patch panels. Use jumper cables that have SC connectors on one end, and ST connectors on the other end, when interfacing from the patch panel to equipment. Field termination of fibers to connectors shall not be permitted.

482.3.3 FIBER OPTIC DISTRIBUTION EQUIPMENT: Install a sufficient number of patch panels to terminate all fibers. Blank patch panel covers, of same finish and manufacture as the patch panel, shall be installed for all unused patch panel spaces on fiber optic termination units.

Use fiber optic patch panels that have 6 couplers for ST applications and 12 couplers for SC applications that can be easily installed and removed from the termination housing.

482.3.4 LABELING: Meet the requirements of Section 480.2.4.

482.4 TESTING REQUIREMENTS: Fiber optic cable and distribution equipment shall meet the following certification, factory and stand-alone test requirements. General test requirements are covered in Section 480.3.4.

482.4.1 DESIGN APPROVAL TESTS (DAT): Submit certification or test results for all required factory testing of fiber optic cable. Submittal of RUS certification will satisfy this requirement for the tests that are required by RUS 1755.900.

482.4.2 FACTORY ACCEPTANCE TESTS (FAT): Test all fiber optic cable, pigtails, jumper cables and patch panels in the factory to demonstrate compliance with specification requirements. Submit a copy of the results of factory tests to the Engineer.

482.4.3 STAND-ALONE TESTS:

482.4.3(A) PRE-INSTALLATION TESTING: Visually inspect all cable and equipment upon delivery and again prior to installation. Test any cable and equipment that is found to have visual damage.

482.4.3(B) POST-INSTALLATION TESTING: Prior to testing, furnish the Engineer with a complete original version of TIA/EIA-526-7A. Testing of spare fiber is required. Identify any unacceptable losses and make corrective actions at no additional cost. Failed splices may be remade and re-tested for compliance. Replace any cable in its entirety that is found not compliant to the Specifications. Perform the following post-installation tests using the procedures of TIA/EIA-526-7A and all standards and procedures invoked therein, subject to the following clarification:

Power Meter Tests: Conduct power meter tests for each connected fiber circuit to demonstrate connectivity from origin to destination, in accordance with the fiber assignment tables. Submit a test check-off sheet of each circuit to the Engineer. Power meter tests shall be conducted after all splices have been made and all connectors, jumper cables, and pigtails are in place. Testing shall be conducted at the equipment interfaces. For circuits with multiple devices, couple the connectors together at the equipment interface and test the entire circuit.

OTDR Tests: Conduct bi-directional tests using an OTDR for each fiber string from field cabinet to hub location, between hub locations, inclusive of all jumper cables, pigtails, and patch panels. Demonstrate that the attenuation for each fiber string, termination, and splice, individually and as a

whole, comply with the loss budgets required by the Specifications. Test fibers at 1310 nm and 1550 nm. Submit OTDR traces for approval. Clearly annotate each event (connector, jumper cable, pigtail, splice, etc.) and identify the measured loss.

Following completion of all testing, and approval by the Engineer, compile and submit two organized test notebooks that include all required test results, summary tables, OTDR traces, and electronically saved test data. Test notebooks shall at a minimum, include the following:

- Identification of each fiber by cable (as it is identified in the field), buffer tube, color, and string number as appropriate;
- A summary sheet with each submittal that clearly illustrates length and measured loss versus budgeted loss for each fiber or connected fiber string as appropriate; and
- Calculations and notations for each fiber and wavelength that include total loss, measured dB/km loss, the number of connectors/terminations, pigtails, and jumper cables and any anomalies over 0.1 dB.

482.5 WARRANTY REQUIREMENTS: The following requirements apply, in addition to the warranty requirements identified in Section 480.4:

Repair or replace defective fiber optic cable and equipment for a period of two years following final acceptance of the system.

482.6 SPARE PARTS: Prior to final acceptance, furnish an inventory of the following spare parts. The spare parts inventory shall include the minimum quantity stated based on the total number of like parts supplied, or a minimum of one, whichever is greater:

482.7 DOCUMENTATION: Provide maintenance manuals for fiber optic cable and equipment per the requirements of Section 480.5.

482.8 7 TRAINING: When required, meet the training requirements of Section 480.6.

482.9 8 METHOD OF MEASUREMENT: Fiber optic cable will be measured by the linear foot for actual cable length installed, for each type installed.

Fiber optic splice units, termination units, integrated splice and termination units, and underground splice closures will be measured as a unit for each type installed.

Fiber optic jumper cables, pigtails, patch panels, terminations, splice trays, and splices are considered incidental to the item requiring the work.

The cost of testing, warranty, documentation, and training and spare parts are considered incidental included to in the unit price of the item requiring the work.

482.10 9 BASIS OF PAYMENT: The accepted quantities of items, measured as above, will be paid for at the contract unit price, as designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described.

Part 400 add the following new Section:

SECTION 483

CLOSED CIRCUIT TELEVISION:

483.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing, installing, and testing CCTV equipment including camera assemblies (camera, lens, pan/tilt, camera control receiver, sun shield, environmental enclosure, systems and cables, lightning and surge protection), cabinets, software, and various accessories as needed.

483.2 MATERIALS

483.2.1 FUNCTIONAL REQUIREMENTS (CAMERA ASSEMBLY): Provide a camera assembly that interoperates with an existing central software driver, available from 360 Surveillance. A list of available software drivers may be found at: <http://360surveillance.com>. All responds to all commands and inquiries supported by the central software. With the exception of protocol converters, all components of the camera assembly shall be off-the-shelf items.

Provide certificate of compliance per the requirements of Section 480.3.4(A) that certifies all functional requirements listed herein for camera, lens, pan/tilt unit, camera control receiver, software, and communication protocols system are met.

The total weight of pole mounted CCTV equipment shall not exceed 45 lbs.

483.2.2 CAMERA AND LENS: Cameras shall produce quality video that is clear, low-bloom, low-lag, video with no jitter, interlace, pairing, or ghosting when viewed at the TMC. Provide cameras and lenses that meet the following requirements:

Function/Feature	Requirement
Camera	Day/Night (23X), DSP, color, solid state
Signal Format	NTSC
Image Sensor	¼" or 1/3" interline charged coupled device (ICCD)
Effective Pixels	724 (H) X 494 (V) (NTSC)
Horizontal Resolution	> 470 TV Lines (NTSC)
Lens mMount	C-type lens mount or integrated camera/lens combination
Zoom	23X optical, 10X digital
Zoom speed (optical range)	2.9 / 4.2 / 5.8 seconds Min to max focal length in <4 seconds
Horizontal Angle of view	54° at 3.6 mm wide zoom;
Angle of view	2.5° at 82.8 mm telephoto zoom
Focus	Automatic and with manual adjustment override
Maximum Sensitivity @35 IRE NTSC/EIA	0.08 lux at 1/2 sec (color) 0.3 lux at 1/60 sec shutter (B-W) 0.013 lux at 1/2 sec (B-W)
Sync System	Internal / AC line lock, phase adjustable via remote control, V-Sync
White Balance	Automatic with manual override
Shutter Speed NTSC	Automatic (electronic iris) / Manual 1/2 ~1/30,000
Iris Control	Automatic Iris Control with manual override adjustment in

	steps
Gain Control	Automatic gain control (AGC)/ OFF
Video Output	1 Vp-p, 75 ohms
Video Signal to Noise	> 50 dB
Presets	60 minimum
Wide Dynamic Range	80X
Presets Cable length	24 The supported length of cable between the camera mounted CCTV and the cabinet equipment is 260' minimum

Provide cameras with power input circuitry designed to protect the internal electronics from damage from a power surge and from an under voltage condition per the guidelines of IEEE C62.36-1991.

