MARICOPA COUNTY
Department of Transportation

MEMORANDUM

DATE: June 29, 2004

TO: Engineers, Contractors, Consultants, and Agency Staff

FROM: Michael S. Ellegood, P.E., Director of Public Works,
Transportation Director, and County Engineer

SUBJECT: MCDOT Supplement to MAG Uniform Standard Specifications and Details for Public Works Construction

Work performed within Maricopa County rights of way shall comply with the MAG Uniform Standard Specifications and Details for Public Works Construction as modified by the Maricopa County Department of Transportation Supplement. The attached supplement dated July 1, 2004 shall continue in effect until reissued or updated. Address specific issues or concerns to:

Robert Herz, MCDOT Engineering Division (602) 506-4760
(email: rherz@mail.maricopa.gov).

This document is available on the MCDOT web site:

http://www.mcdot.maricopa.gov/manuals/

or for purchase at Maricopa County Department of Transportation offices located at 2901 West Durango, Phoenix, Arizona 85009, Customer Service (602) 506-2055.

MARICOPA

COUNTY

DEPARTMENT OF TRANSPORTATION

METRIC SUPPLEMENT TO THE

MARICOPA ASSOCIATION OF GOVERNMENTS'

UNIFORM STANDARD SPECIFICATIONS

FOR

PUBLIC WORKS CONSTRUCTION

JULY 1, 2004

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2032-A	Sidewalk Ramp Arterial Streets
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2033	Wing Type Driveway/Alley Entrance with Attached Sidewalk
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2054	Street Name Sign Installation Details (2 pages)
2055	Barricade (Portable)
2056	Roadway Markers
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2058	Square Perforated Tube Sign Post Foundation & Splice Details
2059	U-Channel Post Selection and Installation Details
2060	Offsets, Clearances and Mounting Details for Signs on County Roadways (2 pages)
2061	Sign Blanks – Layouts (24 pages)
2062	Street Sign – Post Caps and Brackets (6 pages)
2065	Mailbox Relocation Detail for Curb Section without Sidewalk
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2069	Recommended Mailbox Clearances at Intersections
2070	Typical Mailbox Turnout
3001	Typical Guardrail
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Number	Old Number	Description
4701	S-200-1m	Plan Symbols
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4720	S-202-1m	Signal Pole Foundations (Pole Types A, E, F & PB)
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4722	S-202-3m	Square Base Pedestal (SB) Pole Foundation (ITS Only)
4723	S-202-4m	'P' Cabinet Foundation
4724	S-202-5m	'SP' Service Pedestal Foundation Detail
4725	S-202-6m	Anchor Bolt W/ Hook
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4729	S-203-1m	'G' Cabinet (ITS Installation Only)
4730	S-203-2m	'P' Cabinet
4731	S-203-3m	'SP' Electrical Service Pedestal
4732	S-203-4m	Flasher Transfer Circuits
4735	S-203-5m	Controller Cabinet Wiring Schematic
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4738	S-204-1m	Type 'A' Pole
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4741-2	(S-204-7m)	'E' & 'F' Pole Details
4742	S-204-4m	Type 'J' Pole
4743	S-204-5m	Type 'Q' Pole
4744	(S-204-8m)	'J' & 'Q' Pole Details
4745	S-204-6m	Type 'SB' Pole (ITS Installation Only)
	S-204-7m	See Detail 4741-2 {Pole Details (Pole Types E & F)}
	S-204-8m	See Detail 4744 {Pole Details (Pole Types J & Q)}
	S-204-9m	See Detail 4739 {Pole Hand Hole Details}
4747-1	S-204-10m	Multi-Use Pole (SRP)
4747-2	S-204-11m	Multi-Use Pole (APS)
4748	S-204-12m	Type 'K' Pole
4749-1	S-204-13m	Type 'R' Pole
4749-2	S-204-14m	'K' & 'R' Pole Details
4750	S-204-15m	Type 'PB' Pole
4751	S-205-1m	Square Base Pedestal (ITS Installation Only)
4757	S-207-1m	Loop Installation Details
4758	S-207-2m	Conduit Stub-Out Detail (Without Curb & Gutter)
4759	S-207-3m	Conduit Stub-Out Detail (With Curb & Gutter)
4760	S-207-4m	Loop To Detector Amplifier Connection
4773	S-208-1m	Standard Signal Faces
4774	S-208-2	Signal Head Visor

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4775	S-210-1m	Side Mount (Type XI) Assembly (Vehicle & Pedestrian)
4776	S-210-2m	Pole Top (Type III) Mounting Assembly
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4778-2	S-210-4m	Elevator Plumbizer Detail
4780-1		Metro Street Sign Layout Sheet
4780-2		Metro Street Sign Layout and Installation
4780-3	S-210-5m	Metro Street Sign Clamp
4783	S-210-6m	Pedestal Post Top Mounting (G-I) (ITS Installation Only)
4784	S-210-7m	Post Side Mount (G-2) (ITS Installation Only)
4785	S-210-8m	Pole Plate
4786	S-210-9m	Pole Top Mount Adaptor
4787	S-210-10m	Pedestal Pole Top Mounting Adapter (ITS Only)
4788	S-210-11m	Elbow
4789	S-210-12m	Tee
4790	S-210-13m	Pole Plate With Wire Guide (OBSOLETE – DISCONTINUED)
4791	S-210-14m	Ornamental Cap
4792	S-210-15m	Side Mounted Terminal Compartment
4793	S-210-16m	Terminal Compartment Cover
4794	S-210-17	Type V Mounting Assembly
4795	S-210-19	Type VII Mounting Assembly
4797-1	S-211-1m	Type PB Pedestrian Push-Button Mount
4797-2	S-211-2m	Pedestrian Push-Button Housing
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4798	S-215-3m	Underground Power Service (Type 5)
4799-1	S-216-1m	Color Code - 4 Conductor Cable
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4801		Typical Outerduct Installation
4810		Conduit and No. 7 Pull Box Installation
4811		Conduit and No. 9 Pull Box Installation
4812		Typical Installation Through Sleeves Depth Less Than or Equal to 9’
4813		Typical Installation Through Sleeve Depth Greater Than 9’
4820		Fiber Optic No. 9 Pull Box

MCDOT 2004 Supplement to MAG Uniform Standard Specifications (Metric)

SECTION 101

ABBREVIATIONS AND DEFINITIONS

101.1: ABBREVIATIONS

Add the following:

ADEQ	Arizona Department of Environmental Quality
ha	Hectare
SWPPP	Stormwater Pollution Prevention Plan

101.2: DEFINITIONS AND TERMS:

Add the following:

Americans With Disabilities Act of 1990: “(ADA)” as the act that makes it unlawful to discriminate in employment and service provision, against a qualified individual with a disability.

Certified Laboratory: An AASHTO accredited laboratory, certified in the relevant engineering materials and testing specialty areas(s) referenced in the Contract Documents.

County: The Maricopa County Department of Transportation, acting through its legally constituted officials, officers, or designated employees.

Maricopa County Minority Business Office: "(MBO)": The office responsible for administering the Maricopa County Minority and Woman-Owned Business Enterprise Program.

Maricopa County Minority and Woman-Owned Business Enterprise Program: "(MBE/WBE)" as being the program adopted by the Board of Supervisors, effective January 1, 1992.

Maximum Density: The maximum dry density of soil obtained from the procedures defined in Section 301.3.

Metric 'Hard' Conversion: An English measurement is approximated with a new, rounded, rationalized Metric number that is convenient to remember and work with.

Metric 'Soft' Conversion: An English measurement is mathematically converted to its exact (or nearly exact) Metric equivalent, used primarily to convert the measurements of standard/ proprietary products available only in specific sizes.

The following definitions are revised to read:

Force Account Work: Work performed in accordance with Section 109.5

Professional Engineer: A person who has a current engineering registration granted by the Arizona State Board of Technical Registration in one or more branches of engineering recognized by the board.

Professional Geologist: A person who has a current registration as a geologist granted by the Arizona State Board of Technical Registration.

SECTION 102

BIDDING REQUIREMENTS AND CONDITIONS

102.2 CONTENTS OF PROPOSAL PAMPHLET:

The Third paragraph of Section 102.2 is replaced by the following:

The work described in the specifications and shown on the plans for this project, shall be performed in accordance with the MCDOT Supplement to MAG Uniform Standard Specifications, Maricopa County Association of Governments current issue of the Uniform Standard Specifications for Public Works Construction, and all revisions thereto, Uniform Standard Specifications and the Special Provisions.

In the event a conflict exists between the Contract Documents the following order of precedence shall be as follows:

Addenda

Special Provisions

Project Plans

MCDOT Supplement to MAG Uniform Standard Specifications

MAG Uniform Standard Specifications

Standard Drawings or Standard Details

102.5 PREPARATION OF PROPOSAL

Revise the third paragraph of Section 102.5 to read:

102.5.1 Proposal Preparation:

Contractor shall submit the entire construction specifications document intact and shall complete and submit the following documents with its bid:

(A) No Collusion Affidavit - form must be filled out, signed and notarized.

(B) Verification of License - form must be filled out, dated and signed.

(C) MBE/WBE Assurance Affidavit - select one of two options, sign and notarize form.

(D) Proposal - appropriate sections of the form must be filled out, addenda listed, if any, and signed.

(E) Bidding Schedule - must include unit costs, amounts per bid item, and total bid amount. Addenda, if any, must be listed. All notations in the bidding schedule must be legible and in pen or ink.

(F) Surety Bond - proposals must be accompanied by a certified check, cashiers check, or a surety bond for an amount equal to ten percent (10%) of the total amount bid.

(G) All addenda issued by the County for the specific project must be included with the bid and noted on the second page of the proposal.

Other forms - execution of the Contract, submittal of the Performance/Payment Bond and the Certificate of Insurance is not required at the time of bid submittal. These documents must be submitted to the County by the successful bidder at time of contract execution.

Contractor may be required to provide proof of satisfactory completion of similar public works projects.

Add the following to Section 102.5:

It shall be the responsibility of the prospective bidder to determine, prior to the submittal of its bid, if any addenda to the project have been issued by Maricopa County Department of Transportation. All addenda issued, if not already bound in the Special Provisions, shall be submitted by bidder with its bid and noted in the proposal section. All quantity adjustment, required as a result of the addendum, shall be reflected on the bidding schedule in pen and ink.

Bids which do not reflect the appropriate changes on the bidding schedule, do not have all issued addenda attached and noted in the proposal section of the Contract, will be rejected by the County.

Prospective bidders may call Maricopa County Department of Transportation in order to ascertain if addenda have been issued for this project.

102.6 SUBCONTRACTORS' LIST

Section 102.6 add the following:

The Contractor shall submit to the County with the Bid documents a listing of all major Subcontractors and Material Suppliers the Contractor intends to use in the performance of the work specified in this contract. In determining the amount of work assigned to each Subcontractor, the Contractor shall adhere to the mandates set forth in Section 108.2, Subsection E, of the MAG Uniform Standard Specifications.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103.6 CONTRACTOR'S INSURANCE:

Section 103.6 is revised to read:

103.6.1 GENERAL

Contractor, at Contractor's own expense, shall purchase and maintain the herein stipulated minimum insurance with companies duly licensed, possessing a current A.M. Best Company, Inc. rating of at least B++ or a Financial Performance Rating (FPR) of at least 6, or approved unlicensed companies in the State of Arizona with policies and forms satisfactory to the County.

All insurance required herein shall be maintained in full force and effect until all work or service required to be performed under the terms of the Contract is satisfactorily completed and formally accepted. Failure to do so may, at the sole discretion of the County, constitute a material breach of this Contract.

The Contractor's insurance shall be primary insurance as respects the County, and any insurance or self-insurance maintained by the County shall not contribute to it.

Any failure to comply with the claim reporting provisions of the insurance policies or any breach of an insurance policy warranty shall not affect coverage afforded under the insurance policies to protect the County.

The insurance policies may provide coverage which contains deductibles or self-insured retentions. Such deductible and/or self-insured retentions shall not be applicable with respect to the coverage provided to the County under such policies. The Contractor shall be solely responsible for the deductible and/or self-insured retention and the County, at its option, may require the Contractor to secure payment of such deductibles or self-insured retentions by a surety bond or an irrevocable and unconditional letter of credit.

The County reserves the right to request and to receive, within 10 working days, certified copies of any or all of the herein required insurance policies and/or endorsements. The County shall not be obligated, however, to review such policies and/or endorsements or to advise Contractor of any deficiencies in such policies and endorsements, and such receipt shall not relieve Contractor from, or be deemed a waiver of the County's right to insist on strict fulfillment of Contractor's obligations under this Contract.

The insurance policies required by this Contract, except Workers' Compensation, shall name the County, its agents, representatives, officers, directors, officials and employees as Additional Insureds.

The policies required hereunder, except Workers' Compensation, shall contain a waiver of transfer of rights of recovery (subrogation) against the County, its agents, representatives, officers, directors, officials and employees for any claims arising out of Contractor's work or service.

103.6.2 COMMERCIAL GENERAL LIABILITY

Contractor shall maintain Commercial General Liability insurance with a limit of not less than $1,000,000 for each occurrence with a $2,000,000 Products/Completed Operations Aggregate and a $2,000,000 General Aggregate Limit. The policy shall include coverage for bodily injury, broad form property damage, personal injury, products and completed operations and blanket contractual coverage including, but not limited to, the liability assumed under the indemnification provisions of this Contract which coverage will be at least as broad as Insurance Service Office, Inc. Policy Form CG 00 01 10 93 or any replacements thereof. The coverage shall include X, C, U.

The policy shall contain a severability of interest provision, and shall not contain a sunset provision or commutation clause, or any provision which would serve to limit third party action over claims.

The Commercial General Liability additional insured endorsement shall be at least as broad as the Insurance Service Office, Inc.'s Additional Insured, Form CG 20 10 11 85, and shall include coverage for Contractor's operations and products and completed operations.

If the Contractor subcontracts any part of the work, services or operations awarded to the Contractor, he shall purchase and maintain, at all times during prosecution of the work, services or operations under this Contract, an Owner's and Contractor's Protective Liability insurance policy for bodily injury and property damage, including death, which may arise in the prosecution of the Contractor's work, service or operations under this Contract. Coverage shall be on an occurrence basis with a limit not less than $1,000,000 per occurrence, and the policy shall be issued by the same insurance company that issues the Contractor's Commercial General Liability insurance.

103.6.3 AUTOMOBILE LIABILITY

Contractor shall maintain Automobile Liability insurance with an individual single limit for bodily injury and property damage of no less than $1,000,000, each occurrence, with respect to Contractor's vehicles (whether owned, hired, non-owned), assigned to or used in the performance of this Contract. Coverage will be at least as broad as coverage code 1, "any auto" (Insurance Services Office, Inc. Policy Form CA 00 01 12 93, or any replacements thereof). Such insurance shall include coverage for loading

and off-loading and off-loading hazards. If hazardous substances, materials, or wastes are to be transported, MCS 90 endorsement shall be included and $5,000,000 per accident limits for bodily injury and property damage shall apply.

103.6.4 WORKERS' COMPENSATION

The Contractor shall carry Workers' Compensation insurance to cover obligations imposed by federal and state statutes having jurisdiction of Contractor's employees engaged in the performance of the work or services, as well as Employer's Liability insurance of not less than $1,000,000 for each accident, $1,000,000 disease for each employee, and $1,000,000 disease policy limit.

In case any work is subcontracted, the Contractor will require the Subcontractor to provide Workers' Compensation and Employer's Liability insurance to at least the same extent as required of the Contractor.

103.6.5 BUILDERS' RISK (PROPERTY) INSURANCE

The Contractor shall purchase and maintain, on a replacement cost basis, Builders' Risk insurance in the amount of the initial Contract amount as well as subsequent modifications thereto for the entire work at the site. Such Builders' Risk insurance shall be maintained until final payment has been made or until no person or entity other than the County has an insurable interest in the property required to be covered, whichever is earlier. This insurance shall include interests of the County**,** the Contractor, and all subcontractors and sub-subcontractors in the work during the life of the Contract and course of construction, and shall continue until the work is completed and accepted by the County. For new construction projects, the Contractor agrees to assume full responsibility for loss or damage to the work being performed and to the structures under construction. For renovation construction projects, the Contractor agrees to assume responsibility for loss or damage to the work being performed at least up to the full Contract amount, unless otherwise required by the Contract documents or amendments thereto.

Builders' Risk insurance shall be on an all-risk policy form and shall also cover false work and temporary buildings and shall insure against risk of direct physical loss or damage from external causes including debris removal, demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for architect's service and expenses required as a result of such insured loss and other "soft costs" as required by the Contract.

Builders' Risk insurance must provide coverage from the time any covered property comes under Contractor's control and/or responsibility, and continue without interruption during construction, renovation, or installation, including any time during which the covered property is being transported to the construction installation site, and while on the construction or installation site awaiting installation. The policy will provide coverage while the covered premises or any part thereof are occupied. Builders' Risk insurance shall be primary and not contributory.

Required coverages may be modified by an amendment to the Contract documents.

If the Contract requires testing of equipment or other similar operations, at the option of the County, the Contractor will be responsible for providing property insurance for these exposures under a Boiler Machinery insurance policy.

103.6.6 CERTIFICATES OF INSURANCE

Prior to commencing work or services under this Contract, Contractor shall furnish the County with Certificates of Insurance, or formal endorsements as required by the Contract, issued by Contractor's insurer(s), as evidence that policies providing the required coverages, conditions and limits required by this Contract are in full force and effect. Such certificates shall identify this contract number and title.

In the event any insurance policy(ies) required by this contract is(are) written on a "claims made" basis, coverage shall extend for two years past completion and acceptance of the Contractor's work or services and as evidenced by annual Certificates of Insurance.

If a policy does expire during the life of the Contract, a renewal certificate must be sent to the County fifteen (15) days prior to the expiration date.

103.6.7 CANCELLATION AND EXPIRATION NOTICE

Insurance required herein shall not expire, be canceled, or materially changed without thirty (30) days prior written notice to the County.

SECTION 104

SCOPE OF WORK

104.1.3 CLEANUP AND DUST CONTROL:

Section 104.1.3 add the following:

Contractor shall dispose of construction debris on an as-needed basis in order to keep the site safe to Contractor's personnel and the general public. Construction debris shall be disposed of only in a manner or in a location approved by the Engineer.

Contractor shall be responsible for the safe and clean condition of the site during the entire period the site is under Contractor's care, custody and control.

104.3 VALUE ENGINEERING

Section 104 addthe following:

104.3.1 PURPOSE:

This clause defines a Construction Incentive Change Order Proposal ("CICOP") and establishes the policy and procedure for the application of CICOP's in the Maricopa County construction process.

104.3.2 DEFINITION:

A CICOP is a defined, written proposal for a change order during construction and shall be initiated, developed and identified by Contractor. The CICOP shall result in gross capital savings and a net capital improvement cost reduction, shall not increase the total maintenance cost of the project and shall meet the following requirements:

104.3.2.1 All Time Extensions for the project shall be agreed upon by both parties at the time the CICOP is approved. The County's determination shall be binding upon the Contractor and shall not be subject to challenge.

104.3.2.2 The CICOP shall not alter the initially intended function, quality and safety standards of the project.

104.3.2.3 The CICOP shall not change the overall scope of the work, which would require a re-bidding of the project.

104.3.2.4 The CICOP shall not conflict with any contract provisions regarding proprietary and restrictive specifications for bids in connection with Uniform Standard Specifications and details, or any other applicable specifications.

104.3.2.5 The CICOP shall not cause undue interruption of the contract work schedule.

104.3.2.6 The proposed changes in connection with the CICOP shall comply with all federal, state and local regulations, mandates and permits.

104.3.2.7 If the Contractor wishes to submit a CICOP, he shall submit a preliminary CICOP in writing, which shall address all components required for a final CICOP, in summary form. The County will review the preliminary CICOP and inform the Contractor in writing if the County wishes to implement the CICOP. The Contractor would then be requested to prepare a detailed final CICOP.

104.3.3 APPLICABILITY:

All Maricopa County construction contracts.

104.3.4 CONTENT:

The CICOP shall contain pertinent information and support documentation to allow comprehensive review by the appropriate contracting agency. At a minimum, the CICOP shall include the following information:

104.3.4.1 Name and title of individuals associated with the design and preparation of the CICOP.

104.3.4.2 Detailed scope description with sealed plans and specifications. A comparison summary of present design, proposed changes and detailed description of the advantages and disadvantages for each change proposed. The CICOP shall be sealed and signed by a Professional Engineer.

104.3.4.3 Comprehensive procedure and schedule outlining implementation of CICOP, including all required contract amendments and the absolute latest approval date for the CICOP.

104.3.4.4 Estimated cost summary which shall include but not necessarily be limited to the following:

104.3.4.4.1 Project cost with and without CICOP, which shall include the following items:

104.3.4.4.1.1 Quantities of materials and equipment.

104.3.4.4.1.2 Unit prices for materials and equipment.

104.3.4.4.1.3 Hourly rates and total labor hours required for installation.

104.3.4.4.1.4 Overhead and fee percentage of Contractor and all subcontractors of any tier involved in the performance of the work outlined in the CICOP.

104.3.4.4.2 Operations and maintenance cost prior to and after implementation of CICOP.

104.3.4.4.3 Implementation cost of the CICOP not covered in Section 104.3.4.4.1.4, above.

104.3.4.4.4 Contractor's cost of the savings, based on the formula specified below.

104.3.4.4.5 Other pertinent data, as may be required by the County to prepare and execute a change order to the Contract.

104.3.4.4.6 If Contractor fails to notify the County of all required changes for the CICOP during the initial CICOP approval stage, Contractor shall absorb all costs connected with the implementation of changes of which the County was not made aware of. If conditions occur, which could not be foreseen by any prudent Contractor, the County may enter into negotiations with Contractor and make the necessary cost adjustments to the Contract.