Provide cameras and lens combinations that automatically recover from over and under voltage conditions, when the prime power is returned to values defined by the Specifications, by returning to the last position prior to the over/under voltage condition.

Use lenses that mechanically or electrically protect the motor from overrunning in extreme positions.

483.2.3 PAN/TILT UNIT: Pan/tilt units shall be designed specifically for the environmental conditions that they will be subjected to while meeting the following minimum requirements:

Function/Feature	Minimum Requirement
Pan range	0° to 350°
Tilt range	10° up and 90° down from horizontal axis
Pan/tilt minimum speed (loaded)	7° pan/second and 3° tilt/second.
Presets	24 60 minimum

Pan/tilt units that pan or tilt at speeds in excess of 30°/second shall have variable speed operation.

Pan/tilt units shall utilize housings that are corrosion resistant, rated NEMA 4 or better, and provide for feed through cabling.

Pan/tilt units shall have either adjustable worm gears drives or stepper motors that are capable of instantaneous reverse motor action, are corrosion resistant, do not require lubrication, and meet the following minimum requirements:

Description	Minimum Requirement
Allowable load (worm gear motor)	40 lbs
Allowable load (stepper motor)	20 lbs
Bearings	Heavy-duty ball or roller bearings.
Gears	Hardened steel.
Finish	Light color baked enamel or anodized.
Cabling	Internal feed through cabling.

483.2.3(A) PRECISION PAN/TILT UNITS: Precision pan/tilt units shall meet the requirements stated for pan/tilt units except that they shall have stepper motors and stop on a programmed pan/tilt preset within an accuracy of 1/4°. The pan/tilt unit shall provide the remote user with variable pan and tilt speeds. The minimum rate of pan shall be 30°/second. The minimum rate of tilt shall be 20°/second.

483.2.4 ENVIRONMENTAL ENCLOSURE: Environmental enclosures shall be used to house the camera and lens. Environmental enclosures shall be sealed and corrosion resistant. The interface with the pan/tilt unit shall be achieved in a manner that leaves no exposed cabling.

Equip the environmental enclosure with a thermostatically controlled heater/fan. Use separate conductors and operate the heater circuit independently from the camera power circuit.

Provide a corrosion resistant sun shield that covers the upper half of the environmental enclosure. The sun shield shall permit air to freely circulate between the sun shield and the environmental enclosure.

Environmental enclosures shall be cylindrical in shape (or approved equal) not exceeding 5.2” outside diameter, or hemispherical dome no larger than 15” for the lower half.

Provide enclosures with optically clear, impact resistant front window (for cylindrical enclosure) or dome acrylic lens (for dome enclosures). The front window or acrylic lens shall not yellow, introduce appreciable light loss, or distort over a 10-year service life when exposed to a desert environment.

483.2.4(A) CYLINDRICAL ENCLOSURE: Match the finish of the environmental enclosure and sun shield, with the finish of the pan/tilt unit housing.

483.2.4(B) DOME ENCLOSURE: Either the upper or lower half of the dome enclosure shall be easy to remove without the use of tools.

A safety wire (or approved equivalent) shall be used to hold the removed half when disconnected. Bond the dome enclosure to mounting arm/bracket, and ensure that the mounting arm/bracket is bonded to the CCTV pole or structure. It is preferred to have an exterior corrosion resistant pin connector that enables testing of the camera assembly within the dome without unsealing the dome.

483.2.5 MOUNTING: Provide all mounting equipment and adapter plates needed to securely mount the pan/tilt unit or dome assembly to the CCTV pole or other structure as required.

483.2.6 CAMERA CONTROL RECEIVER (CCR): CCRs may either be mounted in a cabinet or integrated with the pan/tilt and mounted within the environmental enclosure. CCRs mounted in a cabinet shall be designed to be rack mounted in two door cabinets, and shelf mounted in one door cabinets. Shelf mount CCRs shall have all connections, controls, and displays facing the front of the cabinet.

CCRs shall be capable of storing information for a minimum of 24 pan/tilt/zoom presets using non-volatile memory.

483.2.7 SURGE SUPPRESSION: Install surge protectors in the CCTV cabinet for all conductors (power, data, and video) between pole mounted and cabinet mounted CCTV equipment. Ground each surge protector to a terminal block mounted to the cabinet rack. Bond the terminal block directly to the cabinet ground using an #8 AWG copper ground wire. Surge protector leads shall be a minimum 3’ in length and installed straight as possible.

Wire, ground, and bond equipment in accordance with Section 250-86 of the NEC.

483.2.7(A) COAXIAL CABLE SURGE PROTECTOR: Install one coaxial cable surge protector on the coaxial cable that meets the following requirements:

Connector:	BNC type
Attenuation:	0.1 dB @ 10 MHz
Input/Output impedance:	75 ohms nominal

Peak Surge Current:	500 amperes minimum
Response Time:	1 nanosecond or less

483.2.7(B) POWER CABLE SURGE PROTECTOR: Install power cable surge protectors on all power conductors. At locations where the CCR is integrated with the pan/tilt unit, this surge protector is not required. Power cable surge protectors shall meet the following requirements:

Clamping Mode:	2-stage
Clamping Voltage:	350-volts for a 20,000-ampere, 10,000-volts per microsecond waveform
Peak Clamping Current:	20,000-amperes for an 8 x 20 microsecond waveform
Response Time:	0.5 microseconds or less
Number of Peak Surges:	20 surges at peak current, minimum
Holdover Current:	Zero
Service Current Rating:	Adequate for the continuous load imposed by the equipment served

483.2.7(C) LOW VOLTAGE CONTROL CABLE SURGE PROTECTOR: Install low voltage control cable surge protectors in on each data conductor that meet the following requirements:

Clamping Mode:	2-stage, hybrid
Clamping Voltage:	As appropriate for the specific circuit as approved by the Engineer
Peak Clamping Current:	4,000-amperes for an 8 x 20 microsecond waveform
Response Time:	30 nanoseconds or less
Number of Peak Surges:	25 surges at peak current, minimum

483.2.8 LIGHTNING PROTECTION: Provide an air terminal that is fabricated of galvanized steel or copper-clad steel. Mount the air terminal to the top of the pole such that it does not hinder the ability of the camera to view areas deemed critical by the Engineer. Directly ground the air terminal to the pole ground rod using a 1/2" woven copper ground wire.

483.2.9 CABLES: Use power and control cables that meet IMSA 20-1 specification requirements (latest revision).

Use cCoaxial cable that supports NTSC color video requirements and meet stranded shall be RG-59/U specification requirements (1983 revision) between the camera and the VOTR. Connect coaxial cable for single end operation and do not exceed an impedance of 75 ohms ± 10% (unbalanced) composite video over the frequency range of the camera. An optical fiber may replace the coaxial cable.