104.3.4.4.7 All CICOP'S become public record when submitted to the County for review and approval. Propriety information may be protected by Contractor**.**

104.3.4.4.8 For CICOP'S accepted by the County, processing procedure for change orders shall be used.

104.3.4.4.9 If a CICOP is rejected by the County, Contractor may not appeal such a rejection.

104.3.5 SHARING PROVISIONS:

Upon acceptance and implementation of a CICOP, Contractor will share the net capital savings derived from the implementation of the CICOP, in accordance with the formula outlined below:

104.3.5.1 Initial construction cost minus revised construction cost minus CICOP development cost and CICOP implementation cost equals Net Capital Savings.

104.3.5.1.1 The CICOP implementation cost shall include Contractor's actual cost and fee for reviewing and redesigning the CICOP, documented to the satisfaction of the County.

104.3.5.1.2 CICOP development cost shall include Contractor's cost directly associated with the preparation of the CICOP package, documented to the satisfaction of the County.

104.3.5.1.3 CICOP implementation and development costs shall include COUNTY costs for review and approval of the CICOP package.

104.3.5.2 Sharing Formula: Net Capital Savings, calculated in accordance with the formula outlined in Section 104.3.5.1, above, shall be shared with Contractor on an equal 50/50 percentage basis.

SECTION 105

CONTROL OF WORK

105.1 AUTHORITY OF THE ENGINEER

Section 105.1 addthe following:

The Engineer may adjust design grades or adjust the location of structures (especially drainage structures) prior to construction. Such adjustments are considered minor changes in the work and do not constitute extra work.

105.2 PLANS AND SHOP DRAWINGS:

Section 105.2 addthe following:

Initial submittal for review - five copies, of which one copy will be returned to the Contractor within five working days.

Final submittal for approval – five copies, of which two copies will be returned to the Contractor within five working days.

Shop drawings for major temporary support structures such as falsework, shoring, soldier piles, and other major temporary structures that facilitate construction shall be prepared by and bear the seal and signature of a Professional Engineer. Temporary

support structures for Minor Structures as defined in Section 505.1.1 are exempt from this requirement.

105.3 CONFORMITY WITH PLANS AND SPECIFICATIONS:

Section 105.3 add the following:

Metric project conversions for projects designed and detailed using Metric Units. Where inconsistencies exist/arise between English Unit Standard Drawings and Details, and the Metric Project Contract Documents, the Project Documents will take precedence. The Contractor shall use Metric 'Hard' Conversions in all such related project activities. Where measurement inconsistencies exist/arise between equivalent Proprietary/ Standard Products and the Metric Project Contract Documents, the Proprietary/Standard Products will be acceptable. The Contractor shall use 'Soft' Conversions' in all such related project activities.

105.4 COORDINATION OF PLANS AND SPECIFICATIONS:

Section 105.4 is replaced with the following:

Contractor shall perform the work under this Contract in accordance with the intent of the Plans and Specifications and shall not take advantage of any error or omission in the Plans and/or specifications. In the event Contractor discovers an error or omission in the Plans and/or specifications, Contractor shall promptly advise the Engineer of such an error or omission. If Contractor fails to notify the Engineer of an error or omission in the Plans and/or specifications, which Contractor has discovered or should have discovered through the exercise of reasonable diligence, any additional work required as the result of such errors or omissions, shall be compensated by the County on a force account basis and such compensation shall be the exclusive compensation to Contractor for any costs, expenses or damages resulting directly or indirectly from the correction of such errors and omissions.

105.6 COOPERATION WITH UTILITIES

Section 105.6 is supplemented by the following:

Contractor is solely responsible for any damage to existing utilities resulting from Contractor's operations at the site. The use of hand tools (pothole) to expose a marked facility is required when proposed excavation is within the 0.6 meters tolerance zone of a marked facility, or if uncertainty exists as to the exact location of a facility.

An attempt has been made by the County to identify the location of all underground utilities located within the perimeter of the site and to design the location and elevation of all irrigation and drainage pipes, culverts and structures to avoid interference with existing utilities. It shall be the Contractor's responsibility to cooperate with the appropriate utility companies in order to facilitate requested adjustments of obstructing utilities. (Please refer to the Special Provisions for specific telephone numbers and contact persons of utilities within the project area).

Contractor's installation of conduits, brackets, piping, valve adjustments or other material at the request and for the convenience of the utility shall be paid by the utility unless specifically identified otherwise in the plans or the Special Provisions. Contractor shall make all required arrangements for such construction and payment with the utility. The County will not extend the performance period of the contract to accommodate construction performed for the convenience of the utility.

105.8 CONSTRUCTION STAKES, LINES AND GRADES:

The third paragraph of Section 105.8 of the Uniform Standard Specifications is revised to read:

Maricopa County will furnish one time the necessary survey control for the Contractor's guidance. Staking shall consist of the following:

(A) Right-of-Way lines at 30 m intervals for clearing, fencing, and control of Contractor's operations.

(B) Slope stakes shall be offset from the edge of the embankment at 30 m intervals.

(C) Blue tops in subgrade at centerline and edge of pavement at 30 m intervals except on curves. Contractor shall have all material in place and compacted within 60 mm ± prior to requesting the survey crew.

(D) Blue tops on aggregate base course at centerline, edge of pavement, and 1/4 points at 15 m intervals. Contractor shall have all material in place and compacted within 60 mm ± prior to requesting the survey crew.

(E) Catch basin stakes shall be offset at 3 m and 5 m to the center of the structure with cuts or fills shown to the top of grate.

(F) Grade and line stakes for all structures, pipe lines, culverts, and ditches.

(G) Straddle points for permanent monuments.

105.12 MAINTENANCE DURING CONSTRUCTION:

Section 105.12 add the following:

The Contractor shall be responsible to protect the construction site, construction activities, and new construction from the detrimental effects of weather, including flooding, until acceptance by the Engineer.

SECTION 106

CONTROL OF MATERIALS

106.1 SOURCE OF MATERIALS AND QUALITY:

Section 106.1 add the following:

All materials not specifically noted as provided by the County or other participating agency shall be obtained from commercial sources. Contractor shall pay all royalties or any other charges or expenses incurred in connection with the securing and hauling of the material. Contractor shall provide the Engineer with a list of proposed commercial sources prior to utilization of such sources and shall present satisfactory evidence that the material obtained from the commercial sources meets the specifications of this project.

If the use of borrow material is required during the performance of the work outlined in the Construction Specifications, Contractor shall assure that the borrow material used for the project, if the source is other than that recommended by the County, does not contain any substances which may be harmful to humans, animals, vegetation, ground and surface water, and the environment and which are regulated under the Hazardous Material Transportation Act, the Toxic Substances Control Act, the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

106.4 TRADE NAMES AND SUBSTITUTES:

Section 106.4 is revised to read:

Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the specification or description is intended to establish the type, function and quantity required. Unless the specification or description contains or is followed by words reading that no like, equivalent or "or-equal" item or no substitution is permitted, other items of material or equipment of other suppliers may be accepted by the Engineer under the following circumstances:

106.4.1 "Or-Equal":

(A) If in the Engineer's sole discretion an item of material or equipment proposed by the Contractor is functionally equal to that named and sufficiently similar so that no change in related work will be required, it may be considered by the Engineer as an "or-equal" item, in which case review and approval of the proposed item may, at the Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for acceptance of proposed substitute items.

(B) Substitute Items: If in the Engineer's opinion an item does not qualify as an "or-equal" item under 106.4.1(A), it will be considered a proposed substitute item. The Contractor

shall submit sufficient information, as provided below, to allow the Engineer to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefore. The procedure for review by the Engineer will include the following as supplemented in the Special Provisions and as the Engineer may decide is appropriate under the circumstances. Requests for review of proposed substitute items of material or equipment will not be accepted by the Engineer from anyone other than the Contractor. If the Contractor wishes to furnish or use a substitute item of material or equipment, the Contractor shall first make written application to the Engineer for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified and be suited to the same use as that specified. The application will state the extent, if any, to which the evaluation and acceptance of the proposed substitute will prejudice the Contractor's achievement of completion on time, whether or not acceptance of the substitute for use in the work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with County for work on the project) to adapt the design to the proposed substitute and whether or not incorporation or use of the substitute in connection with the work is subject to payment of any license fee or royalty. All variations of the proposed substitute from that specified shall be identified in the application and available maintenance, repair and replacement services shall be indicated. The application shall also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other Contractors affected by the resulting change, all of which will be considered by the Engineer in evaluation the proposed substitute. The Engineer may require Contractor to furnish additional data about the proposed substitute.

(C) All data provided by Contractor in support of any proposed "or-equal" or substitute item will be at Contractor's sole expense.

106.4.2 Substitute Construction Methods or Procedures:

If a specific means, method, technique, sequence or procedure of construction is shown or indicated and expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence or procedure of construction acceptable to the Engineer. Contractor shall submit sufficient information to allow the Engineer at the Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The procedure for review by the Engineer will be similar to that outlined in Section 106.4.1.

106.4.3 Engineers Evaluation:

The Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Sections 106.4.1 and 106.4.2, above. The Engineer will be the sole judge of acceptability. No "or-equal" or substitute shall be ordered, installed or utilized without the Engineer's prior written acceptance which will be evidenced by either a Change Order or an approved Shop Drawing. The County may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any "or-equal" or substitute. The Engineer will record time required by the Engineer and the County's consultants in evaluating substitutes proposed or submitted by Contractor pursuant to Sections 106.4.1 and 106.4.2, above and in making changes in the Contract Documents occasioned thereby. Whether or not Engineer accepts a substitute item so proposed or submitted by Contractor, Contractor shall reimburse the County for cost incurred for the evaluation of the proposed substitute item by the Engineers and/or County's consultant.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.1 LAWS TO BE OBSERVED:

Section 107.1 add the following:

Contractor, in connection with any activity under this Contract, shall not discriminate against any person on the grounds of race, color, religion, sex, national origin, age, disability, political affiliation or belief. Contractor shall include a clause to this effect in all subcontracts. Contractor shall also comply with all applicable provisions of the Americans with Disabilities Act of 1990.

Contractor and its subcontractors and their respective employees, agents, and representatives, when performing the work described in the Construction Specifications, shall comply with all rules and regulations set forth by the County, pertaining to the safety, loss control and environmental regulations, and shall perform the work in compliance with governmental laws and regulations pertaining to occupational health, and environmental protection, including any local sound control and noise level rules, regulations and ordinances which apply to any work performed pursuant to the contract.

Contractor is solely responsible for jobsite ("site") conditions during all phases of construction, beginning with Contractor's mobilization of equipment and/or personnel until the work has been accepted by the Engineer and a certificate of completion has been issued by the County. Contractor's responsibility for the site during the period specified above, shall not be limited to Contractor's working hours and shall include but not necessarily be limited to the following:

* Physical condition of the site;
* Safety of Contractor's personnel at the site and all other persons entering the site or areas adjacent to the site;
* Security of Contractor's equipment and material; and
* Reasonable aesthetic appearance of the site.

Contractor shall insure that internal combustion equipment is operated with a muffler of a type recommended by the manufacturer.

107.1.1 CITY OF PHOENIX-MARICOPA COUNTY CONSOLIDATED CERTIFICATION PROGRAM

107.1.1.1 Contracting Requirements:
The following conditions will apply in the calculation of the percentage attainment:

1. All MBE/WBE firms used in attainment of the goal must be certified with the **City of Phoenix-Maricopa County Consolidated Certification Program.** The **City of Phoenix-Maricopa County Consolidated Certification Program is located at 251 West Washington Street, 7th Floor, Phoenix, Arizona 85003.** In addition, only those firms certified at least five (5) calendar days prior to the bid opening will be considered in the attainment of the goal.

2. Prime contractor subcontracts to DBE, MBE or WBE:
   The DBE/MBE/WBE amount to be applied to the goal will be based on that portion (dollar value) of the contract that the DBE/MBE/WBE performs. For example, if a prime contractor subcontracts work amounting to $100,000 of a contract for which the total project cost is $1,000,000 the DBE/MBE/WBE participation will be credited as 10 percent.

3. Prime Minority Contractor:
   A DBE/MBE/WBE prime contractor will be credited with the DBE/MBE/WBE participation for that portion of the contract which they themselves perform plus those portions subcontracted to other DBE/MBE/WBE firms. For example, if an DBE/MBE/WBE prime contractor proposes to perform 50 percent of a project quoted at $1,000,000 and subcontracts 25 percent to a DBE/MBE/WBE firm and 25 percent to a non- DBE/MBE/WBE firm, DBE/MBE/WBE participation will be credited as 75 Percent, or $750,000.

4. Minority-Non-Minority Joint Venture:
   A joint venture consisting of MBE/WBE participation and non-DBE/MBE/WBE business enterprises, functioning as a prime contractor, will be credited with minority participation on the basis of the percentage of profit accruing to the DBE/MBE/WBE firm. For example, if a DBE/MBE/WBE and non- DBE/MBE/WBE joint venture proposes to perform 50 percent of a $1,000,000 project and 50 percent of the joint venture profits ($500,000) are to accrue to the DBE/MBE/WBE partner in the joint venture, DBE/MBE/WBE participation will be credited at 25 percent or $250,000.

5. Lower Tier Non- DBE/MBE/WBE Participation:
   DBE/MBE/WBE subcontractors proposing to further subcontract to non-DBE/MBE/WBE contractors shall not have that portion of subcontracting activity considered when determining the percentage of DBE/MBE/WBE participation.

6. DBE/MBE/WBE Suppliers:
   Any DBE/MBE/WBE supplier that manufactures or substantially alters the material or product it supplies will have that portion of activity considered when determining the percentage of DBE/MBE/WBE participation.

7. DBE/MBE/WBE Trucking:
   Credit for trucking by DBEs, MBEs, or WBEs will be the amount to be paid when the DBE, MBE, or WBE trucker will perform the trucking with his/her trucks, tractors, and employees or when a DBE, MBE, or WBE trucking broker has signed agreements with DBE, MBE, and WBE truckers.

107.1.1.2 Required Forms:

Two Affidavits are included with the Bid/Contract Documents. The first form, the **"DBE/MBE/WBE Assurances Affidavit"**, must be completed and submitted with the bid.

A SAMPLE of the second affidavit, the **"Actual DBE/MBE/WBE Participation Affidavit"**, is provided for information purposes. This form with actual information must be returned by the first and second low bidders by 4:00 p.m. on the seventh calendar day after bid opening. The Affidavit will list the DBE/MBE/WBE participation by DBE/MBE/WBE firm name and the related dollar value of the DBE/MBE/WBE contract. The information in this Affidavit is binding on the contractor, to the extent that any amounts may be increased and not decreased, and that if any listed DBE/MBE/WBEs are unable to enter into a subcontract with contractor, the contractor must provide a written report to the Procurement Officer through the Owner's representative in accordance with instructions provided in Section 107.1.1.6 Substitution of Subcontractors.

107.1.1.3 Good Faith Efforts:

Bids which fail to meet DBE, MBE, or WBE minimum goals at levels which equal or exceed established goals may be considered nonresponsive unless good faith efforts can be determined. Only DBE, MBE, and WBE firms certified by the City of Phoenix-Maricopa County Consolidated Certification Program prior to the bid opening and which will perform a commercially useful function will be counted toward meeting the participation goals. Any portion of the work that a proposed DBE, MBE, or WBE firm will subcontract to other than another certified firm, regardless of tier, will not be counted toward the applicable goals.

The apparent first and second low bidder who do not fulfill the established DBE, MBE, and WBE goals must demonstrate, through detailed and comprehensive documentation, that "good faith" efforts have been made to solicit, assist and utilize DBE, MBE, and WBE firms to meet participation goals.

Maricopa County Department of Transportation will assist prime contractors in identifying possible qualified and interested DBE, MBE, and WBE subcontractors to meet designated DBE, MBE, and WBE goals. A D/M/WBE directory will be made available which contractors must utilize in identifying DBE, MBE, and WBE firms. It will be the responsibility of the prime contractors to obtain the DBE, MBE, and WBE firms necessary to meet the DBE, MBE, and WBE goals.

FAILURE TO CONTACT THE MARICOPA COUNTY DEPARTMENT OF TRANSPORTATION FOR ASSISTANCE in complying with these goals may result in not having implemented "good faith" efforts. Contact may be in writing, by telephone, or in person. If by phone or in person, name of the County person spoken to should be obtained and written within the **"CONTRACTOR CERTIFICATE OF GOOD FAITH"** submittal form.

FAILURE TO IMPLEMENT "GOOD FAITH" EFFORTS IN ACCORDANCE WITH THE CITY OF PHOENIX-MARICOPA COUNTY CONSOLIDATED CERTIFICATION PROGRAM TO THE SATISFACTION OF MARICOPA COUNTY, COULD RESULT IN THE REJECTION OF THE BID.

If information submitted by a prime contractor indicates that established DBE, MBE, and WBE goals have not been met, the contractor must be required to provide sufficient documentation to demonstrate that he/she has complied with DBE, MBE, and WBE

requirements or good faith efforts. Good faith efforts will be determined by both quality and intensity of these efforts. Documentation provided to the County must include:

1. The date bidder requested assistance in writing, in person, or by telephone from the County. The bidder should request assistance from the County in order for a determination to be made. As City of Phoenix-Maricopa County D/M/WBE listings are updated frequently, bidders shall contact the Procurement Officer to ensure that they have the most recent edition.

2. Names, addresses and telephone numbers; and dates of notification of City of Phoenix-Maricopa County certified DBEs, MBEs, and WBEs solicited by direct mail for this project; and dates and methods used for follow up of initial solicitations to determine with certainty whether DBEs, MBEs, or WBEs were interested in subcontracting.

3. Items of work for which bidder requested sub bids, or materials to be supplied by DBEs, MBEs, and WBEs; information furnished to interested DBEs, MBEs, and WBEs such as specifications and requirements of the work; plans; and any breakdown of items of work into economically feasible units to facilitate DBE, MBE, and WBE participation.

4. Names of DBEs, MBEs, and WBEs who submitted bids for any of the work indicated above and were not accepted by the prime contractor. An explanation of why DBEs, MBEs, or WBEs contacted were not awarded subcontracts. If price was the reason for rejection of the bid, the bid price of rejected DBEs, MBEs, or WBEs and bid price of the selected subcontractor shall be submitted. Since utilization of available DBEs, MBEs, and WBEs is the program objective, price differences will not automatically be considered cause for rejection of DBE, MBE, and WBE bids.

5. Documentation of written notices or telephone calls to a reasonable number of D/M/WBEs soliciting their participation in sufficient time to allow D/M/WBEs to participate effectively. All D/M/WBEs listed on the City of Phoenix-Maricopa County Certification list which provide applicable goods and services for subject procurement/project shall be contacted.

GOOD FAITH EFFORTS MUST HAVE BEEN CONDUCTED DURING THE BIDDING PERIOD AND PRIOR TO THE BID OPENING WITH SUBSTANTIAL TIME IN ORDER TO ALLOW FOR A RESPONSE FROM POTENTIAL M/WBE SUBCONTRACTORS. ORIGINAL CONTACT BY A PRIME CONTRACTOR JUST PRIOR TO OR ON THE DATE OF THE BID OPENING WILL NOT BE CONSTRUED AS HAVING PROVIDED SUFFICIENT RESPONSE TIME FOR SUBMISSION OF SUBCONTRACT BIDS.

The following efforts can also be utilized in demonstrating "Good Faith" in soliciting M/WBE participation:

1. A description of the efforts made to assist D/M/WBEs whose bids were rejected to be more competitive in their subcontracting bids. These efforts could include assistance in meeting bonding or insurance requirements.

2. Names and dates of advertisement of each newspaper, trade paper, and minority focus paper in which a request for D/M/WBE participation for this project was placed by the bidder.

Contractors are encouraged to seek D/M/WBEs in the same geographical area in which the work is to be performed or goods provided. If the bidder cannot meet the established goals using D/M/WBEs from the geographical area, the bidder should expand its search to a reasonable wider geographical area.

The County will make the final decision as to whether good faith efforts were met, based on the information submitted.

The County will determine if good faith efforts were met, based on the information submitted.

107.1.1.4 Appeal Process for Bid Award:

If the Owner is considering award of a contract to a bidder other than the low bidder because of failure to meet DBE, MBE, and WBE participation goals or good faith efforts, the low bidder shall be notified and give an opportunity to protest the decision. This protest shall be made in accordance with the Maricopa County Procurement Code, Article 9, MCI-905, which is incorporated by reference.

107.1.1.5 Contract Compliance:

Failure of any bidder, contractor or subcontractor to comply with any of the requirements of the DBE, MBE, and WBE contract provisions shall be a material breach of contract. During the term of an awarded contract, the prime contractor shall:

1. Fulfill the DBE, MBE, and WBE participation commitments submitted with their bid;

2. Continue to make every effort to utilize DBEs, MBEs, and WBEs;

3. Require that subcontractors make every effort to utilize DBEs, MBEs, and WBEs;

4. Maintain records necessary for monitoring compliance with provisions contained in the D/M/WBE Program.

The primary responsibility for assuring contractor's compliance with these D/M/WBE contract requirements after award rests with the County's designated representative. The County's designated representative should ascertain that no one other than the approved DBE, MBE, or WBE contractors or subcontractors are performing the work, and that DBE, MBE, and WBE subcontractor substitutes have been approved in advance. The prime contractor shall not perform any contract work items without prior approval by the Owner's designated representative.

In the event of violation of the DBE, MBE, WBE contract provisions, an investigation will be held by the County's designated representative. Intentional noncompliance with the DBE, MBE, and WBE requirements may result in withholding funds on the items already completed, in termination of the contract, and/or formal debarment from future contracts. The Procurement Officer reserves the right to inspect all records of the contractor, DBEs, MBEs, and WBEs concerning this project.

The County will conduct DBE, MBE, and WBE compliance reviews on a regular basis.

107.1.1.6 Substitution of Subcontractors:

The prime contractor shall request approval to replace an approved DBE, MBE, or WBE subcontractor that is unable or unwilling to perform successfully on a contract with another DBE, MBE, or WBE. This failure does not remove the contractor's responsibility for meeting the DBE, MBE, and WBE participation goals on the contract. A written request for substitution must be made to the Procurement Officer. The substitute DBE, MBE, or WBE, obtained to perform an equal or greater dollar value of work, must be approved by the Procurement Officer, prior to beginning of any work by the substitute DBE, MBE, or WBE. The request for substitution must include, but is not limited to the following:

1. Reason for substitution.

2. Name, address, and telephone number of the approved DBE, MBE, or WBE.

3. Name, address and telephone number of the DBE, MBE, or WBE substitute.

4. Item, numbers, description of work and the proposed DBE, MBE, and/or WBE dollar amount.

5. Good faith effort documentation if the substitute subcontractor is not a DBE, MBE, or WBE.

107.1.1.7 Requests for Pay:

Each Request for Pay must be accompanied by a DBE/MBW/WBE Participation Report in the form as provided in these documents.

The final pay request shall include a listing of total contract DBE/MBE/WBE participation. Line numbers and a description of actual work performed shall also be included. If, at the time of contract completion, the DBE, MBE, and WBE commitments are not actually attained, the report is to provide an explanation of failure to comply. These reports shall be submitted within thirty (30) days of contract completion, prior to release of any remaining contract retention.

107.1.2 ORDER FOR PROHIBITION OF DISCRIMINATION IN STATE CONTRACTS NONDISCRIMINATION IN EMPLOYMENT BY GOVERNMENT CONTRACTORS AND SUBCONTRACTORS

107.1.2.1 During the performance of this Contract, **CONTRACTOR** agrees as follows:

A. **CONTRACTOR** shall not discriminate against any employee or applicant for employment because of race, age, color, religion, sex, disability, or national origin. **CONTRACTOR** shall take affirmative action to insure that applicants are employed and that employees are treated during employment without regard to their race, age, color, religion, sex, disability, or national origin. Such action shall include but not be limited to the following: Employment, upgrading, demotion or transfer, recruitment or recruitment advertising, lay-off or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. **CONTRACTOR** agrees to post in conspicuous places, available to employees and applicants for employment notices setting forth the provisions of this nondiscrimination clause.

B. **CONTRACTOR** shall in all solicitations or advertisement for employees, placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, age, color, religion, sex, disability, or national origin.

C. **CONTRACTOR** shall send to each labor union or representative of workers with which Contractor has a collective bargaining agreement or other contract or understanding a notice to be provided by the agency contracting officer advising the labor union or workers' representative of **CONTRACTOR'S** commitments under this Executive Order and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

D. **CONTRACTOR** shall furnish all information and reports required by the contracting agency and will permit access to its books, records and accounts by the contracting agency and the Civil Rights Division for purposes of investigation to ascertain compliance with such rules, regulations and orders.

E. In the event of **CONTRACTOR'S** noncompliance with the nondiscrimination clauses of this Contract or with any of such rules, regulations or orders of the Arizona Civil Rights Division said noncompliance will be considered a material breach of the contract and such contract may be canceled, terminated or suspended in whole or in part, and **CONTRACTOR** may be declared ineligible for further government contracts until **CONTRACTOR** has been found to be in compliance with the provisions of this order and the rules and regulations of the Arizona Civil Rights Division, and such sanctions may be imposed and remedies invoked, as provided in Section 107.1.2.2 ENFORCEMENT of this order, and the rules and regulations of the Arizona Civil Rights Division.

F. **CONTRACTOR** shall include the provisions of paragraphs A through E in every subcontractor's contract and/or purchase order so that such provision will be binding upon each subcontractor or vendor. **CONTRACTOR** will take such action with respect in the subcontract or purchase order, as the contracting agency may direct, as a means of enforcing such provisions, including sanctions for noncompliance; provided, however, that in the event **CONTRACTOR** becomes involved in or is threatened with litigation with a subcontractor or vendor as a result of such direction by the contracting agency, **CONTRACTOR** may request the State of Arizona to enter into such litigation to protect the interests of the State of Arizona.

G. Each **CONTRACTOR** having a contract containing the provisions prescribed in this section shall file and shall cause each of his subcontractors to file compliance reports with the contracting agency or the Civil Rights Division, as may be directed. Compliance reports shall be filed within such times and shall contain such information as the practices, policies, programs and employment policies, programs and employment statistics of **CONTRACTOR** and each subcontractor in a form as the Arizona Civil Rights Division may prescribe.

H. Bidders or prospective contractors or subcontractors shall state whether they have participated in any previous contract subject to the provisions of this order or any preceding similar Executive Order and in that event to submit on behalf of themselves and the proposed subcontractors compliance reports prior to, or as an initial part of negotiation of a contract.

I. Whenever **CONTRACTOR** or subcontractor has a collective bargaining agreement or other contract or understanding with a labor union or an agency referring workers, or providing or supervising apprenticeship or training for such workers, the compliance report shall include such information from such labor unions or agency practices and policies affecting compliance as the contracting agency or Civil Rights Division may prescribe; provided that, to the extent such information is within the exclusive possession of a labor union or an agency referring workers or providing or supervising apprenticeship or training and such labor union or agency shall refuse to furnish such information to **CONTRACTOR**, **CONTRACTOR** shall so certify to the contracting agency as part of its compliance report and shall set forth what efforts Contractor has made to obtain such information.

J. The contracting agency or the Civil Rights Division requires that the bidder or prospective contractor or subcontractor submits as part of his compliance report, a statement in writing, signed by an authorized officer or agent on behalf of any labor union or any agency referring workers or providing or supervising apprenticeship or other training with which the bidder or prospective contractor deals, with supporting information to the effect that the signer's practices and policies do not discriminate on the grounds of race, color, religion, sex, disability, or national origin, and that the signer either will affirmatively cooperate in the implementation of the policy and provisions of this order or that it consents and agrees that recruitment employment and the terms and conditions of employment under the proposed contract shall be in accordance with the purpose and provisions of this order. In the event that the union or the agency refuses to execute such a statement, the compliance shall so certify and set forth what efforts have been made to secure such a statement and such additional factual material as the contracting agency or the Civil Rights Division may require.

107.1.2.2 ENFORCEMENT

A. Each contracting agency shall be primarily responsible for obtaining compliance with this Executive Order with respect to contracts entered into by such agency or its contractors. All contracting agencies shall comply with the rules of the Civil Rights Division in discharging their primary responsibility for securing compliance with the provisions of contracts and otherwise with the terms of this order and rules and regulations and orders of the Civil Rights Division issued pursuant to this order. They are directed to cooperate with the Civil Rights Division and to furnish the Division such information and assistance as it may require in the performance of the Division's functions under this order. They are further directed to appoint or designate from among the agency personnel compliance officers. It shall be the duty of such officers to first seek compliance with the objective of this order by conference, conciliation, mediation or persuasion.

B. The Civil Rights Division may investigate the employment practices of any government contractor or subcontractor or initiate such investigation by appropriate contracting agency or determine whether or not the contractual provisions specified in this order have been violated. Such investigations shall be conducted in accordance with the procedures established by the Civil Rights Division and the investigating agencies shall report to the Civil Rights Division any action taken or recommended. The Civil Rights Division may receive and investigate or cause to be investigated complaints by employees or prospective employees of a government contractor or subcontractor which alleges discrimination, contrary to the contractual provisions specified in Section 107.1.2.1 of this order. If the

investigation is conducted for the Civil Rights Division by a contracting agency, that agency shall report to the Civil Rights Division that action has been taken or is recommended with regard to such complaint.

C. The Civil Rights Division shall use its best efforts directly and through contracting agencies, other interested state and local agencies, contractors and all other available instrumentality's to cause any labor union engaged in work under government contracts or any agency referring workers or providing or supervising apprenticeship or training for or in the course of such work, to cooperate in the implementation of the purposes of this order.

D. The Civil Rights Division or any agency, officer or employee in the executive branch of the government designated by rule, regulation or order of the Civil Rights Division may hold such hearings, public or private as the Division may deem advisable for compliance, enforcement or educational purposes. The Civil Rights Division may hold or cause to be held hearings in accordance with rules and regulations issued by the Civil Rights Division prior to imposing, ordering or recommending the imposition of penalties and sanctions under this order.

E. No order for debarment of any contractor from further government contracts under this order shall be made without affording the contractor an opportunity for a hearing.

F. Sanctions and Penalties. In accordance with such rules, regulations or orders as the Civil Rights Division may issue or adopt, the Civil Rights Division or the appropriate contracting agency may publish or cause to be published the names of contractors or unions which it has concluded have complied or have failed to comply with the provisions of this order and with the rules, regulations and orders of the Civil Rights Division.

1. Contracts may be canceled in whole or in part, terminated, or suspended absolutely, or continuation of contracts may be conditioned upon a program for future compliance approved by the contracting agency or the Civil Rights Division; provided that any contracting agency shall refrain from entering into further contracts, extensions or other modifications of existing contracts with any non-Complying contractor until such contractor has established and will carry out personnel and employment policies in compliance with the provisions of this order.

2. Under rules and regulations prescribed by the Civil Rights Division, each contracting agency shall make reasonable efforts within a reasonable time limitation to secure compliance with the contract provisions of this order by methods of conference, conciliation, mediation and persuasion before proceedings are instituted under this order or before a contract is canceled or terminated in whole or in part under this order for failure of a contractor or subcontractor to comply with the contract provisions of this order.

107.2 PERMITS:

Section 107.2 is revised to read:

It is Contractor's responsibility to obtain all permits and licenses, pay all fees, charges,

and taxes and prepare all required notices for the lawful execution of the work.

Permits for earth moving may be obtained from Air Pollution Control, Maricopa County Department of Environmental Management, 2406 South 24th Street, Suite E-214, Phoenix, Arizona 85034, Telephone Number (602) 506-6700. A copy of the earthmoving permit and dust control plan shall be submitted to the Engineer prior to commencement of any earthmoving activities.

107.2.1 AZPDES (NPDES) Construction General Permit Requirements:

Unless otherwise directed by the County, the Contractor shall be responsible for compliance with the Arizona Pollutant Discharge Elimination System (AZPDES) requirements administered by the Arizona Department of Environmental Quality (ADEQ). For projects that include Indian Tribal Lands, the Contractor shall also be responsible for compliance with the National Pollutant Discharge Elimination System (NPDES) requirements of the Environmental Protection Agency (EPA).

107.2.1.1 Regulation Compliance: The Contractor shall take all necessary measures to assure compliance of employees and subcontractors with the AZPDES Construction General Permit for Arizona as well as all other applicable federal, state and local laws, ordinances, statutes, rules and regulations pertaining to stormwater discharge and air, ground water and surface water quality. As the permittee, the Contractor is responsible for preparing, in a manner acceptable to the ADEQ and the EPA, all documents required by regulation, which shall include but not necessarily be limited to the following:

107.2.1.1.1 Notice of Intent (NOI).

107.2.1.1.2 Stormwater Pollution Prevention Plan (SWPPP).

107.2.1.1.3 Notice of Termination (NOT).

107.2.1.2 NOI Submittal: Preliminary copies of the NOI and the SWPPP shall be submitted to the County during the pre-construction conference and shall be subject to review by the County prior to implementation.

The Contractor shall ensure the completed and duly signed NOI form(s) are submitted in a timely manner to prevent a delay to project construction.

The AZPDES form shall be submitted to ADEQ's Phoenix office by certified mail or hand delivered to the address below:

Stormwater Program-Water Permits Section/NOI
Arizona Department of Environmental Quality
1110 West Washington, 5415B-3
Phoenix, AZ 85007

The form may also be faxed to ADEQ at 602-771-4674 or submitted via "smart NOI" on the ADEQ's website at:

http://www.az.gov/webapp/portal/.

If the construction is near an impaired or unique water, the SWPPP shall be submitted with the NOI. Permit activation may require 32 business days or more for construction sites near impaired or unique waters, as well as for construction sites with special concerns, therefore documentation is to be submitted to ADEQ as early as possible (preferably at least 32 business days prior to the desired start of construction).

All local municipalities within the construction project limits shall be notified, as applicable.

When Indian Tribal Land is involved a NOI shall be submitted to EPA's San Francisco office by certified mail or hand delivered to the address below:

Stormwater Program-Water Permits Section/NOI
Water Division
EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

A copy of all submitted NOI forms shall be posted at the construction site. An additional copy shall be submitted to the Engineer.

107.2.1.3 Time Extension: Failure by the Contractor or subcontractor of any tier to submit a NOI within the mandated time frame shall result in delay of the construction start date and no claims for extension of time will be granted for such a delay.

107.2.1.4 SWPPP: The Contractor shall develop, implement, update and revise the SWPPP, as necessary, to assure compliance with permit requirements. The SWPPP shall be retained on the project site at all times during construction. Copies of forms and guidance for preparing the SWPPP are available in the "Drainage Design Manual for Maricopa County, Volume III Erosion Control." The manual is available at the Flood Control District, 2801 West Durango Street, Phoenix, Arizona 85009. In addition, a "Construction SWPPP Checklist" can be obtained from ADEQ for assisting in the preparation of the SWPPP.

107.2.1.5 Inspections: Contractor shall perform inspections of all stormwater pollution control devices on the project once every fourteen (14) days and within twenty-four (24) hours of each 0.5-inch or greater storm event, as required under the provisions of the AZPDES Construction General Permit for Arizona. Contractor shall prepare reports on such inspections and shall retain the reports for a period of at least three (3) years following the completion of the project. Inspection reports shall be submitted monthly to

the County along with progress payment requests. Additionally, Contractor shall maintain all stormwater pollution control devices on the project in proper working order, which shall include cleaning and/or repair during the duration of the project.

107.2.1.6 NOT Submittal: Upon project completion, acceptance and demobilization, Contractor shall submit to the permitting agency a completed, duly executed Notice of Termination form for each NOI issued, with a copy to appropriate municipalities, thereby terminating all AZPDES permit coverage for the project. Contractor shall then provide to the County copies of the SWPPP, inspection information and all other documents prepared and maintained by the Contractor in compliance with the AZPDES Construction General Permit. Contractor shall retain the originals of such documents for a period of at least three (3) years following the completion of the project and make such documents available for inspection by representatives of the Environmental Protection Agency, the Arizona Department of Environmental Quality, the County, and any municipality having jurisdiction, upon request.

107.2.1.7 Fines and Penalties: Fines and penalties imposed by the ADEQ or the EPA for Contractor's failure to comply with any or all of the permit requirements shall be borne by the Contractor.

107.2.1.8 Payment: The lump sum price for AZPDES shall include all material, labor, and costs relating to the NOI, NOT, and the SWPPP. This includes but is not limited to the preparation, installation, maintenance, and removal of temporary SWPPP elements, assuring proper operation of the pollution control devices installed, and all maintenance, cleaning, and disposal costs associated with clean-up and repair following storm events, runoff or releases on the project. The lump sum price for AZPDES shall be inclusive of all related costs, and no additional claims shall be made by the Contractor under any other specification provision, including changed conditions. Contractor shall be compensated for this bid item at a rate of 25% of the total bid price with the first progress payment, with the remaining 75% prorated over the entire length of the project.

107.3 PATENTED DEVICES MATERIALS SOURCES:

Section 107.3 add the following:

All materials not specifically noted as provided by the County or other participating agency shall be obtained from commercial sources. Contractor shall pay all royalties or any other charges or expenses incurred in connection with the securing and hauling of the material. Contractor shall provide the Engineer with a list of proposed commercial sources prior to utilization of such sources and shall present satisfactory evidence that the material obtained from the commercial sources meets the specifications of this project.

107.5 SAFETY, HEALTH AND SANITATION PROVISIONS:

Section 107.5 add the following:

All water for Contractor's own use, drinking water, temporary electric power, heat, and telephone services shall be arranged for or provided by Contractor, at Contractor's sole expense.

107.5.3 HAZARDOUS MATERIAL HANDLING

107.5.3.1 Material Safety Data Sheets:

Contractor shall furnish to the County Material Safety Data Sheets (MSDS) for all regulated and/or hazardous substances which Contractor plans to bring to the site and which may be harmful to humans, animals, vegetation, ground and surface water, and the environment and which are regulated under the Hazardous Material Transportation Act, the Toxic Substances Control Act, the Resources Conservation and Recovery Act, and the Comprehensive Environmental Response, Compensation, and Liability Act.

107.5.3.2 Regulated and/or Hazardous Materials:

Contractor shall further furnish to the County prior to the start date of the work a list of all regulated and/or hazardous materials, identified above, which Contractor intends to bring to the site. The list shall contain the following information:

Quantity of material
Description of material
Intended use of the material

Additionally, Contractor shall furnish the County with Material Safety Data Sheets for all regulated and/or hazardous substance Contractor plans to bring to the site or use during the performance of the work.

Contractor shall immediately report spills of oil, gasoline, diesel, lubricants, chemicals and other hazardous material or regulated substances to the County and to all federal, state and local agencies having jurisdiction. Accidental spills shall be immediately contained, the spilled material and contaminated soil removed in accordance with the guidelines established on the Material Safety Data Sheets and in accordance with all applicable federal, state and local laws, mandates, regulations and ordinances. After completion of the clean-up activities, Contractor shall restore the spill area to preexisting conditions.

107.5.3.3 Identify Potentially Hazardous Materials:

The County will make reasonable effort to locate and identify potentially hazardous materials and/or underground storage tanks within the project area, prior to construction. In the event material is found by the Contractor or subcontractors of any tier, during the performance of the work, that is suspected to be hazardous, Contractor shall follow the following procedure:

(A) Call “911” in a life threatening situation.

(B) Stop work at the affected area and remove all personnel from that area.

(C) Barricade the area and provide traffic control to prohibit unauthorized entry.

(D) Notify the MCDOT Safety Office (602 506-8601) and the Engineer.

(E) Notify the appropriate regulatory agency(ies) and emergency services.

The Engineer, in consultation with the appropriate regulatory agencies and emergency services, will determine the necessary remediation plan for the Project.

Remediation activities shall only be performed by a certified hazardous waste disposal remediation company, approved by the County.

107.5.4 ENERGIZED ELECTRIC POWER LINES:

Whenever the Contractor has construction equipment and personnel in the immediate vicinity of energized aerial electric power lines, the Contractor shall not consider these lines to be insulated. Construction personnel working in proximity to these lines are exposed to extreme hazard from electrical shock. Contractors, their employees, and all other construction personnel working on this project must be warned of the danger and instructed to take adequate protective measures, including maintaining a minimum clearance between the lines and all construction equipment and personnel. Minimum clearances to be maintained are 3.1 meters from 12kv lines, 3.4 meters from 69kv lines and 4.9 meters from 230kv lines (see OSHA Std. 1926.550 (a) 15 and Arizona Revised Statutes 40.360.41 through 45.). When it is necessary to work less than the designated distance from energized power lines the Contractor must notify the appropriate utility company and make necessary arrangements which will insure adequate protection of personnel, equipment and the utility company power lines. The cost of such temporary arrangement will be borne by the Contractor.

107.5 SAFETY, HEALTH AND SANITATION PROVISIONS add the following:

107.5.5 Safety Plan

The Contractor’s Safety Plan, in accordance with 29CFR1926.20, must be completed by the contractor and submitted to the Construction Engineer no later than five (5) business days prior to the pre-construction conference. Contractor Safety Plan Guidelines are available on the MCDOT website at:

http://www.mcdot.maricopa.gov/manuals/home.htm

107.6 PUBLIC CONVENIENCE AND SAFETY add the following:

107.6.3 Control of Airborne Pollutants and Sediment Tracking

Contractor shall cover dump trucks while transporting materials that may become airborne during transit. After dumping of such materials, Contractor shall either cover truck bed or take measures to remove all residues that may become airborne.

Contractor shall minimize off-site tracking of sediments by brushing or blowing off construction vehicles, or any other method deemed appropriate by Contractor, prior to exiting the construction site.

107.6.4 Protective Fencing

The Contractor shall furnish and install 1830-mm temporary chain link fencing, or approved equal, satisfactory to the Engineer, around all major structure construction areas (i.e., bridges, pump houses, drop structures, retaining walls, etc.) and around any unattended excavation deeper than four feet with slopes steeper than 1:2. Temporary fencing shall completely enclose the construction activity and shall be secured after normal working hours to prevent unauthorized access.

Section 107 add the following new section:

107.15 COMMUNITY RELATIONS:

107.15.1 General: Contractor shall provide a community relations / public information program for projects with a bid item for COMMUNITY RELATIONS. The Contractor shall submit for approval a proposed community relations information program plan to the engineer no later than at the pre-construction conference. The program shall include, but not necessarily be limited to:

(A) Printing and distribution of public notices.
(B) Providing media news releases after review by the Engineer.
(C) Providing telephone "Hot Line" 24-hour service.
(D) Participate in public meetings as required by the Engineer.
(E) Documenting existing property conditions prior to starting construction.
(F) Preparing, mailing and tabulating the results of a final evaluation questionnaire.
(G) Planning or otherwise participating in Dedication Ceremonies as requested by the Engineer.

Contractor shall use these or other approved means to inform the local residents and businesses of hours of construction, necessary operations which create high noise levels, street closures, detour locations, disruption of bus routes, haul routes and material delivery routes, and other delivery/pick-up routes.

107.15.2 Meetings: Contractor shall conduct a public pre-construction meeting at a location convenient to residents and business affected by the project. The time, location, agenda and notification procedure shall be approved by the Engineer. This meeting shall be conducted after execution of contract documents and prior to the start of construction.

Contractor shall attend public meetings deemed necessary by the Engineer.

107.15.3 Informational Signage: Contractor shall provide and install advance information signs and project information signs. Advanced Project Notification Signing shall be installed at least 14 days before beginning construction to inform the public of the forthcoming project, construction dates, and suggested alternate routes. Signs shall not be constructed or installed prior to approval by the Engineer of the designs, sizes and proposed locations. Contractor shall maintain the signs as necessary and update the information as requested by the Engineer. Advance information signs and project information signs are not part of Section 401 Traffic Control but their location shall be shown in the Traffic Control Plan.

107.15.4 Telephone Hotline: Contractor shall furnish a private telephone line to be used solely for receiving incoming calls from local residents and businesses with questions or complaints concerning construction operations or procedures.