483.2.10 ENVIRONMENTAL: Camera equipment shall meet the environmental requirements of Section 480.2.1, except that the camera assembly shall perform to the stated specifications over an ambient temperature range of -30°F to +158°F.

483.2.11 TEXT GENERATION: Provide camera assemblies with the capability to generate and superimpose two lines of text on the video stream, one for camera ID text and one for preset text. Provide a minimum of 20 alphanumeric characters per line that are between 20 and 30 horizontal TV lines in height. Provide the remote user with the ability to enable, disable, and edit the text messages. Store text messages within the camera assembly using non-volatile memory.

Camera location ID text consists of a single, user defined text message that is unique to each camera location.

483.2.12 MAINTENANCE SOFTWARE REQUIREMENTS: Provide software that can be used to provide local operation and full diagnostic support for each different camera assembly configuration supplied on the project using the County maintenance laptops and video monitor.

During submittals, furnish a list of minimum requirements for the County maintenance laptop computers. If local software requires an operating system that is not offered by the County laptops, then furnish and install the necessary operating system including a start-up screen that allows the user to choose the appropriate operating system.

Software requirements will be waived if identical software is already loaded on the County's maintenance laptop computers, or the CCR provides local operation and diagnostic capabilities.

483.2.13 MAINTENANCE LAPTOP COMPUTER INTERFACE: Provide a data/control interface and a video interface in the CCTV cabinet for the County's maintenance laptop computer. The interface between the maintenance laptop computer, video monitor, and the camera assembly may be accomplished by disconnecting the data and video cables from the communication end equipment, and connecting them to the laptop computer and monitor respectively.

483.2.14 COMMUNICATION REQUIREMENTS: Match communication signal format with the central system.

483.2.15 COMMUNICATION PROTOCOL: The camera communication protocol shall be compatible with an existing driver available to MCDOT from 360 Surveillance of Vancouver, British Columbia. Local software shall conform to the protocol and message structure of the County's central CCTV control system. Proprietary protocols shall not be used. Protocol converters may be utilized provided that all functionality and general requirements of the Specifications are met.

483.2.16 CCTV CABINET: MCDOT will furnish a Type G cabinet for each CCTV location, per MCDOT Detail 4729. Refer to Sections 470.5, 475.2.2 and 475.3.2 for more information.

The CCTV cabinet shall be mounted to the CCTV pole per MCDOT Detail 4784.

483.3 CONSTRUCTION REQUIREMENTS: Set electrical or mechanical pan and tilt limit stops at positions determined by the Engineer.

Program in camera location identification text labels obtained from the Engineer.

Furnish and install local CCTV software on the County's maintenance laptop computers (furnished with RS-422 port).

Bond the pan/tilt unit to the mounting plate.

483.4 TESTING REQUIREMENTS: Meet the requirements of Section 480.3.4 and the following:

483.4.1 DESIGN APPROVAL TESTS (DAT): Provide DAT certification for the camera, lens, pan/tilt unit, environmental enclosure, and camera control receiver.

483.4.2 STAND-ALONE TESTS: For each unit of equipment, conduct approved stand-alone tests that exercise all stand-alone (non-network) functional operations of the equipment including the following:

- Control of focus, iris, and power on/off;
- Range of pan, tilt, zoom and digital zoom;
- Presence and quality of video signal;
- Camera ID and preset text generation; and

- Pan and tilt limit stops are set to the Engineer's specification.

483.4.3 SUBSYSTEM TESTS: For each camera location that is installed and interconnected in a system, conduct approved SST from a workstation at the Traffic Operations Center that includes the following:

- All items in the stand-alone test;
- Transmission of quality video to the Traffic Operations Center;
- Response to all central software commands identified under functional requirements;
- Horizontal and vertical resolution*; and
- Signal to noise (S/N) ratio of 48 dB or greater*.

* Perform these tests if in the opinion of the Engineer the picture quality is substandard. Measure the horizontal/vertical resolution and the S/N ratio on a monitor in the Traffic Operations Center for a picture generated by the CCTV camera installation furthest from the Traffic Operations Center and at two other locations specified by the Engineer to verify compliance.

483.5 WARRANTY REQUIREMENTS: Except as required by the following, meet the warranty requirements of Section 480.4.

Provide a 105-year warranty for the front window (cylindrical enclosure) or acrylic lens (dome enclosure) against yellowing, appreciable light loss, or distortion.

483.6 SPARE PARTS: Prior to final acceptance, furnish an inventory of the following spare parts. The spare parts inventory shall include the minimum quantity stated based on the total number of like parts supplied, or a minimum of one, whichever is greater:

483.7 DOCUMENTATION: Provide maintenance manuals for CCTV equipment per the requirements of Section 480.5. Include the following diagrams (as appropriate):

- Video system block diagram showing all components;
- Video signal path diagram;
- Control signal path diagram;
- System connection diagram; and
- Detailed connection diagrams.

483.8 7 TRAINING: When required, meet the training requirements of Section 480.6.

483.9 8 METHOD OF MEASUREMENT: CCTV camera assembly, including the camera, lens, pan/tilt, camera control receiver, sun shield, environmental enclosure, cables, lightning and surge protection, and any other required accessories, will be measured as a unit for each installed.

CCTV cabinets will be measured as a unit for each type installed. Testing, warranty, documentation, and training and spare parts are considered incidental to the item requiring the work.

483.10 9 BASIS OF PAYMENT: The accepted quantities of items, measured as above, will be paid for at the contract unit price, as designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described.

Part 400 add the following new Section:

**SECTION 484
DYNAMIC MESSAGE SIGNS**

484.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing, installing, and testing of structure mounted dynamic message sign (DMS) equipment including DMS cases, displays, controllers, cables, surge protection, cabinets, software, and various accessories as needed.

DMS shall be constructed by a company that is ISO 9001 or ISO 9002 registered. At the Engineer's discretion, the ISO requirements may be waived for companies with comparable quality control programs. Furnish ISO certificates or evidence of a comparable quality control program with the bid documents.

484.2 MATERIALS: Provide certificate of compliance per the requirements of Section 480.2.6 that certify all functional requirements listed herein for the DMS case, display, sign controller unit, dimming system, software, and communication protocols are met. The DMS unit shall be such as to withstand the mechanical shock, and vibration caused by winds up to 80 mph.

484.2.1 DMS CASE

484.2.1(A) GENERAL: The DMS case shall be NEMA 3R rated and fully maintainable from a catwalk located along the front face.

484.2.1(B) STRUCTURAL STEEL AND ALUMINUM: The sign case shall be manufactured using 480% extruded aluminum. Sheet aluminum shall be a minimum of 0.126" thick. Aluminum members shall be seamless with continuous welds in the corner and shall be 6063-T6, 5052-T3, or 6061-T6 aluminum or approved equal.

484.2.1(C) VENTILATION: The sign case shall have convection and fan cooling that is activated via temperature sensor to cool the case in high heat conditions.