Contractor shall publish the Hotline phone number and maintain a 24-hour answering service. The answering service shall be manned during all hours. Contractor shall maintain a log of incoming calls, responses, and action taken, which shall be submitted to the Engineer weekly or at the request of the Engineer.

107.15.5 Existing Conditions Documentation: Contractor shall document existing property conditions within a 30 meter (minimum) radius of the project limits prior to construction. Documentation shall be video recorded tape supplemented with 35 mm photographs. The videotape shall not be made from a moving vehicle. One (1) copy of the documentation package shall be provided to the Engineer within ten (10) calendar days of the Notice to Proceed date.

107.15.6 Public Notification: Contractor shall submit a Public Information and Notification Plan in such a manner that the public pre-construction meeting shall be held prior to start of construction. No payments shall be made to the Contractor for this item until the Engineer approves the plan.

Prior to the start of the project, Contractor shall notify, by letter, all businesses and residents within the limits of this project. This letter shall have the following information:

(A) Contractor's name and phone number (day and night)
(B) Name of Contractor's Project Manager
(C) Name of Contractor's Project Superintendent
(D) Brief Description of Project

(E) Construction Schedule, including anticipated work hours
(F) Lane restrictions
(G) Name of Maricopa County Department of Transportation Construction Manager/Engineer

Contractor shall furnish to the Engineer for approval a copy of the proposed letter, along with a proposed list of businesses and residents to whom the letter is to be sent.

All public notices, fliers, questionnaires, etc. shall be submitted to the engineer for approval prior to distribution.

All public notices, fliers, questionnaires, etc. shall adhere to MCDOT Right Roads Graphic Standards.

Prior to the completion of the project, if requested by the Engineer, a final evaluation questionnaire and containing return postage shall be distributed in a newsletter issue.

Contractor shall submit a final report/evaluation of the public information and notification plan process performed for this project. The report shall be submitted before the Contractor receives final payment.

107.15.7 Payment: The County will pay, based upon approved time and material invoices, in accordance with Section 109.5 an amount not to exceed the ALLOWANCE shown in the Bidding Schedule under Item COMMUNITY RELATIONS, for approved work performed in notifying and coordinating with the local population impacted by the project.

Work which is eligible for reimbursement includes: pre-construction public meeting(s) and construction meetings with impacted businesses, residents, schools, churches, and other parties; bi-weekly newsletters (plus others when necessary); advanced information signs, project information signs and temporary signs for individual local accesses; copies of documentation of existing conditions provided to the Engineer; and maintaining of a 24-hour telephone "hot line" for complaints. Contractor shall coordinate with the County to determine the population that shall be notified of meetings.

No payment will be made under this item for any calendar day during which there are substantial deficiencies in compliance, as determined by the Engineer.

SECTION 108

COMMENCEMENT, PROSECUTION AND PROGRESS

108.1 NOTICE TO PROCEED:
Add section 108.1.1 as follows:

108.1.1 PRE-CONSTRUCTION CONFERENCE

After execution of the Contract by both parties and prior to the commencement of the work, the Engineer will schedule a pre-construction conference at the facilities of the Maricopa County Department of Transportation located at 2901 West Durango Street, Phoenix, AZ 85009. Contractor shall be represented at a minimum by a company official with signature authority on behalf of its organization.

Contractor shall submit to the Engineer during the pre-construction conference the following documents:

(A) List of all subcontractors

(B) List of all material sources

(C) Assumptions and calculations used to determine each of the unit bid prices

(D) Preliminary work schedule

(E) Traffic control plans

(F) Emergency telephone numbers

(G) Signing authority letter

(H) Name and telephone number of the certified safety professional

(I) Copies of all Permits required for project Construction

(J) Preliminary SWPPP and NOI

The following items shall be submitted at the preconstruction conference when reasonably feasible. When not submitted at the preconstruction conference, the submittal(s) shall be specifically shown in the work schedule. The submittals shall be scheduled at least 45 days prior to intended use and/or material transport to the project site.

(K) Material safety data sheets

(L) Mix designs

(M) Manufacturer's certification for all materials

(N) Shop drawings

The pre-construction conference will cover topics such as critical elements of the work schedule, payment application and the processing of invoices. Additionally, a scheduled start date for the work will be determined.

108.2 SUBLETTING OF CONTRACT

Add the following:

The Engineer will not consent to subletting of any portion of the contract if a copy of the subcontract or lower tier subcontract is not received. The Engineer's consent shall in no way be construed to be an endorsement of the subcontractor or its ability to complete the work in a satisfactory manner.

The subcontract, purchase order, or lease agreement shall be evidenced in writing and contain all pertinent provisions and requirements of the prime contract. The following data shall be submitted seven calendar days prior to the start of each subcontractor's work.

(A) A complete copy of each subcontractor agreement and each second tier subcontractor agreement.

(B) Verification that all required Federal Provisions; i.e., Federal Form 1273, Executive Order, and Wage Determination Decisions are attached to each subcontract in any federal-aid funded contract.

(C) Subcontracts must show the total price subcontracted. The items of work, and quantities of each item subcontracted shall be shown. Unit Prices or Extended Prices may be deleted except in the case of DBE subcontractors.

(D) DBE subcontracts shall include full extensions of all unit prices.

(E) Partial items shall be explained in detail and show the amount of each contract item being subcontracted. Non-contract item work shall be fully explained.

(F) The contractor shall certify to the County that all of its subcontractors have all required registrations.

108.4 CONTRACTOR'S CONSTRUCTION SCHEDULE:

Section 108.4 is revised to read:

Contractor shall be solely responsible for the planning, scheduling and execution of the work to assure timely completion of the project.

108.4.1 The initial schedule shall be submitted to the County in triplicate for review at the pre-construction conference. The schedule shall be a schematic (arrow) or precedence diagram, reflecting the work stages and all activities required for the successful completion

of the project. The schedule shall show enough detail to allow day to day monitoring of Contractor's operation and shall include major milestone dates for the work.

108.4.2 The schedule shall include a complete critical path schedule and shall include a detailed network diagram with the following elements:

108.4.2.1 Contractor's schedule shall be time scaled in calendar days and all activities shall be recorded from the initial start dates to their completion dates. Unless specific approval was given by the Engineer, the individual activities shall not exceed fifteen (15) calendar days in length. The plot size and scale shall be acceptable to the Engineer**.**

108.4.2.2 The schedule shall reflect the order and the individual categories for each activity described in section 108.4.2.7, below. Critical activities shall be highlighted by use of color or any other method acceptable to the Engineer.

108.4.2.3 The schedule shall include, in addition to all construction activities, such tasks as mobilization, demobilization, submittal and approval of material samples and shop drawings, procurement of major material and equipment items, fabrication of special items and the installation and testing of such items. The schedule shall also reflect coordination activities with other projects.

108.4.2.4 Activities shall show sufficient detail to allow the reviewer to easily follow the sequence of the work, for example, forming, reinforcing and placement of concrete on the specific calendar days such activities are scheduled.

108.4.2.5 The diagram shall show each activity, the preceding and the following activity, the activity description, the total float time, and the duration of the activity in working days.

108.4.2.6 Activity descriptions on the diagram shall be job-specific and not of a generic nature.

108.4.2.7 In addition to the diagram, Contractor shall submit a schedule report of the network outlining the following data for each activity:

(A) preceding and following event and activity numbers

(B) activity description

(C) activity duration

(D) earliest commencement date

(E) earliest completion date

(F) latest commencement date

(G) latest completion date

(H) total float times

(I) responsible party for specific activity

108.4.3 Contractor shall update its schedule as mandated by the following events or as requested by the Engineer.

108.4.3.1 Contractor shall submit to the County on the tenth (10th) working day of each month a construction progress report (three originals and three copies) describing all completed or in progress activities and the level of completion of all activities to date in connection with this project. Detailed information shall be given for all negative float time. If the Engineer determines that any or all parts of the network diagram requires revision, Contractor shall furnish the County with the requested revisions within ten (10) calendar days of such request.

108.4.3.2 The monthly report shall be accompanied by a brief description of the job progress, problems encountered, current and anticipated delaying factors and the potential impact on the project schedule, and a description of corrective measures taken or proposed. It shall also include any departures from earlier schedules, including but not limited to, logical sequence or logical ties, constraints, changes in scheduled activities and the duration of such changes, addition or deletion of event numbers, activity numbers and activity descriptions. Contractor shall outline the reason for the departure from the original schedule.

108.4.3.3 All costs and expenses incurred by the Contractor for the preparation of schedules and/or reports and all revisions thereto, are considered an overhead item and therefore not reimbursable as a separate pay item.

108.4.3.4 In addition to allowances for various activities in connection with the work, Contractor shall base the schedule on normal weather conditions and shall incorporate the following factors:

(A) procurement and shipping times for material
(B) concrete curing time
(C) reasonable allowances for relocation of utilities

108.4.3.5 The Engineer's review of the schedule shall not constitute an acceptance of responsibility by the County for the content of the schedule and shall not relieve Contractor of its obligations to commit all its resources to meet the schedule set forth in the specifications. Free float time within the project's stated contract time limit shall remain available for use by the project. The County or the Contractor may use as needed the available project free float time. The Engineer's review of the schedule shall not constitute a basis for additional time to complete the work specified in the scope of work nor shall it serve as basis for additional compensation.

108.5 LIMITATION OF OPERATIONS

Add the following:

Regular work hours vary depending on time of year, the Contractor shall submit proposed weekday regular work hours at the pre-construction meeting (pre-job conference) for approval. The Contractor shall be subject to additional inspection fees for overtime work when work is performed on weekends, legal holidays, or at times other than the approved regular work hours.

The Contractor shall comply with all local noise ordnances. For unincorporated areas the Contractor shall not conduct any work during the hours 7:00 p.m. to 6:00 a.m. without the written approval of the Engineer. Special noise abatement conditions and procedures may be required if nighttime work is approved.

108.8 GUARANTEE AND WARRANTY PROVISIONS:

The first paragraph of the guarantee and warranty provisions of the Uniform Standard Specifications shall be replaced with the following paragraphs:

Contractor warrants that the work performed and materials used shall be free of defects for the period of one (1) year from the date of final acceptance of the work, excluding ordinary wear and tear or unusual abuse and neglect. Additionally, Contractor warrants that all corrections made under the warranty provisions of Section 108.8 of the Uniform Standard Specifications shall be free of defects in workmanship or material for a period of one (1) year, commencing on the day of final acceptance of the corrections by the Engineer.

Failure by the Engineer to reject defective workmanship and/or material during construction shall not be construed as an acceptance of said workmanship and/or material and Contractor shall correct such workmanship and/or material at the request of the County at any time prior to final acceptance of the work or for a one (1) year period thereafter.

SECTION 109

MEASUREMENTS AND PAYMENTS

109.1 MEASUREMENT OF QUANTITIES

The first sentence of the first paragraph is replaced with the following:

> All work completed under the contract will be measured by the Engineer according to United States standard measures for U.S. Customary Units or International System of Units. Conversions between the two systems shall comply with AASHTO specification R 1-00 or IEEE/ASTM SI 10-1997.

Section 109 add the following:

109.2 SCOPE OF PAYMENT:

109.2.1 Scope of Payment:

The "complete-in-place" rate shall include but not necessarily be limited to all labor, material and equipment costs for preparation, installation, construction, modification, alteration or adjustment of the items, which shall include all costs for salaries and wages, all payroll additives to cover employee benefits, allowances for vacation and sick leave,

company portion of employee insurance, social and retirement benefits, all payroll taxes, contributions and benefits imposed by any applicable law or regulation and any other direct or indirect payroll-related costs. The rate shall also include but not necessarily be limited to all costs for indirect charges or overhead, mileage, travel time, subsistence, materials, freight charges for material to Contractor's facility or project site, equipment rental, consumables, tools, insurance to the levels specified in Section 103.6, CONTRACTOR'S INSURANCE, all applicable taxes, as well as Contractor's fee and profit. This rate shall further include all site clean-up costs and hauling of construction debris to disposal sites designated by the Engineer.

109.2.2 Payment

Payment will be made for only those items listed in the proposal and will not be made in accordance with the measurement and payment provisions of the Uniform Standard Specifications where this differs from the items listed in the proposal. All materials and work necessary for completion of this project are included in proposal items. Any work or materials not specifically referred to in these items are considered incidental to the item and are included in the unit price.

Payment will not be made for unused materials.

109.2.3 Sales Tax

It is the responsibility of the bidders to contact all municipalities in the area to determine if they will charge Contractor sales taxes or any other fees for work on this project. Any such taxes or fees shall be paid by Contractor.

109.4 COMPENSATION FOR ALTERATION OF WORK

Revise the first sentence of Section 109.4.1 (B) to read “For an increase greater than 20 percent in either the total cost of the contract or the total cost of a major item, any adjustment made will only apply to that cost in excess of 120 percent of the original extended unit price bid."

109.5 ACTUAL COST WORK

109.5.1 Equipment add the following:

Payment to the Contractor for equipment will be made following the calculations in Section 109 of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction. The value of 0.933 shall be used for the adjustment factor F used in the rental rate formulas (F = 0.933).

109.7 PAYMENT FOR BOND ISSUES AND BUDGET PROJECTS add the following:

The County will accept securities in a form and from a financial institution acceptable to the County, in accordance with the Arizona Revised statutes, Section 34-221, as amended, in lieu of ten percent (10%) retainage on pay estimates, if requested by Contractor**.**

109.8.2 CONTRACTING AGENCY DELAYS add the following:

Recovery of expenses incurred by Contractor for a delay for which the County is responsible, and which is unreasonable under the circumstances and which was not

contemplated by the parties, shall be negotiated between Contractor and the County. This provision shall not be construed to void any provisions of the Contract which require notice of delays, provide for arbitration or other procedures for settlement, or provide for the assessment of liquidated damages.

Section 109.10 is added as follows:

109.10 MOBILIZATION/DEMOBILIZATION

The County will compensate Contractor for one-time, round trip mobilization /demobilization of Contractor's personnel, equipment, supplies and incidentals, establishment of offices, buildings and other facilities required for the performance of the work on the project, as well as preparatory work and operations prior to the commencement of the work on the project site.

Mobilization/demobilization will be measured for payment by the lump sum as a single complete unit of work.

Payment for mobilization/demobilization, measured as provided above, will be made at the contract lump sum price. Payment shall be made in equal one-third portions. The first payment will be paid with Contractor's initial billing. The second payment will be made when the total payments to Contractor for the bid items, exclusive of payments for mobilization/demobilization, equals one-half of the total bid by Contractor, exclusive of mobilization/demobilization. The remaining one-third will be paid as part of the final payment due Contractor.

When other contract items are adjusted as provided in Section 109, and if the costs applicable to such items of work include mobilization costs, such mobilization costs will be considered as recovered by Contractor in the lump sum price paid for mobilization, and will be excluded from consideration in determining compensation under Section 109.

If the Contractor performs a second mobilization/demobilization of personnel, material and/or equipment at the Engineer's express written request, the County will compensate the Contractor for such expenses at the Contractor's actual costs. The Contractor shall provide all documentation for these costs at the request of the Engineer.

SECTION 110

NOTIFICATION OF CHANGED CONDITIONS AND DISPUTE RESOLUTION

Section 110 is deleted in its entirety and replaced with the disputes provision of Article 9 of the Maricopa County Procurement Code.

Part 100 add the following new Section:

SECTION 111

ENGINEER'S OFFICE FACILITIES

111.1 DESCRIPTION:
Contractor shall provide office space with adequate lighting, located on or near the project site for exclusive use by the Engineer during the project construction. Proposed offsite office locations shall be subject to approval by the Engineer. The facility shall be made available concurrent with the construction notice to proceed, and shall remain continuously available for the sole use of the Engineer until seven (7) days after project acceptance. The facility (meeting the requirements of Type I or Type II Engineer Office Facilities) may either be separate or in the same structure or trailer used by the Contractor. If a shared structure or trailer is provided, a separate lockable area, with floor to ceiling walls shall be provided. Trailer type facilities shall be equipped with tie-downs. Type I and Type II Engineer Office Facilities shall be exclusive use facilities for the Engineer. Type II Engineer Office Facilities will be required unless otherwise indicated by the Engineer or the project special provisions.

Contractor shall provide the same level of security for the Engineer's Office Facility as is being provided for the Contractor's field office. Protection against illegal entry, vandalism, and theft shall be provided.

Contractor shall provide a separate sanitary facility for the Engineer and inspectors. Contractor shall provide janitorial services to maintain cleanliness of office, meeting spaces, and sanitary facilities. Janitorial services shall be at least twice a week.

Heating and cooling facilities shall be adequate to maintain interior temperature of 22°-26°C (72°- 78° F).

Electrical power shall be available 24 hours a day.

111.2 Type I Engineer Office Facilities shall consist of a weatherproof insulated temporary office type trailer built to the uniform building code series of codes with floor plan and equipment layout similar to the following drawing and meeting or exceeding the following minimum requirements:

111.2.1 Facility:
Dimensions (minimum): 8.5 meters (28') long x 2.4 meters (8') wide with an inside room height of 2.28 meters (7'- 6").
Windows: a minimum of four (4) with provisions for cross ventilation and locking.
Exterior doors: two – shall be reinforced and have dead bolt locks. An exterior landing with steps and handrails shall be located at each door.

Heating: a thermostat controlled forced air unit with a minimum input capacity of 200 BTU per 0.09 square meters (1.0 sq. ft.) of floor area.
Air conditioning: one unit with capacity equal to 8,300 BTU minimum.
Electrical: work shall conform to the national electrical code for 110/220 volts 60 HZ applications and provide reliable uniform power to properly operate all field office equipment.
Lighting: fluorescent lighting directly over all drafting tables and desk areas.
Fire extinguisher: one dry chemical 10 lb class ABC Underwriters Laboratories Inc. approved.
Drinking water: bottled drinking water dispensed from an acceptable cooling device.

111.2.2 Furnishings:

Desk: one desk top 762 mm (30”) deep x full inside room width x 762 mm (30”) high located at office end of the trailer. Supported along each adjacent wall and having one 2-drawer legal size metal filing cabinet center pedestal. Each desk top shall have an overhead shelf and two pen drawers.
Meeting table: one 2.4 m x 0.76 m (96”x30”) or two 1.2 m x 0.76 m (48”x 30”).
Drafting table: one 0.9 m x 1.8 m (36”x 72”) hinged board. Board to be 0.94 m (37”) high at front edge and slope upward at 12:1 (horiz:vert) rate.
Chairs: Two (2) chairs with rollers and two (2) drafting stools each of appropriate height. Ten (10) folding chairs.
Trash receptacles: Two (2) each.
Facsimile machine: One (1) plain paper FAX machine (including toner).
Copy machine: One (1) plain paper copier (including toner) with an automatic document feeder capable accepting multiple size sheets and of sorting 10 stacks.
Printer/scanner/copier: One (1) HP printer/scanner/copier 700 series (or equivalent) including installation software compatible with Windows NT or 2000 and one set of manufacture replacement printing cartridges.

Dry Marker Erase Board: wall mounted adjacent to meeting table, size = 0.9 m x 1.8 m (3’ x 6’) with markers and eraser.

111.2.3 Telephones and Data Circuits:

Two telephones. Three private lines with touch tone service from the local service provider. One phone line is to be shared by the two telephones and have voice mail service from the local service provider. The second phone line is to be a dedicated line connected to the computer. The third phone line is to be a dedicated line connected to the facsimile machine. Trailer wiring shall include four boxes equipped with RJ –11 jacks (two wire pairs per jack) two at each end of trailer.

The dedicated computer line shall be a high-speed DSL line and include internet service. When high-speed internet service is available through a cable TV service, it shall be provided and the corresponding telephone line requirement deleted.

All initial hook up and basic monthly telephone charges, high-speed internet service, basic fax service, and electrical expenses for the Engineer’s Office Facility shall be

borne by the Contractor. The Contractor will be reimbursed for all long distance charges authorized by the Engineer.

111.3 Type II Engineer Office Facilities shall consist of a weatherproof insulated temporary office type trailer built to the uniform building code series of codes with floor plan and equipment layout similar to the following drawing and meeting or exceeding the following minimum requirements.

111.3.1 Facility:

Dimensions (minimum): 15.2 meters (50') long x 3.6 meters (12') wide with an inside room height of 2.28 meters (7'- 6").

Windows: a minimum of six (6) with provisions for cross ventilation and locking.

Doors: Two inside doors may be located either at one side or at center of partition. The two exterior doors shall be reinforced and have deadbolt locks. An exterior landing with steps and handrails shall be located at each exterior door.

Heating and Air Conditioning: 3-ton capacity air conditioning and 80,000 BTU capacity heating, connected to ducting and be thermostat controlled.

Electrical: work shall conform to the national electrical code for 110/220 volts 60HZ application and provide reliable uniform power to properly operate all field office equipment.

Lighting: fluorescent lighting directly over all drafting tables and desk areas.

Fire extinguishers: Two (2) dry chemical 10 lb class ABC Underwriters Laboratories Inc. approved.

Drinking water: bottled drinking water dispensed from an acceptable cooling device.

Sanitary facilities consisting of a toilet and wash sink shall be located in a separately enclosed room inside the Type II Facility.

111.3.2 Furnishings:

Desk: one desk top 762 mm (30") deep x full inside room width x 762 mm (30") high located at each end of trailer. Desk tops are to be supported along each adjacent wall and have two 2-drawer legal size metal filing cabinets acting as pedestals. Each desk top shall have an overhead shelf and two pen drawers.

Drafting table: one 0.9 m x 1.8 m (36"x 72") table. Board to be 0.93 m (37") high at front edge and slope upward at 12:1 (horiz:vert) rate or have provision for adjusting the slope.

Tables: Three (3) 1.2 m x 0.76 m (48"x 30") tables.

Chairs: Four (4) chairs with rollers and two (2) drafting stools, each of appropriate height. Fourteen (14) folding chairs.

Trash receptacles: Three (3) each.

Plan storage: a plan rack or file for full size plans.

Facsimile machine: One (1) plain paper FAX machine (including toner).

Copy machine: One (1) plain paper copier (including toner) with an automatic document feeder capable accepting multiple size sheets and of sorting 10 stacks.

Printer/scanner/copier: One (1) HP printer/scanner/copier 700 series (or equivalent) including installation software compatible with Windows NT or 2000 and one set of manufacture replacement printing cartridges.

Dry Marker Erase Board: wall mounted adjacent to meeting table, size = 0.9 m x 1.8 m (3' x 6') with markers and eraser.

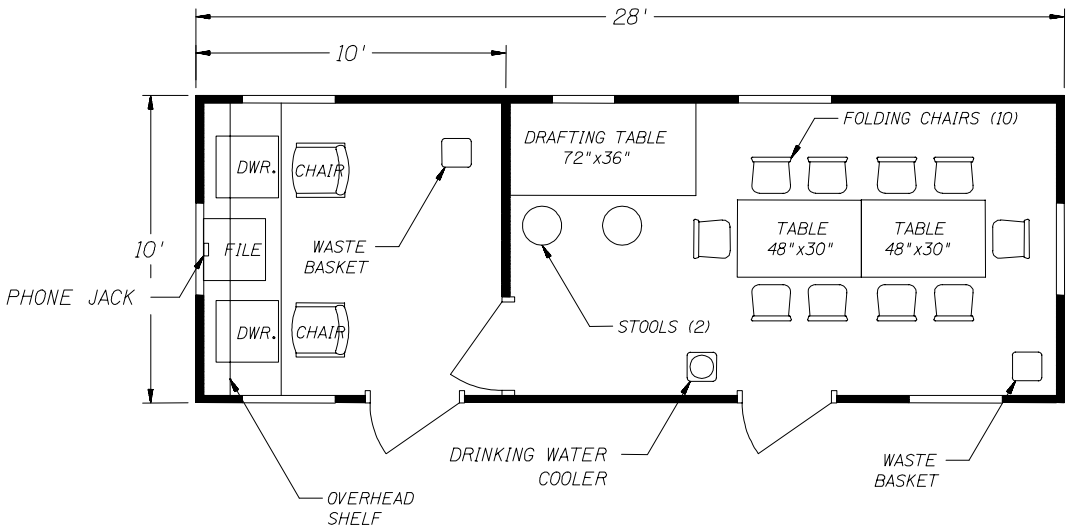
111.3.3 Telephones **and Data Circuits:**
Three (3) two-line telephones. Four private lines with touch tone service from the local service provider. Two lines are for telephone service with roll over capability for the three telephones and voice mail service from the local service provider. The third line is to be a dedicated line connected to a computer. The forth line is to be a dedicated line connected to the facsimile machine. Trailer wiring shall include six boxes equipped with RJ-11 jacks (two wire pairs per jack), two in each office and center area.

The computer line shall be a high-speed DSL line and include internet service. When high speed internet service is available through a cable TV service, it shall be provided for the computer and the corresponding telephone line requirement deleted.

All initial hook up and basic monthly telephone charges, high-speed internet service, basic fax service and electrical expenses for the Engineer's Office Facility shall be borne by the Contractor. The Contractor will be reimbursed for all long distance charges authorized by the Engineer.

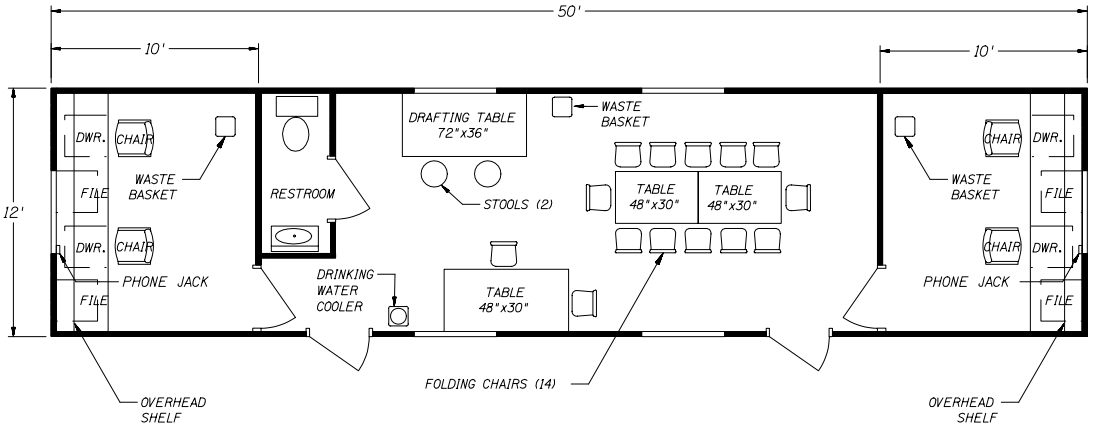
111.4 Payment:
Payment for Type I Engineer Office Facilities or Type II Engineer Office Facilities will be made at the contract lump sum price bid. Payment shall be made in equal one-third portions. The first payment shall be paid with Contractor's initial billing. The second payment shall be made when the total payments to the Contractor for the bid items, exclusive of payments for mobilization/demobilization, equals one-half of the total bid by the Contractor, exclusive of mobilization/demobilization. The remaining one-third payment shall be paid as part of the final payment due the Contractor. No additional payment will be made for occupancy and services resulting from contract time extensions.

Payment reduction for incomplete facilities or unsatisfactory maintenance shall be made at a rate of 1% of the contract lump sum price bid for Engineer Office Facilities for each calendar day the facility remains out of compliance with the requirements of this specification. Payment reduction for incomplete facilities shall commence on the day following the notice to proceed date and shall continue until the facilities are brought into compliance with the specifications.



SAMPLE SCHEMATIC

Maricopa Co. Dept. of Transportation	CONSTRUCTION TRAILER (TYPE I)	5-21-03



SAMPLE SCHEMATIC

Maricopa Co. Dept. of Transportation	CONSTRUCTION TRAILER (TYPE II)	5-21-03

Part 200 add the following new Section:

SECTION 202

REMOVAL OF STRUCTURES

202.1 DESCRIPTION:

The work under this Section shall consist of the removal, wholly or in part, and satisfactory disposal of all structures within the right-of-way which have not been designated on the project Plans or specified in the Special Provisions to remain, except for those structures which are to be removed and disposed of under other items of work in the contract. The work shall also include salvaging of designated materials and backfilling the resulting cavities.

Existing structures, and other existing improvements which are to become an integral part of the planned improvements shall remain even though not specifically noted.

Materials removed and not designated to be salvaged or incorporated into the work shall become the property of the Contractor.

202.2 BLANK

202.3 CONSTRUCTION REQUIREMENTS:

202.3.1 General:

Bridges, culverts, retaining walls, and other structures in use by or facilitating traffic shall not be removed until satisfactory arrangements have been made to accommodate the traffic.

Blasting or other operations necessary for the removal of an existing structure, which may damage new construction, shall be completed prior to commencing the new work.

Items designated to be salvaged shall be carefully stockpiled or stored by the Contractor at locations designated in the Special Provisions or as requested by the Engineer.

Items which are to be salvaged or reused in the new construction, that are damaged or destroyed as a result of the Contractor's operations, shall be repaired or replaced by the Contractor at no additional cost to the County.

Holes, cavities, trenches and depressions resulting from the removal of major structures, except in areas to be excavated, shall be backfilled with suitable material

which shall be compacted to a density of not less than 95 percent of maximum density, as requested and approved by the Engineer.

202.3.2 Removal of Bridges:

The removal of existing bridges, either wholly or in part, shall be as shown on the project plans or as described in the Special Provisions. Bridge removal operations shall be conducted in such a manner as to cause the least interference to public traffic.

At least ten days before beginning bridge removal over or adjacent to public traffic or railroad property, the Contractor shall submit to the Engineer details of the removal operations showing the methods and sequence of removal and equipment to be used.

When total bridge removal is specified, all materials designated for salvage, such as structural steel, structural steel members, timber and other reusable materials shall be carefully dismantled, removed and salvaged in accordance with the requirements of Section 202.3.1. Steel members shall be match marked as requested by the Engineer.

Piling, piers, abutments, footings and pedestals shall be removed to at least 0.3 meters below ground line or 1.5 meters below finished subgrade elevation unless specified otherwise in the Special Provisions or on the project Plans.

When partial bridge removal is specified or alteration of an existing bridge requires removal of portions of the existing structure, such removal shall be performed with sufficient care as to leave the remaining portion of the structure undamaged.

In case of damage to the existing bridge structure, the Contractor shall make necessary repairs at no additional cost to the County. Reinforcing steel extending from the remaining portion of the structure shall be protected, cleaned and incorporated in the new portion of the structure in accordance with the details shown on the project plans or as requested by the Engineer.

Flame cutting and saw cutting may be used for removing, widening, or modifying bridges, provided the Contractor complies with all protection, safety and damage requirements.

Explosives shall not be used in bridge removal operations unless approved by the Engineer.

Before beginning concrete removal operations involving the removal of a portion of a monolithic concrete element, a saw cut a minimum of 25 millimeters deep shall be made to a true line along the limits of removal on all faces of the element which will be visible in the completed work.

Removed concrete shall be disposed of a provided in Section 350.

202.3.3 Removal of Minor Structures and Miscellaneous Structural Concrete:

Minor structures and miscellaneous structural concrete shall be defined as all or portions of minor retaining walls, spillways, drainage structures, concrete box culverts, foundations, footings and all other Portland cement concrete construction, except bridges. All existing miscellaneous concrete shall be removed to a depth of at least 1.5 meters below finished subgrade elevation, unless otherwise specified in the Special Provisions or on the project plans.

Where new concrete is to join existing concrete, the existing concrete shall be saw cut to a true line with straight planar edges free from irregularities.

Concrete removal operations shall be performed without damage to any portion that is to remain in place. All damage to the existing concrete which is to remain in place shall be repaired to a condition equal to that existing concrete damaged by the Contractor's operations shall be at no additional cost to the County.

Existing reinforcement that is to be incorporated in new work shall be protected from damage and shall be thoroughly cleaned of all adhering material before being embedded in new concrete.

Removed concrete shall be disposed of as provided in Section 350.

The floors of concrete basements, pits, and structures not required to be removed, and which are located within the roadway, shall be broken in a manner that will prevent the entrapment of water.

202.3.4 METHOD OF MEASUREMENT:

Removal of structures will be measured on a lump sum basis except, that when the bidding schedule contains specific items under this section on a unit basis, measurement will be made by the units designated in the bidding schedule.

202.5 BASIS OF PAYMENT:

Payment for the accepted quantities of removal of structures will be made by lump sum, or by specific removal items, or by a combination of both. Payment for removal of structures and obstructions not listed in the bidding schedule, but necessary to perform the construction operations designated on the project plans or specified in the Special Provisions, shall be considered as included in the prices of contract items.

The prices shall include all excavation and subsequent backfill incidental to the removals, and the salvaging, hauling, storing and disposing of all materials as provided herein.

SECTION 205

ROADWAY EXCAVATION

Section 205.1 Description add the following:

Roadway excavation shall also consist of the placement and compaction of excavated material in embankments as provided under Section 211 Fill Construction.

SECTION 206

STRUCTURE EXCAVATION AND BACKFILL

Section 206 add the following:

206.4 STRUCTURE BACKFILL:

206.4.1 Prior to the placement of Structure Backfill in accordance with the requirements of this Section, the Contractor shall remove all loose, unstable materials from the sides of the structure excavation. The Contractor shall then compact the bottom of the remaining open structure excavation to a uniform density of not less than 95 percent maximum dry density. With the approval of the compaction of the bottom of the open structure excavation by the Engineer, the Contractor may start the placement of the Structure Backfill, in accordance with the applicable requirements of Sections 206.4.2 through 206.4.5.

206.4.2 Structure Backfill to be placed against concrete structures designed to retain earth loads, such as bridge abutment backwalls and wingwalls, box culvert outside walls and wingwalls, and retaining walls:

(1) Shall conform to the material requirements of Section 701.2.1 Crushed Rock, and the gradation requirements for Select Material, Type A or B in Table 702-1, both of the Uniform Standard Specifications.

(2) Shall not be placed until the concrete has reached its full design strength.

(3) Shall be placed in layers not more than 200 millimeters in depth before compaction, when compacted by pneumatic or mechanical tamping devices.

(4) Shall be uniformly compacted to at least 95 percent of maximum density.

206.4.3 Structure Backfill placed against concrete structures not designed to retain earth loads:

(1) Shall conform to the requirements for Select Material, Type A or B, of Section 702.2 Crushed Aggregate.

(2) Shall not be placed until the concrete has attained a minimum compressive strength of 17 MPa and in no case less than 72 hours after casting.

(3) Shall be uniformly compacted to at least 90 percent of maximum density.

206.4.4 Where a structure is located within a paved area:

(1) All backfill material above the finished subgrade elevation of the pavement structure shall conform to the requirements of the typical pavement structure and roadway prism at that location.

(2) All Structure Backfill below the finished subgrade elevation shall be uniformly compacted to the density requirements for pavement subgrade.

206.4.5 Minor structures, as defined in Section 505.1.1, when furnished as precast structures, shall be placed on a layer of Structure Backfill at least 150 millimeters in depth. The Structure Backfill shall conform to the material requirements of Section 206.4.3. The layer shall have been shaped to fit the bottom surface of the precast unit and compacted to not less than 100 percent maximum density. The Structure Backfill shall be at or near optimum moisture content, as approved by the Engineer. After the unit has been initially set in place and checked for line and grade, it shall be removed, and any defects in its bearing area shall be corrected by trimming and by placing and compacting similarly moistened Structure Backfill. The process of removal, correction and replacement shall continue until the imprint of the unit on the bearing area indicates essentially uniform contact, and the unit is in reasonable conformity with the lines and grades shown on the project plans.

206.5 Payment:

When the Special Provisions identify Structure Excavation and/or Structure Backfill as pay items, they shall be paid for on the basis of accepted, measured volume(s), the following methods of measurement and payment shall be used:

206.5.1(A) Measurement – Structure Excavation: Structure Excavation will be measured for payment by the cubic yard (meter), based on the volumes calculated from the measurement/pay limits shown on the Project Plans. If no limits are shown, the measurement for Structure Excavation shall be in accordance with the applicable details shown on the current Arizona Department of Transportation (ADOT) Standard Drawings B-19.30 and/or B-19.50.

No reduction in measurement for payment will be made when the Contractor elects to not excavate all material between the limits of the actual structure, and the pay limits shown on the Project Plans and/or the above referenced ADOT Standard Drawings.

No additional measurement for payment will be made for excavation resulting from lack of side support for structure excavations, nor due to carelessness of the Contractor.

206.5.1(B) Measurement – Structure Backfill: Structure Backfill will be measured for payment by the cubic yard (meter), based on the volumes calculated from the measurement/pay limits shown on the Project Plans. If no limits are shown, the measurement for Structure Backfill shall be in accordance with the applicable details shown on the current ADOT Standard Drawings B-19.40 and/or B-19.50.

206.5.2 Payment – Structure Excavation and Structure Backfill: Payment will be based on the accepted quantities of Structure Excavation and Structure Backfill, and will be paid for at their respective contract unit prices.

Full compensation for hauling, placing, and compacting surplus Structure Excavation in embankments, or otherwise disposing of the material, shall be considered as included in the contract price paid for Structure Excavation.

Payment for additional Structure Excavation, where it is found necessary to excavate to a depth greater than three feet (0.9m) below the elevation shown on the Project Plans to remove unsuitable material in accordance with the requirements of Section 206.2, payment will be made in accordance with the provisions of Section 104.2.

SECTION 210

BORROW EXCAVATION

SECTION 210.2 IMPORTED BORROW

Add the following:

Borrow material for fill construction shall meet the following requirements:

The Plasticity Index (PI) (AASHTO T90) and the percent passing the 0.075 mm sieve (Minus 200) (ASTM C136) when used in the equation below, shall give a value of X that does not exceed 62.

$$X = (\text{Minus } 200) + 2.83\ (PI)$$

Part 200 add the following new Section:

SECTION 212

ROADWAY OBLITERATION

The work under this section shall consist of obliterating existing roadway to the satisfaction of the Engineer and in accordance to the Special Provisions.

Obliteration is defined as restoring the abandoned segments of roads to as near natural contours as possible by forming natural rounded slopes.

The Contractor shall scarify existing pavement and dispose of it in fill areas approved by the Engineer. Fill material in excess of construction requirements shall be placed in the area of the old roadway and shaped to blend with natural contours according to the obliteration detail or specified grades, to the satisfaction of the Engineer. Care shall be taken to insure proper drainage. The area shall be seeded in accordance with Section 430 Landscaping and Planting.

Measurement for pavement removal will be by the square meter prior to removal.

Payment for pavement removal will be by the square meter.

Part 200 add the following new Section:

SECTION 213

DEWATERING

213.1 DESCRIPTION:

The work under this Section consists of furnishing all necessary labor and materials, installing and maintaining all necessary pumps, piping and other equipment for removing water from various locations, and maintaining excavations free of water as required for construction.

213.2 AUTHORIZATION:

If high groundwater levels are encountered, the Engineer will determine whether to implement:

a) Dewatering, as specified herein, or
b) Demobilization and remobilization, with a contract time extension in accordance with Section 108.7 of the Specifications.

213.3 CONSTRUCTION REQUIREMENTS:

213.3.1General Excavation

Prior to starting any work on removal of water from excavations, the Contractor shall have an approved Groundwater and Surface Water Handling Plan. The Plan shall include the Contractor's proposed method of removing water from excavations. The Plan may be placed into operation upon approval of the Engineer, but nothing in this section will relieve the Contractor from full responsibility for the adequacy of the water control.

Contractor shall furnish to the Engineer one set of dewatering calculations as part of the dewatering plan. These calculations shall include determination of well spacing, header sizing, pump selection, pump rating curves, typical well point cross-sections and depth of screened section. They shall include sketches and figures of sufficient detail to illustrate the layout of the dewatering system for the different portions or phases of the dewatering for the work areas. The Contractor shall furnish a listing of all equipment, including model numbers, vendors and suppliers, and catalogue cuts.

The dewatering calculations shall be prepared by a Professional Engineer or Professional Geologist.

The Contractor's Plan shall conform to all local, state and federal requirements. Any groundwater, stormwater or surface water encountered during construction shall be disposed of in such a manner that will not cause damage to public or private property or constitute a nuisance or menace to the public.

213.3.2 Soil – Cement Construction

Where excavation for the soil-cement construction extends below the water table, the portions below the water table shall be dewatered in advance of excavation. The dewatering shall be accomplished in a manner that will prevent the loss of fines, maintain stability of the slopes and bottom of the excavation, and result in construction operations being performed under reasonably dry conditions.

During placement and compaction of the concrete, the water level at every point of the excavation shall be maintained a minimum of one meter below the placement level until the soil-cement has been in place a minimum of 48 hours.

213.4 PAYMENT:

Payment for Dewatering or demobilization and remobilization will be based upon approved time and material invoices, in accordance with Section 109.5 in an amount not to exceed the ALLOWANCE shown in the Bidding Schedule under Item DEWATERING, for approved work performed for the project.

SECTION 215

EARTHWORK FOR OPEN CHANNELS

215.7 MEASUREMENT:

The second paragraph of this Section is revised to read:

Quantities will be computed by the average end area method.

Part 200 add the following new Section:

SECTION 222

CEMENT STABILIZED ALLUVIUM BANK PROTECTION

222.1 DESCRIPTION:

The work under this section consists of constructing cement stabilized alluvium (CSA) bank protection at the locations shown on the plans and in accordance with these specifications, including excavating, backfilling and grading the river bed and banks to the lines, grades and cross sections shown on the plans or established by the Engineer; furnishing, processing and mixing aggregate, cement, fly ash and water; spreading and compacting the mixture; and placement of curing seal.

222.2 MATERIALS:

222.2.1 Aggregate shall be clean, sound, durable, uniform in quality and free of any soft, friable material, organic matter, oil, alkali or other deleterious substances. Aggregate shall conform to the following requirements when tested in accordance with Section 701.1 of the Uniform Standard Specifications.

Aggregate Size	Percent Passing
75 mm	100
4.75 mm	30-65
0.075 mm	0-8

The plasticity index shall be no greater than 10 in accordance with the requirements of AASHTO T-90. Clay lumps larger than 25 mm shall be screened out of the raw soil prior to mixing.

Before placing aggregates upon the stockpile site, the site shall be cleared of vegetation, trees, stumps, brush, rocks and other debris, and the ground leveled to a smooth, firm, uniform surface.

Stockpiles shall be constructed upon prepared sites. The piles when completed shall be neat and regular in shape. The stockpile height shall be limited to a maximum of 4 meters.

Stockpiles in excess of 150 cubic meters shall be built up in layers not more than 1.2 meters in depth. Stockpile layers shall be constructed by trucks, “clamshells”, or other methods approved by the Engineer. Pushing aggregates into a pile by a bulldozer will not be permitted. Each layer shall be completed over the entire layer of the pile before depositing aggregates in the next layer.

The aggregate shall not be dumped so that any part of it runs down and over the lower layers in the stockpile. The method of dropping from a bucket or spout in one location so as to form a cone shaped pile will not be permitted. Any method of placing aggregates in stockpiles, which, in the opinion of the Engineer, segregates, breaks, degrades or otherwise damages the aggregates will not be permitted.

Only pneumatic tired equipment shall be used on the processed or manufactured aggregates in constructing the stockpiles. When removing materials from the face of the stockpile, the equipment shall be operated in such a manner as to face-load from the floor to the top of the stockpile to obtain maximum homogeneity of materials.

Stockpiles shall not be constructed where traffic, vehicles or Contractor’s equipment will either run over or through the stockpile, or cause foreign matter to be mixed with the aggregates.

222.2.2 Cement shall conform to the requirements of Section 725.2 of the Uniform Standard Specifications for low alkali, Type II Portland Cement.

222.2.3 Fly ash shall conform to the requirements of Section 725.2.1 of the Uniform Standard Specifications for pozzolonic materials.