The fan cooling system shall create a positive pressure ventilation system, wherein one or more fans are continuously in operation to draw air into the case through filtered drain holes and inlets. The pressure created shall be sufficient to prevent air from entering the sign enclosure, except through filtered inlets. Filters shall be cleanable and changeable.

A multiple fan system shall be used, with at least twice as many fans provided than are needed to maintain the positive pressure. The fan(s) used to provide the positive pressure shall be automatically swapped every 8 hours to extend the mean time between failures. If a fan fails, it shall automatically be deselected and another fan selected and an error message shall be sent to the SCU. The SCU shall transmit the failure state back to the central control location.

The ventilation system shall be thermostatically controlled, and of sufficient quantity and size, as to not permit temperatures inside the enclosure to exceed 135°F or 35°F above the ambient temperature, whichever is higher, when the sign is in full sun, and all equipment in operation.

Current temperature readings for inside the case shall be transmitted to the central system via the SCU.

484.2.1(D) HEATING: Thermostatically controlled heater strips, or other approved method, shall be used to keep the front face free from condensation.

484.2.1(E) FRONT FACE: The front of the sign case shall be covered by an impact resistant, non-glare, polycarbonate face with an ultra-violet (UV) inhibitor to protect the pixels from fading and to

reduce yellowing of the sign face.

The face of the display shall be easily opened from the front, hinged from the top, and shall be assisted and held into position by gas springs or approved equal. A locking system shall be provided for the front face and keyed as directed by the Engineer. Furnish one key for every DMS installed.

484.2.1(F) MOUNTING PROVISIONS: Provide mounting hardware needed to securely mount the sign case to the DMS sign structure.

484.2.1(G) CONVENIENCE OUTLETS: Two 120 VAC, duplex convenience outlets shall be provided with integral ground fault interrupt and shall be protected by a circuit breaker. The receptacles shall be NEMA Type 5-15 R and shall have a spring-loaded cap and be positioned so that no electrical hazard shall exist when used by service personnel. One duplex outlet shall be located on each end of the DMS case.

484.2.2 DMS DISPLAY

484.2.2(A) GENERAL: The DMS display shall be full matrix LED. The LED shall be manufactured using AllnGap Technology or other LEDs with low susceptibility to temperature degradation (AlGaS LEDs will not be allowed). The display shall support letter heights of 10.5" to 32", single stroke or double stroke.

The minimum matrix size is 24x80 pixels. The space between pixels shall be the same horizontally and vertically, and the columns shall be perpendicular to the rows (i.e. no pitch or slant)

Character sets shall match CIE or FHWA human factors for real-time displays or approved substitute.

Characters forming words shall be readable at a distance of at least 600' and at a distance of 600 times the character height by persons with 20/20 vision, an eye height of 3.5', under normal atmospheric conditions and under any lighting condition, day or night.

Operating contrast values between 6 and 25 shall be demonstrated for each lighting condition. An example of the contrast calculation is as follows:

$$[\text{Candela (on)} - \text{Candela (off)}] / \text{Candela (off)}$$

Writing speed shall be 80 characters per second, minimum.

The display shall be capable of producing graphics and an inverted display of black characters on yellow background.

484.2.2(B) PIXELS: Pixels may be round or square. Round pixels shall have a nominal diameter of approximately 1". Square pixels shall have a nominal height and width of approximately 1".

Each pixel shall be AllnGap technology. Each pixel shall have a minimum 60° viewing angle (30° on either side of the central axis that is perpendicular to the display) wherein the readability requirements of Section 484.2.2(A) are met.

The LEDs in each pixel shall be clustered to maximize long range visibility. All pixels shall have equal color and on-axis intensity and shall be a yellow LED (590 nm) that is rated for a minimum of 480,000 MBTF.

The LED pixels shall be powered by a DC power source that maintains a constant power to the pixels operating on a 60Hz AC line voltage ranging from 80 volts RMS to 135 volts RMS.

484.2.2(C) DISPLAY MODULES: The DMS sign display shall be composed of a minimum of 15 display modules that can be easily removed for maintenance, replacement, or cleaning.

484.2.2(D) TILT: The DMS display shall be tilted up to 6° forward to optimize the viewing angle for the motorist approaching the sign. The degree of tilt, if any, will be provided by the Engineer.

484.2.3 SIGN CONTROLLER UNIT (SCU): The SCU shall perform the following minimum functions:

- Respond to all commands and inquiries supported by the central software;
- Control all sign functions;
- Store messages;
- Monitor sign status;
- Communicate using NTCIP compliant software with the central computer and maintenance laptop computer using the specified protocol;
- Display pre-programmed or customized messages programmed from either the maintenance laptop computer that is interfaced at the DMS cabinet, or from the central software; and
- Provide failure detection for the power supply(s), fan(s), lamp(s), photocell, and absence of current to the LED.

The SCU shall be located either within the DMS case or in the DMS cabinet.

Cabinet SCUs shall be designed to be shelf mounted. All displays shall face the front of the cabinet. All connections shall be accessible without necessitating removal of the SCU from the shelf.

The SCU shall have the means to store a library of at least 16 pre-determined messages in non-volatile memory. Each of the messages shall be addressable from the central software, locally via the maintenance laptop computer, and through a keypad interface located in the DMS cabinet. Obtain messages from the Engineer. Each pre-programmed message shall be documented on a laminated card affixed to the inside of the DMS cabinet door.

484.2.4 DIMMING SYSTEM: A dimming system shall be provided that automatically dims or brightens the LEDs based on lighting conditions as determined by the photoelectric sensors. The dimming system shall support at least 4 different brightness levels than can be configured from both the central software and local software on the maintenance laptop computer.

The photoelectric sensors shall be positioned to sense in three directions (behind the sign, in front of the sign, and along side the sign).

Photoelectric sensors shall be provided integral to the DMS. These devices shall direct the SCU to modify the intensity of the light produced by the pixel elements. The mounting devices for the photoelectric sensors shall allow full adjustment of the sensor orientation. Unless otherwise noted, the sensors shall be aimed north.

The photoelectric sensors shall be located such that they are easily accessible for maintenance.

If the photoelectric sensor fails, the sign shall remain in the normal brightness mode and an error message shall be transmitted to the central software in response to the next system poll.

484.2.5 SURGE SUPPRESSION: Install surge protectors in the DMS cabinet for all conductors (power and data) between pole mounted and cabinet mounted DMS equipment. Ground each surge protector to a terminal block mounted to the cabinet rack. Bond the terminal block directly to the cabinet ground using an #8 AWG copper ground wire. Surge protector leads shall be a minimum maximum of 3' in length and installed straight as possible. Surge protectors shall meet the

requirements of Sections 483.2.7(B) and 483.2.7(C).

Wire, ground, and bond equipment in accordance with Section 250-86 of the NEC.

484.2.6 ENVIRONMENTAL: DMS equipment shall meet the environmental requirements of Section 480.2.1.

484.2.7 MAINTENANCE SOFTWARE REQUIREMENTS: Furnish and install non-proprietary maintenance software that can be used to provide local operation, message uploading, and full diagnostic support for each DMS location. At a minimum, the maintenance software shall provide the following functions:

- Maintain a library of text messages;
- Download and upload of library text messages to the DMS;
- Command messages for display;
- Set the SCU clock;
- Set all user-adjustable sign parameters;
- Mimic the sign display operation on the maintenance laptop display;
- Initiate and monitor the results of diagnostic functions; and
- Permit simulation of all DMS commands without actually implementing the displays on the DMS.