222.2.4 Water used for mixing shall be potable and free from oil, vegetable matter and any other deleterious matter; and shall conform to Section 725.5.5 of the Uniform Standard Specifications

222.2.5 CSA shall have a minimum compressive strength of 5 MPa at seven days, determined in accordance with the requirements of Arizona Test Method 241 (Modification of AASHTO T-134). At least one test (two cylinders) shall be made for each 1,000 cubic meters of CSA placed.

222.2.6 Bedding Mortar shall consist of broomable, high Portland cement/fly ash content, heavily sanded mortar, with a compressive strength of 20 MPa at 28 days, and

shall have a slump of approximately 200 to 230 mm. The sand shall satisfy Section 701.3 of the Uniform Standard Specifications and the following gradation:

Aggregate Size	Percent Passing
9.5 mm	100
4.75 mm	95-100
1.18 mm	45-80
0.3 mm	0-30
0.1 mm	0-10
0.075 mm	0-4

222.2.7 Exterior Concrete shall be Class B, conforming to Section 725.1 of the Uniform Standard Specifications.

222.2.8 Forms shall be mortar tight and designed, constructed, braced and maintained so that the finished concrete will be true to line and elevation; and will conform to the required dimensions and contours. They shall be designed to withstand the pressure of concrete, use of set-retarding admixtures or pozzolonic materials in the concrete, effects of vibration as the concrete is being placed and all loads incidental to the construction operations, without distortion or displacement.

All forms shall be treated with an approved release agent before concrete is placed. Any material that will adhere to or discolor the concrete shall not be used.

222.3 CONSTRUCTION REQUIREMENTS:

222.3.1 Mix Design: Contractor shall determine the mix proportions of the aggregate, cement, fly ash and water; and shall furnish CSA conforming to the requirements specified herein. The job-mix design with supporting test results shall be submitted to the Engineer for review. The Engineers approval shall be obtained prior to incorporating any material into the work.

The mix design objective is to provide the minimum cement plus fly ash content (C+P), W/C ratio and mix proportions to meet the specified strength, plus 2% additional cementitious materials (same C+P content) for durability and material variations. At the same time, the mix shall be dry (stiff) enough to support heavy placement and compaction equipment, yet wet enough to permit effective consolidation by adequate distribution of the paste binder throughout the CSA mass, during the mixing and placing process. The C+P content during CSA production shall not be decreased nor increased from that of the approved job-mix design unless approved by the Engineer. Actual mix designs, used on this project, shall be determined from the Contractor's laboratory tests from material stockpiled after construction of the stockpiles is completed.

The mix design shall be performed in accordance with Arizona Test Method 220 (Determination of Cement Content Required for Cement Treated Mixtures, a

modification of AASHTO T-144) to determine the cementitious (C+P) content necessary for the strength required for CSA.

Determination of the optimum moisture content for compaction of the CSA mixture, including the additional 2% cementitious material for durability, shall be in accordance with AASHTO T-134, Method B. The additional 2% cementitious materials shall be a mixture of cement and fly ash in the same proportions as utilized in the mix design to meet the strength requirement. The total weight of cement replaced by fly ash shall not exceed 15%.

The Contractor shall follow the general provisions in accordance with Arizona Test Method 220 and AASHTO T-99, Method D, with the following exceptions.

The AASHTO T-99, Method D, shall be used in determining maximum dry density, modified to the extent that a rock correction will be calculated to correct for aggregate passing the 75 mm and retained on the 16 mm sieves. No correction will be used in determining the optimum moisture content.

Included in the job-mix design data shall be the grade of cement, brand of fly ash, and source of aggregate. A new mix design shall be submitted for approval at least two weeks prior to use, any time the Contractor requests a change in materials or proportioning of the materials from that given in the approved mix design.

222.3.2 Preparation of Subgrade: CSA shall be placed on a prepared subgrade shaped to the lines and grades shown on the plans, or be placed on existing CSA. The subgrade shall be compacted to a minimum of 95% of the maximum density in accordance with Section 301.3 of the Uniform Standard Specifications. When the embankment material is composed predominately of rock such that these compaction procedures will not achieve the required density, the Engineer will determine the amount of compaction required and the adequacy of equipment used to obtain the required compaction.

Immediately prior to placement of the CSA, the subgrade shall be uniformly moistened and maintained in an acceptable condition throughout the placement operation. Soft or yielding subgrade shall be corrected and made stable before construction proceeds. Saturated or submerged subgrade shall remain dewatered a minimum of 48 hours after placement of the CSA.

When CSA is to rest on rock, the rock shall be fully uncovered. The surface of the rock shall be removed to a depth sufficient to expose sound rock. Bedrock shall be roughly leveled or cut to approximate horizontal and vertical steps. Seams in the rock shall be grouted where determined by the Engineer.

When placed on existing CSA, the surface receiving the new CSA shall be cleaned to the satisfaction of the Engineer in the following manner:

After exposing the CSA structure, the surface shall be thoroughly cleaned of all loose materials foreign to the CSA. The surface shall be cleaned by sand-blast or hydro-blast (14 MPa maximum) to remove all foreign or loosened particles and hand scaled, if necessary, to provide a clean rough surface, free of loose materials, satisfactory to the Engineer.

The old CSA surface shall be moist at the time of placement and a 6 mm layer of broomable bedding mortar (20 MPa) shall be used between the old and new CSA. A set retarding admixture shall be used in the mortar during hot weather placement.

222.3.3 Mixing, General Requirements: Aggregate, fly ash and cement shall be proportioned and mixed in a central mixing plant, unless otherwise permitted by the Engineer. The plant shall be either the batch mixing type (using revolving blade or rotary drum), or the continuous mixing type. The aggregate fly ash and cement shall be proportioned by weight. Certification for each shipment of cement or fly ash shall be provided to the Engineer.

The fly ash and cement shall be added in such a manner so that they are uniformly distributed throughout the mixing operation.

There shall be safe, convenient facilities for sampling the cement and fly ash in the supply line to the weight hopper or pugmill. The charge in the batch mixer or continuous mixer shall not exceed that which will permit complete mixing of the materials.

The water shall be proportioned by weight or volume and there shall be some means to enable the Engineer to verify the amount of water in each batch or the rate of water flow for continuous mixing. The time of the addition of water or the points where it is introduced into the mixer shall be as approved by the Engineer.

Control of water content in the field shall be accomplished in two ways:

(1) The moisture-density relationship for the CSA shall be determined in accordance with AASHTO T-134, Method B, on a routine basis, or when any significant shift in the gradation or rock content occurs.

(2) The actual moisture content of the mixture at the time of compaction, or shortly thereafter, shall be determined in accordance with ASTM D2216 (oven dry) or AASHTO T-0239 (nuclear densimeter), to determine if the optimum moisture content as determined by AASHTO T-134, Method B, is being maintained.
Water content in the aggregates is to be continuously monitored and the mixing water shall be adjusted as necessary to maintain proper moisture.

222.3.4 Batch Mixing: The mixer shall be equipped with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch. The mixer shall be

equipped with a timing device which will indicate, by a definite audible or visual signal, the expiration of the mixing period. The device shall be accurate to within two seconds. The time of mixing shall begin after all the ingredients are in the mixer and shall end when the mixer is half emptied. The allowable tolerance for weight batching of aggregates and cementitious material will be 2.0% and 0.5%, respectively, for each batch.

The batch mixing plant shall provide sampling facilities that are satisfactory to the Engineer and which will allow representative samples of the CSA to be obtained easily and safely.

222.3.5 Continuous Mixing: A control system shall be provided that will automatically close down the plant when the material in any storage facility approaches the strike-off capacity of the feed gate. The plant will not be permitted to operate unless this automatic control system is in good working condition.

The feeder for the aggregate shall be mechanically or electrically driven.

Aggregate shall be drawn from the stockpile by a feeder or feeders that will continuously supply the correct amount of aggregate.

The cement/fly ash and aggregate feeders shall be equipped with devices that can accurately determine the rate of feed while the plant is in full operation.

Continuous mix plants shall provide sampling facilities which are satisfactory to the Engineer, and that allow representative samples of the aggregate and CSA mixture to be obtained easily and safely.

222.3.6 Transporting/Spreading: Mixed materials shall be transported from the plant to the construction site in vehicles and spread on the prepared subgrade or previously completed CSA. Spreading shall be accomplished by the use of approved motor graders or crawler type equipment. The compacted lifts of CSA shall not exceed 200 mm or be less than 100 mm in thickness.

Aggregate shall not be mixed or placed when the air temperature is below seven degrees C in the shade, unless the air temperature is at least seven degrees C in the next 24 hours. CSA shall not be mixed or placed when the air temperature is greater than forty-three degrees C in the shade.

222.3.7 Compacting/Finishing: All completed CSA surfaces that will be covered with succeeding layers of CSA shall be kept continuously moist by fog spraying until placement of next lift.

CSA shall be uniformly compacted to a minimum of 98%, with an average of 100%, of maximum density as monitored by nuclear density tests in accordance with AASHTO T-238 and T-239. Maximum density shall be determined in the lab in accordance with the

requirements of AASHTO T-99, Method D, for minus 19 mm material only, with rock correction at each density test location according to AASHTO T-224, Section 2.2.2. At least one density test shall be taken for each 350 cubic meters of CSA.

At the start of compaction of each lift, the mixture shall be in uniform, loose condition throughout its full depth. The moisture content shall be as previously specified herein. No section shall be left undisturbed for longer than thirty minutes during compaction operations. Compaction of each lift shall be accomplished in such a manner as to produce a dense surface, free of compaction planes, and shall be completed within one (1) hour from the time water is added to the mixture. After compaction, CSA shall be shaped to the required grades, cross sections and rolled to a reasonably smooth surface. Whenever the Contractor's operation is interrupted for more than two hours, the top surface of the completed layer, if smooth, shall be scarified to a depth of at least 25 mm with a spike-tooth instrument prior to placement of the next lift. The surface, after scarifying, shall be swept using a power broom or other method approved by the Engineer, to completely free the surface of all loose material prior to the placement of the next lift.

At the time of compaction, the moisture content shall not be more than one percent (1%) below optimum and shall not be more than one percent (1%) above optimum when the mean air temperature during construction hours does not exceed 32º C.

When the mean air temperature does exceed thirty-two degrees C, or there is a breeze or wind which promotes rapid drying of the CSA mixture, the moisture content shall be increased as needed, at the direction of the Engineer, but shall be less than the amount that will cause the CSA to become unstable during compaction and finishing operations.

Backfill shall not be placed within one meter (1m) of the top of the CSA surface. Construction joints shall be provided at the end of each day's work or when work is halted for two hours or more. The joints shall be trimmed to a straight line and vertical to the full depth of the lift. Before resuming placement of new material, the joints shall be roughened and loose material removed by power broom or compressed air.

Compaction equipment shall be capable of obtaining specified requirements without detrimentally affecting the compacted material. The equipment shall be modern, efficient compacting units approved by the Engineer. The units shall be of a type that is capable of compacting each lift of material as specified, and meet the minimum requirements as contained herein:

Self-propelled drum drive vibratory roller shall be of a type that will transmit dynamic impact to the surface to be compacted through a steel drum by means of revolving weights, eccentric shaft or other methods. The compactor shall have a gross mass of not less than 10400 kg and shall produce a dynamic force of at least 6 kg per 25 millimeters of drum width when operated at 2,400 cycles per minute (cpm). The dynamic force is defined as the force developed by revolving the eccentric weight at 2,400 cpm. The roller shall have a smooth drum or drums and the drum diameter shall

be between 1200 mm and 1700 mm, and the width shall be between 700 mm and 2500 mm. The frequency of vibration during operation shall be 2,400 cpm. The roller shall be operated at speeds not to exceed 25 km per hour in the forward direction. The engine driving the eccentric mass shall have a rating of not less than 90 kilowatts. Variation in speed, frequency and method of operation will be determined when found necessary to secure maximum compaction of materials.

Heavier compacting units may be required to achieve the required density.

222.3.8 Bedding Mortar shall be used between CSA that has been in place more than seven (7) days and the new CSA after the existing CSA has been properly cleaned. The bedding mortar is to be used for achieving bond between the old and new CSA layers and to eliminate and prevent segregation or voids along the margins of CSA placements. Adjustment to the mix design may be required by the Engineer.

222.3.9 Control Strips: A control strip shall be constructed at the beginning of work on the CSA to be compacted. The control strip construction will be required to establish procedures necessary to obtain densities for the specific course plus use of portable nuclear moisture/density testing equipment to determine in-place densities.

Each control strip, constructed to acceptable density and surface tolerances shall remain in place and become a section of the completed CSA. Unacceptable control strips shall be corrected or removed and replaced at the Contractor's expense. A control strip shall cover an area of approximately 350 square meters and be of the same dimensions specified for the CSA course.

The materials used in construction of the control strip shall conform to the specification requirements. They shall be furnished from the same source and be of the same type as used in the CSA. The underlying surface for the control strip shall have prior approval of the Engineer.

The equipment used in the control strip shall be of the same type and weight as used for the CSA.

Compaction of control strips shall start immediately after the course has been placed to the specified thickness, and shall be continuous and uniform over the entire surface. Compaction of the strip shall continue until no discernable increase in density can be obtained by additional effort.

Upon completion of compaction, the mean density of the control strip will be determined by averaging the results of ten density tests taken at random sites within the strip. If the mean density of the control strip is less than 98% of the laboratory compacted specimens as determined by testing procedures appropriate for the material being placed, the Engineer may order the construction of another control strip.

A new control strip may be ordered by the Engineer, or requested by the Contractor when:

(1) A change in material or mix design.
(2) There is reason to believe that the control strip density is not representative for the material being placed.
(3) Ten days of production have passed without a new control strip.

222.3.10 Power Tampers and Small Vibratory Rollers: Small vibratory rollers that are capable of operating within a few millimeters of a vertical face shall be used for compaction adjacent to guide banks, next to utilities and drainage conduit, at transitions to previously constructed levee protection and at other areas where larger vibratory rollers cannot maneuver. The dynamic force produced by the small vibratory rollers shall be at least 2.5 kg per millimeter of drum width.
Tampers shall be a type capable of developing a force per blow of at least 630 kg. The amount of rolling and tamping required shall be whatever is necessary for the particular equipment to provide the same degree of compaction as would be obtained by four passes of the large self-propelled vibratory roller. Standby replacement equipment shall be available within one hour if needed.

222.3.11 Curing: Temporarily exposed surfaces shall be kept continuously moist. Care must be exercised to ensure that no curing material other than water is applied to the surface that will be in contact with succeeding layers.

Permanently exposed surfaces shall be kept in a moist condition for seven days, or they may be covered with bituminous or other suitable curing material, subject to the Engineer's approval. Any damage to the protective covering within the seven days shall be repaired to the satisfaction of the Engineer.

Regardless of the curing material used, any permanently exposed surface shall be kept moist until the protective cover is applied. This protective cover is to be applied as soon as practical, with a maximum time limit of twenty-four hours between the finishing of the surface and the application of the protective cover.

222.3.12 Maintenance: The Contractor will be required, within the limits of the contract, to maintain the CSA and curing seal in good condition until the work is completed and accepted. Maintenance shall include repairs to any defects that may occur. This work will be done at the Contractor's expense and repeated as often as necessary. Faulty work shall be replaced for the full depth of the layer.

222.4 METHOD OF MEASUREMENT:

The work will be measured by the cubic meter of completed CSA bank protection constructed to the lines, grades and cross-sections shown on the plans.

The maximum limit for the placement of CSA due to over excavation or sloughing of existing soils shall be one-tenth of a meter. Any placement beyond these limits will not be included in the pay quantity.

222.5 BASIS OF PAYMENT:

The accepted quantities of CSA will be paid for at the bid price per cubic meter for CSA Bank Protection, subject to the following penalties for failure to achieve the required strength requirements:

Percent of Specified Strength	Percent of Contract Unit Price
≥100	100
97-99	92
94-96	85
90-94	77
85-89	68
80-84	60
75-79	50
<75	See Note

Note: Material represented by lots attaining seven day compressive strengths with a mean value less than 75% of the specified compressive strength will be evaluated as to acceptance. The Engineer will determine if the material can be left in place or removed and replaced at the Contractor's expense.

Part 200 add the following new Section:

SECTION 224

RIPRAP CONSTRUCTION WITH HIGH SURVIVABILITY FILTER FABRIC

224.1 DESCRIPTION:

The work under this Section consists of furnishing all materials and constructing plain riprap with high survivability filter fabric.

224.2 MATERIALS:

224.2.1 Plain Riprap: Riprap stone shall be angular and conform to Sections 703.1 STONE and 701.4 QUARRY STONE. The stone sizes shall be as indicated on the plans or special provisions.

224.2.2 Bedding Material: The bedding material for the Plain Riprap shall consist of processed natural material conforming to the requirements of Section 702.3. The material gradation shall conform to Select Material Type A or B or Aggregate Base as specified in Table 702-1.

224.2.3 Filter Fabric: Filter Fabric shall be a woven or non-woven high survivability filter fabric meeting the following requirements.

Non-woven:

Property	Requirement	Test Method
Grab Tensile Strength N	890	ASTM D 4632
Grab Elongation at Break %	15 minimum 115 maximum	ASTM D 4632
Puncture Strength N	360	ASTM D 4833
Burst Strength M Pa	2.20	ASTM D 3786
Trapezoidal Tear N	220	ASTM D 4533
Permittivity second^{-1}	0.50 minimum	ARIZ 730
Apparent Opening Size Sieve Size μm	106 - 600	ASTM D 4751
Ultraviolet Stability %	70	ASTM D 4355

Woven:

Woven fabric shall meet the physical requirements listed above for nonwoven fabric except that the grab elongation at break, percent, shall be 13 minimum, 115 maximum.

224.3 CONSTRUCTION REQUIREMENTS:

224.3.1 Filter Fabric: The identification, packaging, handling, and storage of the geotextile fabric shall be in accordance with ASTM D 4873. Fabric rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Rolls will be stored on the site or at another identified storage location in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof, light colored, opaque cover. At no time shall the fabric be exposed to sunlight for a period exceeding 14 days.

Fabric shall be placed in the manner and at the locations shown on the project plans. The surface to receive the fabric shall be free of obstructions, depressions, and debris. The fabric shall be loosely laid and not placed in a stretched condition.

The fabric strips shall be placed to provide a minimum 600 millimeter of overlap for each joint. On horizontal joints, the uphill strip shall overlap the downhill strip. On vertical joints, the upstream joint shall overlap the downstream strip.

224.3.2 Bedding Material: The Bedding Material shall be placed uniformly on the filter fabric, to the depth specified on the Project Plans, and shall be free of mounds, dips, and windrows. The Bedding Material shall not be compacted.

224.3.3 Plain Riprap: The plain riprap shall be carefully placed on the bedding material and filter fabric in such a manner as to not damage the fabric. If the Engineer determines that the placement of stone has damaged or displaced the filter fabric to the extent that it cannot function as intended, the Contractor shall remove the placed riprap stone and properly correct the damage to, and/or the displacement of, the filter fabric. Such correction may include the removal and subsequent replacement of the bedding material and fabric, and regrading the affected area, each as determined by the Engineer.

The plain riprap shall be placed in a manner which will produce a reasonably well-graded mass without segregation and with a minimum amount of voids, with the larger stone evenly distributed through the riprap mass. The individual placement of larger riprap stones may be required to obtain a uniform distribution of stone size.

224.4 MEASUREMENT:

The quantities of Plain Riprap with Filter Fabric shall be the completed item, in place within the limits of dimensions shown on the plans. The measurement will be in cubic meters and shall extend from the filter fabric to the top of the plain riprap. Quantities will be computed by the average end area method.

No separate measurement will be made for Filter Fabric or Bedding Material.

224.5 PAYMENT:

Payment for Plain Riprap with Filter Fabric will be at the contract unit price bid for each designated plain riprap gradation. The price shall be full compensation for furnishing all material, labor and equipment for installation of Plain Riprap With Filter Fabric, complete in place, including excavation, ground surface preparation, filter fabric, bedding material, plain riprap, and backfilling.

Part 200 add the following new Section:

SECTION 231

ENGINEERING GEOCOMPOSITES AND GEOGRIDS

231.1 WALL DRAINAGE: The work under this section shall consist of installing a wall drainage system consisting of a geocomposite material and PVC drains as shown on the plans.

The Geocomposite shall consist of a supporting structure of drainage core material and a geotextile filter fabric permanently bonded to both sides of the core material.
The geocomposite shall be resistant to commonly encountered chemicals and hydrocarbons, and resistant to ultraviolet exposure.

The drainage core material shall consist of a preformed, stable, polymer plastic material with a cuspated, nippled, or geonet structure. The drainage core shall provide support for and shall be bonded to the geotextile filter fabric at intervals not exceeding 29 mm in any direction. Its preformed structure shall permit free water flow through the core. The core shall have at least 97 mm^2 per square meter of flat area in contact with the geotextile fabric to support the fabric. The core material shall additionally conform to the following physical requirements:

PROPERTY	REQUIREMENT	TEST METHOD
Thickness with Fabric	minimum 5.84 mm.*	ASTM D1777
Compressive Strength	minimum 287,300 Pa	ASTM D1621
Transmissivity *with Gradient=1.0 and Normal Stress= 143,600 Pa*	minimum 50 l/min/meter width.	ASTM D4716

*Min.- Minimum average roll value, i.e., the average test result for a lot shall meet or exceed the minimum values listed when sampled and tested according to the specified test method.

Geocomposite edges shall be covered with a fabric flap to prevent intrusion of backfill material into the core. Flaps shall either be firmly attached to the fabric or overlaps on loose sides shall be a minimum of 102mm.

The geotextile filter fabric shall be laminated onto or adhere to the drainage core. The geotextile fabric shall be a non-woven polyester or polypropylene fabric meeting the following minimum average roll values:

PROPERTY	REQUIREMENT	TEST METHOD
Weight, kg/m^2	12	ASTM D3776
Grab Tensile Strength KPa	620	ASTM D4632
Mullen Burst Strength, KPa	965	ASTM D3786
Trapezoidal Tear Strength, kg	18	ASTM D4533

Puncture Strength, kg.	18	ASTM D3787
Apparent Opening Size	0.212 μm - 0.150μm	ASTM D4751
UV Stability, %	Fully Stabilized	ASTM D4355

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D4354 and tested according to the test method specified above.