During submittals, furnish a list of minimum requirements for the County maintenance laptop computers. If the maintenance software requires an operating system that is not offered by the County laptops, then furnish and install the necessary operating system including a start-up screen that allows the user to choose the appropriate operating system.

The maintenance software shall provide the means for a user to upload messages in a what-you-see-is-what-you-get format.

Maintenance software requirements will be waived if identical software is already loaded on the County's maintenance laptop computers.

484.2.8 MAINTENANCE LAPTOP COMPUTER INTERFACE: Provide an interface in the DMS cabinet for the County's maintenance laptop computer. The interface between the maintenance laptop computer and the DMS assembly may be accomplished by disconnecting the data cable from the communication end equipment, and connecting it to the laptop computer.

484.2.9 COMMUNICATION PROTOCOL: Local software shall respond to system polling in a manner that is NTCIP compliant and conforms to the protocol and message structure of the County's central system. Proprietary protocols shall not be used. Protocol converters may be utilized provided that all functionality and general requirements of the Specifications are met.

484.2.10 DMS CABINET: MCDOT will furnish a Type G cabinet for each DMS location, per MCDOT Detail 4729. Refer to Sections 470.5, 475.2.2 and 475.3.2 for more information.

484.3 CONSTRUCTION REQUIREMENTS: All conduit entries into the sign case shall be watertight.

All conductors installed between the DMS cabinet and DMS case shall be contained in a watertight environment.

Provide strain relief for conductors within the DMS structure. Strain relief (such as wire mesh grip) and any connectors or splices within the DMS structure shall be located within 6" of a handhole.

Ground the DMS case and contents to the DMS support structure using a # 8 solid copper wire in a manner that provides a positive connection. Grounding method is subject to approval by the County. The DMS cabinet shall be mounted to the DMS structure per MCDOT Detail 4784.

484.4 TESTING REQUIREMENTS: Meet the requirements of Section 480.3.4 and the following:

484.4.1 DESIGN APPROVAL TESTS (DAT): Provide DAT certification for the DMS assembly, including the case, display, SCU, and all electronic equipment.

DAT for the DMS assembly shall also state compliance with the following tests/requirements for operation, chromaticity, NTCIP compliance, and readability.

DATs shall include verification of proper operation of the DMS assembly for at least two hours after having been stabilized at the maximum specified temperature, humidity and voltage; two hours after having been stabilized at the minimum temperature, humidity and voltage; and two hours after having been stabilized at 70°F and nominal input voltage of 120/240 ±15 VAC, 60 ±3Hz.

Chromaticity shall be certified by an independent testing laboratory using a Minolta XY-1 Chromatometer. The chromaticity tests shall be conducted for the following minimum states:

- Night (approximately 0.2 ft candles);
- Low light (overcast)*;
- Direct sunlight*;
- Sunlight directly behind the DMS*; and
- Sunlight directly in front of the DMS*.

*Daytime tests shall be performed during ambient temperature conditions greater than 80°F.

NTCIP compliance shall be certified using the NTCIP exerciser available from the FHWA transportation laboratory to demonstrate that no proprietary protocols have been used, and that the SCU/software is NTCIP compliant.

The readability test shall be conducted using five individuals approved by the Engineer with 20/20 corrected vision. Messages comprised of 12" upper case letters shall be read at a distance of 600' with the sun at a low angle both in front and behind the sign, and at night. Eighty-percent correct response shall be considered passing.

484.4.2 STAND-ALONE TEST: The stand-alone test shall exercise all stand-alone (non-network) functional operations of the installed equipment.

The stand-alone test for the DMS assembly shall be performed using both the SCU front display panel and the County maintenance laptop computer. At a minimum, the test shall verify the following:

- Downloading of messages;
- Placing messages in memory and verifying content;
- Display of all characters in the sign;
- Display of static, alternating, and flashing messages of 54 characters;
- Selection of messages;
- Resumption of normal operations after power is restored;
- Diagnostic activation of all pixels at selectable intervals; and
- Diagnostic routines and failure reporting.

484.4.3 SUBSYSTEM TESTS (SST): For each DMS location that is installed and interconnected in the system, conduct approved SSTs from the Traffic Operations Center that includes the following:

- All items in the stand-alone test; and
- Communication to/from all signs and the Traffic Operations Center.

484.5 WARRANTY REQUIREMENTS: The following requirements apply, in addition to the warranty requirements identified in Section 480.4:

The LED used for the pixels shall be warranted for a minimum 5-year period. If during the warranty period, the LEDs deteriorate due to natural causes to the extent that the sign is unreadable as defined in Section 484.2.2(A), then the LEDs shall be replaced/restored to original effectiveness by the Contractor.

484.6 SPARE PARTS: Prior to final acceptance, furnish an inventory of the following spare parts. The spare parts inventory shall include the minimum quantity stated based on the total number of like parts supplied, or a minimum of one, whichever is greater:

484.7 DOCUMENTATION: Provide maintenance manuals for DMS equipment per the requirements of Section 480.5. Include the following diagrams (as appropriate):

- DMS system block diagram showing all components;
- Control signal path diagram;
- System connection diagram; and
- Detailed connection diagrams.

484.8 7 TRAINING: When required, meet the training requirements of Section 480.6.

484.9 8 METHOD OF MEASUREMENT: DMS assemblies, including the DMS case, display, SCU, mounting, cables, surge protection, software, and any other required accessories, will be measured as a unit for each installed.

DMS cabinets will be measured as a unit for each type installed.

Testing, warranty, documentation, and training and spare parts are considered incidental to the item requiring the work.

484.10 9 BASIS OF PAYMENT: The accepted quantities of items, measured as above, will be paid for at the contract unit price, as designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described.

Part 400 add the following new Section:

**SECTION 485
VIDEO IMAGE DETECTORS**

485.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing, installing, and testing video image detection (VID) equipment including the video detector (camera), image processor, cabinet, cables, mounting, surge suppression, lightning protection, local software, and various accessories as needed, for the purposes of obtaining accurate vehicle data at mid-block or highway locations.

485.2 MATERIALS

Provide certificate of compliance per the requirements of Section 480.2.6 that certify all functional requirements listed herein for VID image processor, video detector, software, and communication protocols are met.

485.2.1 FUNCTIONAL REQUIREMENTS: Provide VID equipment that meets the following requirements:

1. Collects and stores for retrieval, real time calculation of speed, volume, and occupancy to an accuracy within $\pm 5\%$ of actual speed, volume, and occupancy under the following conditions:

- Average traffic flow between 5 mph and 75 mph for speed and volume;
- Day or night operation;
- During fog or haze when the visible meteorological range is at least 0.5 mile;
- During rainfall up to 0.2" /hr;
- When experiencing as much as 3.0" deflection or sway due to wind, vibration, or other means; and
- When the cable distance between the video detector and the cabinet is 650' or less.

Volume, speed, and occupancy are defined as:

- Volume: The number of vehicles per lane, during a specified time period;
- Speed: The average vehicle speed, per lane, during a specified time period; and
- Occupancy: The average percentage of time a detection zone is occupied by vehicles during a specified time period.

2. Detects vehicle presence, per lane.

3. Transmits stored data to the central system in response to system polls that may vary in length, no closer than 5 seconds apart. Include with the transmission, the time elapsed since the data accumulation was zeroed at the last transmission.

4. Transmit status information to central in response to a central status query.

5. Supports local monitoring and diagnostic activities from a local user at the VID cabinet via software loaded on the County's maintenance laptop computers.

6. Continues to respond to the central system polls for status and data when interfaced to the County's maintenance laptop computer.

485.2.2 ENVIRONMENTAL: VID equipment shall meet the environmental requirements of Section 480.2.1, except that the VID equipment shall perform to the stated specifications over an ambient temperature range of -30°F to $+158^{\circ}\text{F}$.

485.2.3 IMAGE PROCESSOR: The image processor may be located either with the video detector on the pole or in the VID cabinet. The image processor shall have the capability to analyze the video signal at a minimum rate of 25 frames per second.

The image processor shall perform the following functions:

- Synchronize with the central system's time and date;
- Establish or change the controller's operational parameters to match those downloaded from the central system;
- Upload the current operational parameters to the central system; and
- Reset detector data accumulators to zero following transmission to the central system.

485.2.4 VIDEO DETECTOR: The video detector shall obtain video and process data for up to 4 lanes of traffic.

485.2.5 VID CABINET: MCDOT will furnish a Type G cabinet for each VID location, per MCDOT Detail 4729. Refer to Sections 470.5, 475.2.2 and 475.3.2 for more information.

The VID cabinet shall be mounted to the VID pole per MCDOT Detail 4784.

485.2.6 CABLES: Use power and control cables that meet IMSA 20-1 the VID manufacturer's specification requirements (latest revision).

485.2.7 MOUNTING: Provide all mounting equipment and adapter plates needed to securely mount the video detector to the VID pole or other structure as required.

485.2.8 SURGE SUPPRESSION: Install surge protectors in the VID cabinet for all conductors (power, data, and video) between pole mounted and cabinet mounted VID equipment. Ground each surge protector to a terminal block mounted to the cabinet rack. Bond the terminal block directly to the cabinet ground using an #8 AWG copper ground wire. Surge protector leads shall be a minimum 3' in length and installed straight as possible. Surge protectors shall meet the requirements of Sections 483.2.7(A), 483.2.7(B), and 483.2.7(C).

Wire, ground, and bond equipment in accordance with Section 250-86 of the NEC.

485.2.9 MAINTENANCE SOFTWARE REQUIREMENTS: Furnish and install maintenance software on the County maintenance laptop computers that can be used to provide local operation and full diagnostic support for video detection. The maintenance software shall enable the local user to obtain current volume, occupancy and speed data on a per lane basis.

During submittals, furnish a list of minimum requirements for the County maintenance laptop computers. If the maintenance software requires an operating system that is not offered by the County laptops, then furnish and install the necessary operating system including a start-up screen that allows the user to choose the appropriate operating system.

The maintenance software shall provide the means for a user to define detection zones through interactive graphics by placing lines or boxes on an image of the detection area that is displayed at the field cabinet. The software shall utilize graphics that provide visual confirmation when a vehicle has been detected as it passes through the detection zone. In addition, the software shall produce a visual read-out for individual vehicle speed that can be selected or turned-off by lane.

Maintenance software requirements will be waived if identical software is already loaded on the County's maintenance laptop computers.

485.2.10 MAINTENANCE LAPTOP COMPUTER INTERFACE: Provide a data and video interface in the VID cabinet for the County's maintenance laptop computer. The interface shall respond to central system polls for status and data while local control, monitoring, configuration, and diagnostic routines are occurring.

485.2.11 COMMUNICATION REQUIREMENTS: Match communication signal format with the central system.

485.2.12 COMMUNICATION PROTOCOL: The VID equipment shall respond to system polling in a manner that conforms to the protocol and message structure of the County's central system. Proprietary protocols shall not be used. Protocol converters may be utilized provided that all functionality and general requirements of the Specifications are met.

485.3 CONSTRUCTION REQUIREMENTS: Install local software on the County's maintenance laptop computers. Configure/calibrate the local software for each location and enter data in all pertinent fields.

Bond the video detector to the mounting bracket or pole.

485.4 TESTING REQUIREMENTS: Meet the requirements of Section 480.3.4 and the following:

485.4.1 DESIGN APPROVAL TESTS (DAT): Provide DAT certification for the video detector (camera) and image processor.

485.4.2 STAND-ALONE TESTS: Conduct a stand-alone test for each configured VID location using a Contractor supplied test vehicle equipped with cruise control. The test vehicle shall be a standard "mid-sized" vehicle similar to a late model Ford Taurus. Certify the accuracy of the speedometer prior to testing. Compare the speedometer reading obtained from the test vehicle against spot speed determined by the image processor.

Conduct the test for the furthest lane from the video detector. Obtain 10 consecutive speed samples from 20 mph to 80 mph, or the posted speed limit, whichever is less, at approximately 5 mph increments.

If the average speed of the 10 samples does not meet the accuracy requirements, then reconfigure and retest until the test requirements are satisfied.

485.4.3 SUBSYSTEM TESTS: Using the County's software at the Traffic Operations Center, verify that all detector data is received. Demonstrate correct responses to all message formats of the County protocol, detector processing, and all functions required in the Specifications.

485.5 WARRANTY REQUIREMENTS: Meet the warranty requirements of Section 480.4.

485.6 SPARE PARTS: Prior to final acceptance, furnish an inventory of the following spare parts. The spare parts inventory shall include the minimum quantity stated based on the total number of like parts supplied, or a minimum of one, whichever is greater:

485.7 DOCUMENTATION: Provide maintenance manuals for VID equipment per the requirements of Section 480.5. Include the following diagrams (as appropriate):

- VID system block diagram showing all components;
- Video and control signal path diagram;
- System connection diagram; and
- Detailed connection diagrams.

485.8 7 TRAINING: When required, meet the training requirements of Section 480.6.

485.9 8 METHOD OF MEASUREMENT: VID equipment assembly, including the video detector (camera), image processor, cables, mounting, surge suppression, lightning protection, local software, and various accessories as needed, will be measured as a unit for each installed.

VID cabinets will be measured as a unit for each type installed.

Testing, warranty, documentation, and training and spare parts are considered incidental to the item requiring the work.

485.10 9 BASIS OF PAYMENT: The accepted quantities of items, measured as above, will be paid for at the contract unit price, as designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described.

Part 400 is supplemented with the following new Section:

**SECTION 486
COMMUNICATIONS EQUIPMENT**

486.1 DESCRIPTION OF WORK: The work under this section shall consist of furnishing, installing, and testing communications equipment systems including, cabinet, cables, mounting, surge suppression, lightning protection, software, and accessories as indicated.