The installed geocomposite shall be a minimum of 0.6 m wide.

The installed geocomposite area shall be computed by multiplying the total length (sum of both sides) of installed geocomposite by 0.6 m of width.

231.2 GEOGRIDS: See Project Special Provisions.

SECTION 301

SUBGRADE PREPARATION

Section 301 add the following:

301.2 Preparation of Subgrade: Subgrade preparation shall also include preparing subgrade to required line and grade for paved or unpaved shoulders, tapers, turnouts, and driveways, and all project locations where aggregate base and/or select material courses are used in accordance with the Project Plans.

301.2.1 The Contractor may use removed existing asphalt concrete and other existing bituminous roadway surfacing materials, originating on the project site, as embankment fill. All materials used shall be thoroughly crushed to sizes not exceeding 100 mm, or as approved by the Engineer. These asphalt/bituminous materials shall be placed not less than 600 mm below subgrade elevation.

Project earthwork quantities when included as separate bid items will include removed asphalt/bituminous material volumes, unless otherwise specified in the Special Provisions.

All unsuitable material and all excess material shall be disposed of in accordance with the requirements of Sections 205.2 and 205.6, respectively. When additional material is required for fill, it shall conform to Section 210.

301.3 Relative Compaction:

Rock 150 mm or greater that becomes exposed due to scarification shall be removed from the scarified subgrade.

(D) All MCDOT Roadway Pavements ..... 95 percent
(E) All MCDOT Graded Shoulders ..... 95 percent

301.7 Measurement: Measurement for Subgrade Preparation will be by the square meter. The area to be measured will be the total accepted area of new asphalt or Portland cement pavement, including paved shoulders, tapers, and turnouts, and unpaved roadway shoulders. Measurement will also include driveways that are paved or are surfaced with aggregate base or select materials. The area under concrete curb and gutter, concrete driveway entrances, and concrete alley entrances will not be measured for this pay item.

Project earthwork quantities for Roadway Excavation, Borrow Excavation, and Fill Construction shall not be measured when they are all omitted from the bidding schedule. Payment for such earthwork items shall be included in the price bid for Subgrade Preparation.

Part 300 add the following new Section:

SECTION 308

LIME SLURRY WITH FLY ASH STABILIZATION

308.1 Description
This section shall consist of constructing a mixture of soil, lime slurry, fly ash and water for the stabilization of soils or base materials. The work shall be performed in conformity with the lines, grades, thickness, and typical cross sections shown on the plans.

308.2 Materials

308.2.1 Soil or Subgrade
The soil or subgrade material used for this work shall consist of materials on the site or imported and shall be free of roots, sod, weeds, and stones larger than 75 millimeters.

308.2.2 Quicklime and Hydrated Lime
Lime used to manufacture the Commercial Lime Slurry specified herein, shall be either Quicklime or Hydrated lime and shall conform to the requirements of ASTM C 977. Lime may only be used in the production of lime slurry. The direct use of dry hydrated lime or quicklime to the soil material is strictly prohibited. All lime shall come from a single source. If a source change is requested, a new mix design shall be submitted using lime from the proposed new source. The new design must be approved by the Engineer prior to use.

308.2.3 Commercial Lime Slurry

Commercial lime slurry shall be a pumpable suspension of solids in water. The water or liquid portion of the slurry shall not contain dissolved material in sufficient quantity naturally injurious or objectionable for the purpose intended. The solids portion of the mixture, when considered on the basis of solids content, shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

(A) Chemical Composition: The solids content of the lime slurry shall consist of a minimum of 90 percent by weight, of calcium and magnesium oxides (CaO and MgO), as determined by ASTM C-25.

(B) Residue: The percent by weight of residue retained in the solids content of lime slurry shall conform to the following requirements:

Residue retained on a 3.35 mm (No. 6) sieve	Max. 0.2%
Residue retained on a 600 µm (No. 30) sieve	Max. 4.0%

(C) Grade: Commercial lime slurry shall conform to a dry solids content as approved by the Engineer.

A certificate of compliance and a field summary of lime slurry produced shall be provided to the Engineer for each load of slurry.

308.2.4 Water

Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water shall be tested in accordance with and shall meet the suggested requirements of AASHTO T-26. Water known to be of potable quality may be used without test.

308.2.5 Fly Ash

Fly ash shall meet the requirements of AASHTO M-295, Class C.

308.3 Mix Design

Before commencing lime / fly ash treatment work, the Contractor shall submit for approval by the Engineer, a proposed mix design. A testing laboratory under the direction and control of a registered Professional Engineer shall prepare the proposed mix design. The mix design shall be determined using the soils or subgrade material to be stabilized and lime and fly ash from the proposed suppliers and shall determine the following:

Percent of fly ash and rate of application.
Percent of lime and rate of application of lime slurry in the treated soil or subgrade material.
Optimum water content during mixing, curing and compaction.
Gradation of in-situ mixture after treatment.

Additional mixing or equipment requirements.
Mellowing time requirements, if needed.

The mix design shall comply with the following requirements:

Plasticity Index: Less than 3, per AASHTO T-89 & 90.
Swell Potential: One (1) percent or less vertical expansion of an air dried soil when inundated with water and allowed to swell at a confined pressure of 2.88 kPa.
Unconfined Compressive Strength: Minimum 2070 kPa in five days curing at 38°C when tested in accordance with ASTM D-1633 Method A.

308.4 Construction

308.4.1 General

The completed subgrade shall consist of a uniform lime / fly ash mixture, free from loose segregated areas, have a uniform density and moisture content, and be well bound for its full depth. A smooth surface suitable for placing subsequent courses is required if pavement is to be placed directly on the treated subgrade.

Prior to beginning stabilization, the subgrade shall be constructed and brought to grade and shall be shaped to conform to the typical sections, lines, and grades as shown on the plans.

When the design requires treatment to a depth greater than 300 mm, the subgrade soil shall be treated in equal layers. The top layer(s) of soil shall be removed and stockpiled. The lower layer of soil to be treated shall then be treated and allowed to cure in place. After final mixing, the lower layer shall be compacted in maximum 300 mm compacted lifts. The stockpiled soil shall then be placed, treated, mixed and compacted in successive maximum 300 mm compacted lifts.

308.4.2 Weather Limitation

Lime slurry / fly ash treated subgrade shall not be constructed if the atmospheric temperature is below 4.5°C or when conditions indicate that temperatures may fall below 4.5°C within 24 hours.

308.4.3 Equipment

Contractor shall provide all equipment necessary to complete the work, including grading and scarifying equipment, lime slurry spreader (gravity feed spreaders will not be permitted), fly ash spreader, mixing and pulverizing equipment, sheepsfoot and pneumatic rollers, sprinkling equipment, and trucks. When using dry hydrate to make slurry, agitators are mandatory in spreader. All equipment used for this work shall be subject to approval by the Engineer.

308.4.4 Application

Lime slurry and fly ash slurry shall be spread only on that area where the mixing operations can be completed during the same working day. The application and mixing

of lime and fly ash with the soil shall be accomplished by the methods hereinafter described as Slurry Placing.

Slurry Placing: Fly ash shall be spread with trucks equipped with an approved distribution system on the prepared subgrade at the rate specified by the job mix design in a single pass, just prior to the application of the lime slurry. The fly ash may be added to the lime slurry and placed together, if approved by the Engineer. Lime slurry / Lime slurry fly ash, shall be mixed in a portable mixing unit and spread with trucks equipped with an approved distribution system as a slurry. Commercial lime slurry shall be applied with a lime percentage not less than specified herein. The distribution of lime slurry shall be attained by successive passes over a measured section of subgrade until the proper amount of lime has been spread, as determined in the job mix design. The rate of application shall be verified using ASTM D-3155 methods.

Thickness: The thickness of the lime slurry treated subgrade shall be determined by visual inspection and/or by depth tests taken at intervals so that each test shall represent no more than 836 square meters per layer, if more than one layer. The method used to remove material to determine depth of lime treatment may be by shovel and/or pick, coring or other method approved by the Engineer. Phenolphthalein solution shall be used to detect the presence of lime. When the grade deficiency is more than 25 mm, the Contractor shall correct such areas in a manner satisfactory to the Engineer. Contractor shall replace, at no cost to the Agency, the material where depth tests are taken.

No traffic other than the mixing equipment will be allowed to pass over the spread of lime slurry until after completion of mixing.

308.4.5 Mixing

The full depth of the treated subgrade shall be mixed with an approved mixing machine. The use of disc plows or blades are prohibited except in areas specified by the engineer. To insure a complete chemical reaction of the lime, fly ash and soil or subgrade, water shall be used as required to maintain a moisture content at or above the optimum prior to beginning compaction and held above optimum during compaction. During the interval of time between application and mixing, lime that has been applied, unmixed and exposed to the open air for 10 hours or more will not be accepted.

After mixing and prior to compaction, clay lumps shall meet the following criteria:

	Percent (by Weight)
Minimum of clay lumps passing 37.5 mm sieve	100
Minimum of clay lumps passing 4.75 mm sieve	60

308.4.6 Compaction

Compaction of the mixture shall begin after final mixing. Sheepsfoot or segmented steel rollers shall be used during initial compaction. Steel wheel or pneumatic tired rollers shall be used only during final compaction, if pavement is to be placed directly on the

treated subgrade. Areas inaccessible to rollers shall be compacted to the required density by methods approved by the Engineer.

The material shall be aerated or watered as necessary to provide and maintain required moisture content. The field density of the compacted mixture shall be a least 95 percent of the maximum density at 0-4 percent above optimum moisture. A composite of treated soil or subgrade materials from a minimum of five (5) random locations, per soil type, within the area to be stabilized shall be used to determine the maximum density and optimum moisture content in accordance with ASTM D-558. The in-place field density shall be determined in accordance with ASTM D-1556, ASTM D-2167 or ASTM D-2922.

After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked to meet requirements.

If pumping subgrade should become evident at any time prior to paving, the Engineer may require proof rolling with a pneumatic-tire roller or other approved equipment in order to identify the limits of the unacceptable area. The proof rolling will be performed at no additional cost to the Contracting Agency.

All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts. Compaction and finishing shall be done in such a manner as to produce a smooth dense surface free of compaction planes, cracks, ridges, or loose materials.

Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion, shall be smooth and shall conform with the typical section shown on the plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at no cost to the County.

308.4.6.1 Tolerances

At final compaction, the lime, fly ash and water content for each course of subgrade treatment shall conform to the approved mix design with the following tolerances.

Material	Tolerance
Lime	+0.5% of design, (ASTM C-114)
Fly Ash	±1.0% of design, (ASTM C-114)
Water	+4%, -0% of optimum, (ASTM D-698)

308.4.7 Finishing and Curing

After the final layer or course of lime slurry / fly ash treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the plans. The completed section shall then be finished by rolling with a pneumatic or other suitable roller.

The final layer of lime slurry / fly ash treated subgrade shall be maintained in a moist condition until the next layer of pavement structure is placed. If required, a fog seal for curing, in compliance with Section 333, shall be furnished and applied to the surface of the final layer of the lime stabilized material as soon as possible after the completion of final rolling and before the temperature falls below 4.5°C. Curing seal shall be applied at a rate between 0.45 and 0.90 liters per square meter of surface. The exact rate will be determined by the Engineer.

After curing begins, all traffic, except necessary construction equipment shall be kept off the lime slurry / fly ash stabilized subgrade for a minimum of 7 days or until the final pavement structure layer(s) are placed.

308.4.8 Maintenance

The Contractor shall maintain, at his / her own expense, the entire lime slurry treated subgrade in good condition from the start of work until all the work has been completed, cured, and accepted by the Engineer.

308.5 Measurement

The quantity of lime slurry / fly ash treated soils shall be measured by the square meter, measured in place, treated, compacted, to the proper depth, and accepted.

The quantity of curing seal shall be measured by the tonne, diluted.

308.6 Payment

The lime slurry / fly ash treated soils measured as provided above, will be paid for at the contract price per square meter, which price shall be full compensation for the item complete in place, as herein described and specified.

Payment for curing seal will be made at the contract price per tonne for Fog Seal (Contingent Item) based on the rate of application as requested by the Engineer.

SECTION 310

UNTREATED BASE

310.1 DESCRIPTION:

Section 310.1 add the following:

Aggregate base shall conform to the requirements of Section 702 of the Uniform Standard Specifications. Aggregate base shall be crushed in accordance with Section 702.2.

310.4 Payment:

Section 310.4 add the following:

The Contractor shall furnish the Engineer certified weight tickets for the aggregate base (AB) placed on the project. Final pay quantities for aggregate base will be based upon the scale tickets submitted to the Engineer for aggregate base specifically used to construct roadway untreated base as shown in the contract documents.

Part 300 add the following new Section:

SECTION 317

ASPHALT MILLING

317.1 DESCRIPTION:

The work under this Section shall consist of milling existing asphalt concrete pavement where shown on the Plans or requested by the Engineer.

317.2 CONSTRUCTION REQUIREMENTS:

Contractor is responsible for locating all milling hazards on and below the surface within the area to be milled which may require special milling. Special milling is not a separate bid item and shall be paid for as Asphalt Milling.

The milling cut depth shall be the depth indicated on the Plans plus or minus 3 mm. Contractor shall remove the milled material and sweep the roadway clean with a power pick-up broom to the satisfaction of the Engineer.

The work shall result in a clean milled surface in the area indicated on the Plans to the specified depth and shall include the areas immediately around and next to any individual hazards located within the area to be milled.

The Contractor shall be responsible for continually checking the milling operation to determine that the proper depth of milling has been achieved, that the proper profile and cross slope are achieved, and that the surface texture is (a) free from longitudinal ridges, and (b) has a uniform pattern.

317.3 MEASUREMENT AND PAYMENT:

Measurement for Asphalt Milling will be by the square meter and shall only include areas milled to the required depth and cross section.

Payment for this work will be made at the unit bid price for Asphalt Milling.

SECTION 321

ASPHALT CONCRETE PAVEMENT

321.3 WEATHER AND MOISTURE CONDITIONS: add the following:

Asphalt concrete of less than 50 mm in thickness shall be placed only when the atmospheric temperature in the shade is 13° C or above.

321.6 CORRECTIVE REQUIREMENTS FOR DEFICIENCIES

Section 321,6,5 is added as follows:
321.6.5 Asphalt Cement Content; Corrective requirements and penalties for deficient asphalt cement as determined by tests conducted on the asphalt material used for paving shall be as indicated in Section 710.4.2 Asphalt Cement Content and Table 710-10 Asphalt Cement Content Corrective Action for Deviations.

Section 321.6.6 is add as follows:
321.6.6 Air Voids; Corrective requirements and penalties for deficient air voids as determined by tests conducted on the asphalt material used for paving shall be as indicated in Section 710.4.4 Volumetrics and Table 710-11 Laboratory Voids Acceptance and Penalties.

Part 300 add the following new Section:

SECTION 325

ASPHALT - RUBBER CONCRETE, GAP GRADED

325.1 DESCRIPTION:

Asphalt-rubber concrete consists of supplying, placing and compaction of plant mixed gap graded asphalt-rubber concrete over asphalt surfaces. The thickness shall be as shown on the plans or as specified in the special provisions. Preparation of existing surfaces will be required except when accomplished by the County and the requirement is modified by special provision.

325.2 MATERIALS:

Asphalt-rubber concrete shall consist of a mixture of aggregate and asphalt-rubber binder. Tack coat, asphalt-rubber concrete mix and transportation thereof shall be as specified in Sections 710 and 321, except as modified below:

325.2.1 - AGGREGATE:

The aggregate shall meet the following gradation:

Overlay Thickness	**25 mm (1”) & 37.5 mm (1-1/2")**	**50 mm (2”)**
Sieve Size	Percent Passing	Percent Passing
25 mm (1")	100	100
19 mm (3/4")	100	97-100
12.5 mm (1/2")	100	78-92
9.5 mm (3/8")	78-92	61-75
4.745 mm (#4)	28-42	30-40
2.36 mm (#8)	15-25	15-25
600 μm (#30)	5-15	5-15
75 μm (#200)	3-7	2-6
*Type II Portland Cement	1.5%	
Or		
*Hydrated Lime	1.0%	

***By total weight of the mineral aggregate.**

The aggregate shall conform to the requirements of MAG 701 and 710 for asphalt concrete, except as modified below:

Sand Equivalent	65 minimum
Crushed Aggregate (retained on 2.36 mm (#8) sieve, at least one crushed face, produced by crushing)	85 minimum

325.2.2 ASPHALT-RUBBER BINDER:
The asphalt-rubber binder shall conform to Section 717.

325.2.3 MIX DESIGNS:
At the Pre-Construction Meeting, the Contractor shall submit the name of the asphalt-rubber concrete supplier, a description of the materials, and the job mix design(s). The design method used shall be in accordance with the Marshall Mix procedure, 75 blows, as described in "Design Methods for Hot-Mixed Asphalt-Rubber Concrete Paving Materials" by James G. Chehovits, October 1989. The job mix designs are subject to approval by the Engineer.

ASPHALT RUBBER BINDER CONTENT:
For Design purposes, the percent of asphalt-rubber binder in the mix(es) shall be:

Overlay Thickness	Asphalt Rubber Binder	
	Heavy Traffic	Low Traffic
25 mm (1”) and 37.5 mm (1-1/2")	8.0% to 8.4%	8.4% to 8.8%
50 mm (2")	7.1% to 7.4%	N/A

The amount of asphalt-rubber binder in each mix shall be provided in the design for approval by the Engineer. Low traffic areas include residential streets. Heavy traffic areas include arterial streets.

AIR VOIDS:
For Design purposes, the percent of air voids in the mix(es) shall be:

Overlay Traffic Volume	Air Voids
Low Traffic	3.0% to 5.0%
Heavy Traffic	4.0% to 6.0%

The amount of air voids in each mix shall be provided in the design for approval by the Engineer.

Mix designs shall include the following information as a minimum:

1. Aggregate
   source and identification (for each material used)

gradation (for each material used)
blend percentage
mixture gradation

2. Asphalt - Rubber Binder (No extender oil allowed)
   source and PG grade of asphalt cement
   source and identification of ground rubber
   ground rubber gradation
   ground rubber percentage of the asphalt - rubber binder
   type and amount of additive(s), if required
   temperature when added to aggregate

3. Recommended asphalt - rubber binder content by both weight of total mix and by weight of dry aggregate.

4. Recommended mixture production, lay down, ambient and/or pavement, and maximum / minimum temperatures.

The mix design shall include sufficient test results and documentation to assure that all requirements for rubber, aggregate and the asphalt-rubber binder are fulfilled.

325.2.4 Production Tolerance:

Production requirements for asphalt-rubber concrete shall be as specified in Section 710.4.4 Volumetrics, Section 710.5.1 Quality Control, and Section 321.6 Corrective Requirements for Deficiencies. The production tolerances including compaction requirements and corrective action will be enforced for asphalt-rubber concrete.

Calibration Factors

A minimum of one week prior to the production of asphalt rubber hot mix, the Contractor shall submit to the Engineer samples of all hot mix materials that will be used on the project. The materials shall be used to determine the calibration factors using the acceptance laboratory and the Contractor supplied ignition furnaces and related quality control test equipment. Calibration factors shall be recalculated whenever a change in the asphalt rubber hot mix materials occurs and when requested by the Engineer.

325.3 SURFACE PREPARATION:

Before placing asphalt-rubber concrete on existing pavements, severely raveled areas or cracked areas that are depressed more than 20 mm from the adjoining pavement shall be cut out and patched at least 48 hours prior to the resurfacing operation. Over-asphalted (bleeding or flushing) areas or rough high spots shall be removed by burning or blading. Large shrinkage cracks shall be filled with asphalt sealing compound acceptable to the Engineer. The entire surface shall be cleaned with a power broom. Raveled areas that do not require removing shall be cleaned by hand brooming. The above surface cleaning requirements are included as part of the Asphalt-Rubber

Concrete paving operations, and the cost thereof shall be included in the Asphalt-Rubber Concrete bid item. Pavement repairs and crack sealing when required are to be compensated for by other appropriate bid items.

Prior to placing the asphalt-rubber concrete on milled surfaces, pot-holes left by the milling operation shall be repaired by the Contractor, as an incidental non-pay item and as required by the Engineer. The milled area shall be swept.

After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat as specified in Section 321.

Traffic will not be permitted over surfaces which have received a tack coat. When the overlay is to extend onto the concrete gutter, the gutter shall be thoroughly cleaned of loose dust and cement particles and shall be tack coated.

325.4 CONSTRUCTION METHODS:

Asphalt-rubber concrete shall be placed only when the surface is dry, and when the atmospheric temperature in the shade is 13° C (55° F) or above. No asphalt-rubber concrete shall be placed when the weather is foggy or rainy. Asphalt-rubber concrete shall be placed only when the Engineer determines that weather conditions are suitable.

Except as otherwise noted, placing and rolling of the asphalt-rubber concrete and the smoothness of the surface shall be as specified in Section 321 for asphalt concrete.
The spreading equipment shall be equipped with a mat reference ski-type control device of not less than 9.2 meters (30 feet) in length, or other method of control approved by the Engineer.

The density of the compacted mixture shall not be less than 95% of the laboratory unit weight composed of the same mixture compacted by the 75 blow method of ASTM D-1559 at 143.3° C ± 2.75° C, or at the job mix design specified compaction temperature. Pneumatic rollers shall not be used.

Placement and compaction temperature shall be specified with the submitted mix design data but in no case less than 135° C (275° F) at the point of placement. The temperature of the material in the truck shall be measured by inserting a thermometer, or other approved measuring device, to a point at least 150 mm (6”) below the surface of material.

If asphalt-rubber concrete is placed in a windrow during paving, the windrow shall not exceed a distance greater than 45.7 meters (150 feet) in front of the paving machine.