486.2 MATERIALS AND EQUIPMENT

486.2.1 FREQUENCY HOPPING SPREAD SPECTRUM RADIO:

Provide certificate of compliance per the requirements of Section 480.5.3(A) that certify all functional requirements listed herein for hardware, software, and communication protocols are met.

486.2.1.1 FUNCTIONAL REQUIREMENTS: Spread Spectrum Radio equipment shall meet the following requirements:

- Operate in the license-free, Spread Spectrum band (902-928 MHz) or frequencies compatible with the system, utilizing Frequency Hopping technology
- Use 139 user-selectable channels, with 62 available hopping sequences, (2 shall be non-overlapping)
- Completely configurable via software
- Software to provide: remote diagnostics, remote maintenance and Spectrum Analyzer
- RS232 interface capable of 1200 bps to 115.2 Kbps
- A maximum 8 mSec. end-to-end latency
- LED indicators for PWR, TX DATA, RX DATA (3 LED Bar graph for RX Signal Strength Indication)
- Receiver Sensitivity of -110 dBm @ 10^{-6} BER
- DB9F connector for RS232 port
- Operating temperature of -40 to +80 degrees C.
- Operate with voltages between 6 VDC and 30 VDC, with a typical current draw of <100mA
- Programmable for RF output levels of 1mW, 10mW, 100mW or 1 Watt
- Provide 16-bit CRC error checking with auto re-transmit
- Available with optional built-in RS485 Interface
- Compatible with standard controller hardware and software
- Built-in store-and-forward repeater (One radio repeater c/w live local comm. port)
- Ability to function in a wireless network configuration that may include a mix of RS232, RS485
- Available in a rack mounted version, and a pole mounted version
- Sleep Mode with a maximum current draw of <1uA
- Equipped with a RP-TNC-F antenna connector

Shelf Mount Unit

- Shall not exceed 4.38" Depth x 3.65" W x 1.69" H (not including connectors or mounting bracket)
- Shall have RP TNC-F antenna connector
- Shall have power cable supplied with radio modem
- Shall have RSSI signal strength LEDS

486.2.1.2 Surge Suppression: Internal surge protectors shall protect the Radio all conductors (power, data, and video) between pole mounted antenna and cabinet mounted equipment. Ground each surge protector to a terminal block mounted to the cabinet rack. The terminal block shall be bonded directly to the cabinet ground using an #8 AWG copper ground wire. Surge protector leads shall be a minimum 3' in length and installed straight as possible. Surge protectors shall meet the requirements of Sections 483.2.7(A), 483.2.7(B), and 483.2.7(C).

Wire, ground, and bond equipment in accordance with Section 250-86 of the NEC.

486.2.1.3 Maintenance Software Requirements: Furnish maintenance software for all County maintenance laptop computers. The software shall provide local operation and full diagnostic support for Spread Spectrum Radio. The maintenance software shall enable the local user to test the radio, analyze the interference and select appropriate operational bands. Provide documented installation instructions to enable installation on all County maintenance laptop computers and demonstrate installation of the maintenance software on at least one County maintenance laptop computer.

During submittals, furnish a list of minimum requirements for the County maintenance laptop computers. If the maintenance software requires an operating system that is not offered by the County laptops, then furnish and install the necessary operating system including a start-up screen that allows the user to choose the appropriate operating system.

Maintenance software requirements will be waived if identical software is already loaded on the County's maintenance laptop computers.

486.2.1.4 Communication Requirements: Match communication signal format with the central system.

486.2.2 DISCRETE FREQUENCY SPREAD SPECTRUM RADIOS: Spread spectrum radio equipment shall communicate over a wireless communication medium. The spread spectrum radio equipment shall provide a high reliability, bi-directional RS-232 serial data, multi-point communication link between field devices. All drops for the multi-point wireless circuit shall share the same EIA-232 communication channel. At the first field cabinet on the multi-point circuit, the spread spectrum radio equipment shall interface with the central equipment, via an extension of the shared EIA-232 channel over a leased telephone line.

486.2.2.1 The spread spectrum radio shall provide, at a minimum, selectable baud rates between 1200 and 19,200 bps, inclusive. Point-to-point and point-to-multipoint bi-directional configurations shall be supported.

486.2.2.2 All system components shall provide for a fully functional operation. The spread spectrum item shall include all communication equipment and accessories necessary to support a single spread spectrum radio site that provides transmitting, receiving, and repeating (for extending range beyond line of sight to the first cabinet on the drop.) capabilities for both point-to-point and point-to-multipoint bi-directional configurations.

486.2.2.3 Transceiver:

The spread spectrum radio (SSR) shall be off-the-shelf equipment that operates within the 902-928 MHz range, capable of 1200 bps to 115.2 Kbps asynchronous, half-duplex operation. The unit shall also support an interface to a full-duplex EIA-232 channel. The unit shall be FCC certified.

- a. Transmitter Range: up to 20 miles
- b. Receiver Sensitivity: -106 dB
- c. Maximum Output Power: 1 Watt
- d. Channels/Hop Pattern: 8 (minimum)

- e. Processing Gain/System Gain 15 dB/135dB
- f. Temperature Range: -40°F to +165°F
- g. Humidity: 5% to 90%, non-condensing

486.2.2.4 Antenna:

The antenna shall be a directional Yagi and provide a nominal gain of at least 8.5 dB. The antenna shall be approximately 24” (height) by 6.4” (width). Operate within a temperature range of -40°F to +165°F and be non-condensing up to 95% humidity.

486.2.2.5 Cables:

Furnish cabling with preinstalled connections for interconnecting the antenna with the transceiver. The cable shall be a low loss Belden 9913 or better with a maximum attenuation of 4.2 dB per 100 feet @ 900 MHz.

An interconnect cable, 4-foot minimum, shall be provided with the spread spectrum equipment for interconnecting directly with the local controller.

486.2.2.6 Lightning Suppressor:

A cabinet mounted lightning suppressor shall be provided as part of the spread spectrum radio system.

486.2.3 TWISTED-WIRE PAIR MODEMS

486.2.3.1 Modems shall communicate over a copper twisted wire pair (TWP) communication medium. The twisted-wire pair modems shall provide a high reliability, bi-directional RS-232 serial data, multipoint (“daisy-chained”) communication link between field devices. The TWP modem shall also operate as a leased line interface modem for tying into the TELCO network.

486.2.3.2 Modems shall communicate at 9,600 bps over both private and leased line applications. The modems shall be selectable for operation on 2-wire, half-duplex and 4-wire full-duplex communications circuits.

486.2.3.3 Modems shall include at least the following LED indicators:

- a. Power (PWR);
- b. Transmit Data (TXD);
- c. Receive Data (RXD);
- d. Request To Send (RTS); and
- e. Clear To Send (CTS).

486.2.3.4 Modems shall support anti-streaming by turning the transmitter off, after a selectable period of time, in the event that the controller malfunctions that streams a constant signal to the modem.

486.2.3.5 Modems shall also be fully functional over an ambient outdoor temperature range of -40°F to +165°F and an outdoor ambient humidity of 5% to 95% non-condensing.

486.2.3.6 Modems shall be standalone units with an aluminum housing that is treated to prevent corrosion. External markings shall include the product name, model number, part number, serial number, manufacturer's name, connection labels, and indicator labels.

486.2.3.7 A voltage converter shall be provided with each standalone modem. The power converter shall operate from a prime power with the following characteristics:

Input Voltage:	115	VAC	±15%
Frequency:	60	Hz	±10%
Phase:	Single		
Maximum Load:	200 mA		

486.2.3.8 The use of a terminal block between the modem and the controller will not be allowed. Each modem shall be provided with a 4-foot interconnect cable. The interconnect cable shall have a connector on one end that directly mates to the RS-232 port of the modem and the connector on the other end shall mate directly to the RS-232 port on the TS-2 signal controller. Documentation on the assigned pin-out configuration for each end of the interconnect cable shall be provided. In the event that a loop through between the RTS and CTS pins are necessary and this function is accommodated within the interconnect cable configuration, it shall be clearly identified in the interconnect cable documentation.

486.2.4 TELEPHONE MODEMS

486.2.4.1 Telephone modems shall provide for point-to-point communications, via a dial-up telephone line, between the central equipment at the TMC and the field cabinet location.

486.2.4.2 Telephone modems shall be commercial off-the-shelf (COTS) external modems that meet the V.34 standard.

486.2.4.3 Modems shall be fully functional over an ambient outdoor temperature range of -40°F to +165°F and an outdoor ambient humidity of 5% to 95% non-condensing.

Modems shall include at least the following LED indicators:

- a. Power (PWR);
- b. Transmit Data (TXD); and
- c. Receive Data (RXD).

486.2.4.4 Modems shall be standalone units with an aluminum housing that is treated to prevent corrosion. External markings shall include the product name, model number, part number, serial number, manufacturer's name, connection labels, and indicator labels.

486.2.4.5 An interconnect cable, 4-foot minimum, shall be provided with each modem for interconnecting to the local controller directly or for interconnecting to the line sharing unit directly.

486.2.5 EIA-232 LINE SHARING UNIT

486.2.5.1 The EIA-232 line sharing unit shall receive the EIA-232 channel from the telephone modem and provide an EIA-232 port for interfacing the local controller and an EIA-232 port for interfacing the multi-point communication transceiver (OTR, TWP modem or spread spectrum equipment). All communication ports on the line-sharing unit shall share the same EIA-232 communication channel.

486.2.5.2 Two interconnect cables, 4-foot minimum, shall be provided with the line-sharing unit. One for interconnecting to the local controller directly and the other for interconnecting directly to the communication transceiver (OTR, TWP modem or spread spectrum equipment).

486.2.6 Industrial Frame Router:

Industrial frame routers to be located in the traffic signal controller cabinet shall comply with the following minimum requirements:

- Eight (8) RS232 DTE serial interfaces with DB9 female connectors;

- Five (5) 10/100 Base TX Ethernet ports;
- T-1 CSU/DSU interface;
- Functions to include terminal server, Ethernet switch, IP router, Frame Relay Access Device (FRAD), and CSU/DSU;
- Operating temperature range from -40 °F to 160 °F;
- High voltage power range of 90 to 250 VAC;
- Frequency range of 50 to 60 Hz; and
- Power consumption: 85 W.

Industrial frame routers shall be supplied with all necessary cabling to provide a functional system.

The industrial frame router shall be Dymec DynaStar 1500 IFR, or equivalent.

486.2.7 High-Capacity Industrial Frame Router:

High-capacity industrial frame routers to be located at the MCDOT Traffic Management Center shall comply with the following minimum requirements:

- One (1) 10BaseT/AUI Ethernet LAN port;
- One (1) RS232 Sync/Async port;
- One (1) RS232 Async console port;
- Two (2) WAN ports;
- Two (2) T1/E1 with integral CSU/DSU WAN ports;
- Five (5) card expansion slots populated with:
- Three (3) Expansion Card Slots with Dual T-1 Interfaces with integral CSU/DSUs (6 Total T-1 Interfaces)
- One (1) Expansion card equipped with a 12 port managed Ethernet switch;
- Operating temperature range from -40 °F to 160 °F;
- High voltage power range of 90 to 250 VAC;
- Frequency range of 50 to 60 Hz; and
- Power consumption: 44 W.

The high-capacity industrial frame router shall be Dymec DynaStar 5000 IFR, or equivalent.

486.2.8 Serial Expansion Device:

Serial expansion device to be located at the MCDOT Traffic Management Center shall comply with the following minimum requirements:

- One (1) 10/100 Ethernet LAN port with RJ45 connector;
- Sixteen (16) RS-232 serial ports with RJ45 connectors;
- Surge protection on all ports;
- 230 Kbps throughput on all ports;
- LEDs for serial and Ethernet activity;
- Port buffering up to 64 Kbps per port;
- Power requirement: 100 to 250 VAC;
- Frequency range of 47 to 63 Hz;
- Power consumption 12 W; and
- Operating temperature range of 32 °F to 130 °F.

The serial expansion device shall be supplied with all necessary cabling to provide full operation.

The serial expansion device shall be a Digi PortServer TS 16, or Moxa CN2510-16, or equivalent.

486.2.9 MPEG-4 CODEC:

MPEG-4 CODEC shall conform to the following minimum requirements:

- MPEG-4 video compression algorithm (ISO/IEC 14496-2);
- Real-time transmission of MPEG-4 video;
- NTSC compatible;
- 10/100 Ethernet with web server for configuration and status;
- Ethernet UDP/IP & RTP;
- Low latency modes;
- Reduced resolution modes;
- One (1) video input/output port with a BNC connector;
- 10/100 Ethernet IP interface with an RJ-45 connector;
- User selectable camera control data rate to include 9.6 Kbps;
- Two (2) data channel ports with DB-9 connectors;
- Voltage range of 90 to 264 VAC;
- Power consumption: 10 W;
- Frequency range of 47 to 63 Hz;
- Encoding units enclosed in a NEMA 4X housing, that shall not exceed 3” x 9” x 13”; and
- Operating temperature range of 32 °F to 122 °F.

MPEG-4 CODEC shall be supplied with all necessary cabling to provide full operation.

MPEG-4 CODEC to be located in the MCDOT Traffic Management Center shall be suitable for 19” rack mounting.

The MPEG-4 CODEC shall be PelcoNet NET300, or VBrick MPEG-4 Encoder/Decoder, or equivalent.

CONSTRUCTION REQUIREMENTS: Install local software on the County’s maintenance laptop computers. Configure/calibrate the local software for each location and enter data in all pertinent fields.

486.9 METHOD OF MEASUREMENT: Communications equipment systems including, cables, mounting, surge suppression, lightning protection, local software, and various accessories as needed, will be measured as a unit for each installed.

Industrial Frame Routers shall be measured by each type furnished, installed, and accepted complete in place.

Serial Expansion Devices shall be measured by each type furnished, installed, and accepted complete in place.

MPEG-4 CODEC shall be measured by each type furnished, installed, and accepted complete in place.

486.10 BASIS OF PAYMENT: The accepted quantities of items, measured as above, will be paid for at the contract unit price, as designated in the bidding schedule, COMPLETE IN PLACE, which price shall be full compensation for the work described including testing, warranty, documentation, and training.