325.4.1 Lime Water:

An application of lime water shall be applied by the Contractor to the compacted asphalt rubber concrete surface after final compaction, but prior to opening the roadway to

traffic, or when requested by the Engineer to cool the pavement to prevent tracking and pick-up. The lime water solution shall be applied at the rate of approximately 2.75 Liters/square meter (1/2 gallon/square yard). The lime shall be mixed using a minimum of (1) one, 22.6 kg (50 pound) bag per 11,364 liters (3,000 gallons) of water.

325.4.2 Adjustments:
After installation of an overlay course:

All necessary frame and cover adjustments for manholes, valves, survey monuments, sewer clean-outs, etc., shall be completed by the Contractor within the given segments being surfaced.

On roads without curb and gutter, the existing shoulder elevation shall be adjusted by the Contractor to match the elevation at the edge of new overlay and slope away from new pavement surface at a rate that the existing quantity of shoulder material will allow. Shoulder material to include existing shoulder, millings, or import shall be compacted to a minimum of 95% of maximum density, determined in accordance with MAG section 301.3.

If the existing quantity of shoulder material is not sufficient to match the elevation at the edge of new overlay Contractor shall use any millings collected from milling operations on the same road to meet this requirement. In the case that there are no millings on the same road or if Contractor uses all the milling material and there is still a deficiency, Contractor shall be compensated for imported fill, measured by certified weigh tickets, at the contract unit price bid for Imported Fill, complete-in-place. The imported fill shall be select, aggregate base course, or a granular material approved by the Engineer**.**

325.4.3 Corrective Requirements For Deficiencies:
Corrective measures shall be as specified in Section 321.6 Corrective Requirements for Deficiencies and in Section 710.4.4 Volumetrics.

325.5 MEASUREMENT:

Asphalt-Rubber Concrete shall be measured by the tonne, for the mixture actually used, which shall include the required quantities of mineral aggregates, filler material, rubberized asphalt binder and anti - strip agent.

Application of Lime Water shall be measured by the square yard. The measured area shall be the area of asphalt-rubber pavement to which the lime water is applied. The measured area shall only be counted one time regardless of the number of applications applied to the asphalt-rubber pavement section.

325.6 PAYMENT:

Payment for Tack Coat will be as specified in Section 321 except as noted above.

Payment for Asphalt Milling will be as specified in Section 317 except as noted above.

Asphalt - Rubber Concrete will be paid at the contract unit price, complete-in-place.

Application of Lime Water as approved by the Engineer will be paid at the contract unit price bid.

SECTION 329

TACK COAT

329.1 Description add the following:

Emulsified asphalt for tack coat shall be grade SS-1h.

SECTION 333

FOG SEAL COATS

333.1 DESCRIPTION:

Section 333.1 add the following:

Fog seal coats for curing seal purposes as specified in Section 308 or Section 309 shall consist of the application of emulsified asphalt.

333.6 APPLICATION OF ASPHALT EMULSION:

Section 333.6 add the following:

For curing seal applications over Lime Slurry Stabilization or Lime Slurry with Fly Ash Stabilization the application rate shall be between 0.45 and 0.90 liters per square meter.

SECTION 340

CONCRETE CURB, GUTTER, SIDEWALK, SIDEWALK RAMPS, DRIVEWAY AND ALLEY ENTRANCE

340.3 CONSTRUCTION METHODS

Revise MAG Section 340.3 Paragraph 2 – Delete the second paragraph and replace with the following:

The subgrade shall be constructed and compacted true to grades and lines shown on the plans and as specified in Section 301. All soft or unsuitable material shall be removed to a depth of not less than 150 mm below subgrade elevation and replaced with material satisfactory to the Engineer.

When the Engineer suspects that the existing subgrade consists of soils with swelling characteristics, the soils shall be tested to determine if they are non-expansive, marginally expansive, or expansive. This determination shall be based on a one-dimensional swell test (ASTM D-4546) remolded to 95% of maximum density at optimum moisture. Use ASTM D-698 for maximum density and optimum moisture determination. Results of this testing will be applied to Table 340-1 to determine the relative level of swell potential and the corrective action required.

Table 340-1

% Swell	Description	Corrective Action Required*
<1	Non-expansive	None
1 – 3	Marginally expansive	Compact to 90% (±3%) of maximum density at moisture content above optimum (ASTM D698).
>3	Expansive	Remove upper 600 mm of subgrade and replace with granular material meeting requirements of Section 601.4.6 or base material meeting requirements of Section 702.

***** Alternative corrective measures may be submitted to the County for review. The submittal must include recommendations affixed with the professional seal of an Arizona registered engineer.

340.5 MEASUREMENT

Add the following to Section 340.5:

Sidewalk ramp installations shall be measured as complete installed units and shall include the ramp curb and the walking surfaces between the ramp curb and back of curb and gutter or single curb. Single curb or curb and gutter shall be paid for

separately. The surface area of sidewalk ramps shall not be included in the measured quantity for sidewalks.

340.6 PAYMENT

Add the following to Section 340.6:

Payment for sidewalk ramps shall include the ramp curb and the walking surfaces between the ramp curb and back of curb and gutter or single curb.

SECTION 350

REMOVAL OF EXISTING IMPROVEMENTS

Section 350 add the following:

The work under this Section shall consist of the disposal of any obstacle to construction, unless specifically noted on the Plans for removal or relocation by other entities.

Arrangements for disposal of all waste material shall be the responsibility of Contractor, except that all usable pipe culvert, as determined by the Engineer, shall be stockpiled within the right-of-way for salvage by the County.

If a Maricopa County Landfill is selected for disposal of road construction waste and/or debris, a Maricopa County Landfill Use Permit will be required. Application for the permit can be made at the Maricopa County Landfill Office, located at 2801 West Durango Street, Phoenix, Arizona 85009 (Telephone Number (602) 506-7060). Charges will be levied on a volume basis for each load delivered to the landfill in accordance with the current Landfill fee schedules which are available at the above address.

If the work specified in the Construction Specifications requires the removal of existing improvements by the Contractor, Contractor shall perform such removal in a safe manner avoiding damage to improvements not designated for removal and dispose of all construction debris in a manner and in a location approved by the Engineer. See Special Provision for additional information.

Part 300 add the following new Section:

SECTION 351

RELOCATION AND ADJUSTMENT OF EXISTING IMPROVEMENTS

351.1 Description: This work shall consist of the movement of existing improvements and specialty items to accommodate project construction. Relocation is the horizontal movement or change in location of an existing improvement or item, as shown or described on the Project Plans. Adjustment is a change in the vertical position of an existing improvement or item, typically required to accommodate a change in grade at the location of the existing improvement. The term mailbox shall be used to describe both the mailbox and the supporting post.

351.2 Materials: All relocations and adjustments requiring reseating, replacement, or the use of additional materials shall be accomplished using materials of the same or better quality than found in the existing improvements, as approved by the Engineer.

For mailbox relocations the Contractor shall supply a replacement support post for any mailbox installation deemed hazardous by the Engineer. Hazardous mailbox installations may include but are not limited to support posts that act as fixed objects (i.e. rigid or non-deflecting posts that exceed the stiffness or breakaway characteristics of a nominal 4”x4” wood post buried 36 inches into the ground) and installations of multiple mailbox receptacles mounted on a horizontal beam.

351.3 Construction: The work shall include the removal of posts and other items necessary to relocate and adjust fences, gates, mailboxes, and other existing improvements; filling and compacting all holes left by such removals; and drilling, placing and/or driving moved posts into their new locations, as appropriate for the types of posts to be moved.

Improvements shall be moved in such a manner that the moved elements and all remaining unmoved portions of previously attached improvements are not damaged. All portions of moved and remaining unmoved improvements that are damaged during the relocation and adjustment of the improvements shall be repaired, or shall be replaced in kind by the Contractor, as approved by the Engineer, at the Contractor’s expense.

All relocated and adjusted improvements shall exhibit the same quality and integrity, function, and appearance as the improvements did prior to relocation and adjustment. New, connecting improvements between the relocated and adjusted improvements and the unmoved portion of the improvement shall be of the same type, quality, and strength as the existing improvement prior to relocation and adjustment.

If for any reason the improvement, fence, and/or gate to be moved cannot be removed, relocated, and adjusted within the same working day, the disturbed/removed portion

shall be secured from theft and damage until such time that it can be permanently installed in its final location/configuration. Also, in such cases where the move cannot be accomplished within the same working day, a temporary substitute facility shall be provided to appropriately secure the enclosure, as approved by the Engineer.

351.4 Measurement: The measurement of relocated or adjusted items will be the number of improvements, gates, and/or meters of relocated fence; and shall include all labor, equipment, and materials, including all additional new, connecting fence to secure the final enclosure, complete in place. For linear items such as relocated fencing, the length measured shall be the installed length; no measurement of the removal length shall be made. The measurement of relocated mailboxes will be the number of mailboxes relocated to a new permanent location as indicated by the project plans or directed by the Engineer and shall include replacement posts to correct conditions deemed hazardous, as required for a complete in place installation. No measurement will be made for temporary relocations made to maintain mail delivery during construction.

351.5 Payment: Payment will be made at the contract unit price for each improvement and shall be full compensation for all tools, equipment, labor, materials, services, transportation, and incidentals necessary to relocate and adjust the improvement including necessary repairs, adjustments, or connections to the unmoved remainder of fences and other facilities.

SECTION 401

TRAFFIC CONTROL

401.2 TRAFFIC CONTROL DEVICES:

Section 401.2 add the following:

401.2.1
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.

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.

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 incidental to the Traffic Control pay item.

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.

401.4 TRAFFIC CONTROL MEASURES:

Section 401.4 add the following:

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. 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 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.

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 work day 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.

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.

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.

401.4.5 Flaggers

All flaggers shall be properly trained and certified by a recognized source, such as the International Municipal Signal Association (IMSA) and shall carry proof of training with them at all times.

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.

401.5 GENERAL TRAFFIC REGULATIONS:

Section 401.5 add the following:

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.

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.

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.

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.

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.

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.

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.

401.5.7 Portable Concrete Barriers / Steel Plating
Open excavations and trenches within 3 meters 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.

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.

401.6 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 devises will be made. All traffic control devises, 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 meter. Otherwise, portable concrete barrier shall not be measured and shall be considered a traffic control device.

401.7 PAYMENT:

Section 401.7 is supplemented with the following:

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.

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.

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.

SECTION 415

FLEXIBLE METAL GUARDRAIL

Section 415 is replaced with the following:

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:
The rail elements, terminal sections, bolts, nuts and other fittings shall conform to the specifications of AASHTO M-180, except as modified in these specifications. The rail metal shall be open hearth, electric furnace, or basic oxygen steel and, in addition to conforming with AASHTO M-180, shall withstand a cold bend, without cracking of 180 degrees around a mandrel of a diameter equal to 2 ½ times the thickness of the plate.

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

All material shall be new.

Railing Parts furnished under these specifications shall be interchangeable with similar parts regardless of source. All surfaces of guardrail elements that are exposed to traffic shall present a uniform, pleasing appearance and shall be free of scars, stains or corrosion.

Nails shall be 16 penny common galvanized. Nails for retainer strap shall be 10 penny common, galvanized.

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

Unless otherwise specified the rail elements, terminal sections, bolts, nuts, and other fittings shall be galvanized in accordance with Section 771. Where galvanizing has been damaged, the coating shall be repaired in accordance with Section 771.

Prismatic guardrail reflector tabs shall have a minimum thickness of 4.8mm, and be either galvanized steel or ultraviolet-resistant plastic. Prismatic guardrail-mounted barrier markers shall have an ultraviolet-resistant reflective surface, be secured to the body in accordance with the manufacturer's recommendations, and have a trapezoidal-shaped body in accordance with MCDOT Standard Drawing 3002 or 3003, Reflector Tab Detail.

Timber for posts and blocks shall be rough sawn (unplanned) or S4S with the nominal dimensions indicated. Any species or group of woods graded in accordance with the requirements for Timber and Posts of the Western Wood Products Association may be used. Timber shall be No. 1 or better, and the stress grade shall be as follows:

152 by 203 mm Post and Block	8.3 MPa
203 by 203 mm Post and Block	6.2 MPa
254 by 254 mm Post and Block	6.2 MPa

When the plans show guardrail systems using 203-mm by 203-mm timber posts and blocks, the Contractor may use 210-mm nominal size posts and blocks with a stress grade of 5.7 MPa. Substitution of 203 by 203mm posts for 152 by 203mm post may be approved on a per project basis by the engineer.

At the time of installation, the dimensions of timber posts and blocks shall vary no more than plus or minus 13 mm from the nominal dimensions as specified on the project plans.

The size tolerance of rough sawn block in the direction of the bolt holes shall vary no more than plus or minus 10 mm. Only one type of post and block shall be used for any one continuous length of guardrail.

All timber shall have a preservative treatment as per the requirements of Section 779.

415.3 CONSTRUCTION REQUIREMENTS

415.3.0 GENERAL:

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.

Terminal sections shall be installed in accordance with the manufacturer's recommendations.

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.

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.

The bolted connection of the rail element to the post shall withstand a 22.2 kN 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.

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.

Where Wood posts with rectangular sections are used, the posts shall be set so that the longest dimension is perpendicular to the rail.

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.

Bolts extending more than 50 mm beyond the nut shall be cut off to less than 13 mm beyond the nut.

Unless otherwise shown on the plans, bolts shall be torqued as follows:

Diameter of Bolt	**Torque, Newton Meters**
M 16	61 - 68
M 20	95 - 102
M22 and larger	163 - 169

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.

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. At the end of each day, guardrail sections having an exposed end toward oncoming traffic, shall have a standard flared terminal section (MAG Standard Detail 135-3 Standard Flared Terminal Section) bolted securely in place.

415.3.1 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.

415.3.2 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 100 mm 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 Bolted Guardrail Anchors, (MCDOT Standard Detail No. 3010).

Wood blocks shall be toenailed 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 13 mm above or below the top of the post, unless otherwise shown on the project plans.

Rail elements shall be spliced at 7.6 meter 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 45 meters or less, the rail elements shall be shop curved.

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

415.3.3 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.

415.3.4 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.

415.3.5 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 meter 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 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 meter 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.

415.5 PAYMENT:
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.

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.

Payment for Additional Steel W-beam will be at the contract unit price bid.

Payment for guardrail transitions will be at the contract unit price bid.

Part 400 add the following new Section:

SECTION 416

GUARDRAIL END TREATMENTS

416.1 DESCRIPTION:
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.

This work shall also include all the work and materials to delineate guardrail end treatments, including all necessary components and markings, installed new.

416.2 MATERIALS:
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.

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-2000 as supplied by Trinity Industries, 2525 Stemmons Freeway, Dallas Texas, 75207.

416.3 CONSTRUCTION REQUIREMENTS:
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.

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.

416.3.1 GUARDRAIL EXTRUDER TERMINALS:
Guardrail Extruder Terminal shall be installed at the locations shown on the project plans as per the manufacturer's specifications.

Further information regarding assembly and installation of the ET-2000 Energy Absorbing Safety End Treatment may be obtained from Trinity Industries, Inc 1-888-818-7976. The manufacturer will provide in-field assistance for first time contractors for this item.

Damaged end treatments shall be repaired or replaced immediately.

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 75 mm in depth, and comply with Section 321. The approach surface slope shall not exceed 1:10.

416.3.2 DELINEATION:
The configuration of reflective sheeting object markers on the approach and departure sides of the ET-2000 shall conform to manufacturer's recommendations. At a minimum, delineation for the ET – 2000 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.

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 100 mm 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 100-mm above the ground as measured along a 1.52-meter cord.

416.4 METHOD OF MEASUREMENT:

416.4.1 GUARDRAIL EXTRUDER TERMINALS:
Measurement for furnishing materials and installing the ET-2000 terminal section will be per each, complete in place, including 7.6 meters or 15.2 meters 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 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-2000 terminal section will be per each, complete in place, including 15.2 meters 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.

SECTION 430

LANDSCAPING AND PLANTING

Section 430 add the following:

430.5.7 Water Truck Irrigation:

When trees, shrubs, and groundcover are planted, they shall immediately be started on an irrigation schedule. All trees, shrubs, and groundcover shall receive 13 mm of water weekly. The water is to broadcast evenly by an 8300 liter 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 122 meters away and a maximum of 610 meters 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.

430.5.8 Native Hydro seeding:

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.

430.5.8.1 Native Seed Mixture:

The following requirements shall apply:

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.

Application rates of seed as specified are for pure live seed (PLS).

Seed source from elevations below 915 meters.

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.

Weed content shall not exceed 0.5%.

Seed that has become wet, moldy, or otherwise contaminated or damaged is not acceptable.

430.5.8.2 Seeding Materials and Equipment:

The following requirements will apply:

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.

Binder: Free flowing, non-corrosive powder produced from natural plant gum.

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.

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.

Part 400 add the following new Section:

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 3.65 m 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 0.6 meters 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) Asphaltic Overlay: The asphaltic 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) Asphaltic Overlay: The asphaltic 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) Asphaltic Overlay: The asphaltic 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 meter 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 100-millimeter wide stripe will be made by the following method:

$$\frac{\text{Plan Width of Striping (millimeters)} \times \text{Meter}}{100 \text{ (millimeters)}}$$

Double marking lines, consisting of two 100 mm-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 100 millimeters 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 meter for the length of painted line applied to the nearest meter.

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 meter 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 crosslink 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 25 ± 1 °C, ASTM D 562	80 - 95	80 - 95
Density: g/mL at 25 ± 1 °C, ASTM D 1475, allowable variation from qualifying sample	± 0.036	± 0.036
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: grams per liter of paint, maximum, ASTM D 3960 according to 7.1.2.	250	250
Flash Point: °C, minimum, ASTM D 93, Method A	38	38
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 250-micrometer 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:

$$\text{Dry Opacity} = \frac{\text{Reflectance over black}}{\text{Reflectance over white}}$$

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 380-micrometer 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:

$$\text{Yellowness Index} = \frac{\text{Amber} - \text{Blue}}{\text{Green}} \text{ x } 100$$

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 380-micrometer 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 0.5 liters of paint in a sealed can and heat in an air circulation oven at 49 ± one degrees Celsius for a period of one week. Remove the paint from the oven and check the viscosity in Krebs Units at 25 ± one degrees Celsius 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, 0.5 liters of the paint is sheared in a Waring Blender at high speed to 66 °C. The blender should have a tight fitting lid taped onto it to minimize volatile loss. When the paint reaches 66 °C, 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 25 ± one degrees Celsius 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 75 to 100 micrometers. Allow the paint to cure for 24 hours. Perform the scrub resistance test at 25 ± one degrees Celsius and 50 ± 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 380-micrometer wet film thickness in the field. The paint shall show the following properties at ambient temperatures of 10 to 38 °C with a paint spray temperature of 66 °C, maximum, and 0.72 to 0.96 kilograms of post-applied glass beads per liter 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, 100 millimeters in width and approximately 3.6 meters long at a location approved by the Engineer.

Wet film thickness of the test stripes shall be approximately 380 micrometers 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 0.72 kilograms of beads per liter 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
600 μm	100
300 μm	15 - 35
212 μm	0 - 15
150 μm	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 265 by 445 millimeters 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 450 by 550 millimeters. 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 ± one degrees Celsius) and humidity (50 ± 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 ± 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 ± 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 three-meter painted segment and a 9-meter 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 10 °C when using water-borne paint, nor when it can be anticipated that the atmospheric temperature will drop below said 10°C 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 66°C 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 three meter 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 150 millimeters in a 12-meter cycle.

The finished line shall be smooth, aesthetically acceptable and free from undue waviness.

Painted lines shall be 100, 200, or 300 millimeters wide as shown on the plans with a tolerance of plus or minus three millimeters and shall be placed at a minimum rate of 38 liters per kilometer for a solid 100-millimeter line and 9.5 liters for a broken 100-millimeter line, based on a three-meter stripe and a nine-meter gap (12-meter cycle).

New pavement striping shall not vary more than 13 millimeters in 15 meter from the striping plans. Existing pavement markings requiring re-stripe shall be re-striped to completely cover existing markings within 6 millimeter and be within a longitudinal tolerance of 150 millimeter 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 0.7 kilograms to each liter of paint.
Wet thickness shall not be less than 380 micrometers.

461.4 Method of Measurement:

Pavement marking paint will be measured by the meter 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 100-millimeter wide stripe. Measurement for striping with a plan width greater or less than the basic 100 millimeters as shown on the plans or requested by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (millimeters)} \times \text{Meters}}{100 \text{ (millimeters)}}$$

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 meter for the total length of painted line applied to the nearest meter, 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.

Part 400 add the following new Section:

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 0.5 kilograms of glass beads per square meter of line (10 meters of 100-millimeter stripe).

(B) Filler: The filler shall be a white calcium carbonate or equivalent filler with a compressive strength of at least 34 megapascals.

(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 ± five minutes at 218 ± 2 °C and cooled to 25 ± 2 °C, 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 ± five minutes at 218 ± 2 °C, the bond strength to Portland cement concrete shall be not less than 1.2 megapascals. 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 ± five minutes at 218 ± 2 °C, applying to concrete blocks, and cooling to (-) 9 ± 2 °C, the material shall show no cracks when observed from a distance exceeding 300 millimeters. 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 ± five minutes at 218 ± 2 °C and forming test specimens, the impact resistance shall be not less than 1.13 joules when tested in accordance with Section 9 of AASHTO T 250.

(H) Softening Point:

After heating the thermoplastic material for four hours ± five minutes at 218 ± 2 °C and testing in accordance with ASTM D 36, the thermoplastic materials shall have a softening point of 102 ± 8 °C.

(I) Flowability:

After heating the thermoplastic material for four hours ± five minutes at 218 ± 2 °C, 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 218 ± 2 °C, 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 3.2 millimeters on a 100- by 100-millimeter square monel panel (thickness 1.27 ± 0.02 millimeters), on which a suitable primer has been previously applied, and subjecting it to 200 revolutions on a Taber Abraser at 25 °C, using H-22 calibrated wheels weighted to 250 grams. The wearing surface shall be kept wet with distilled water throughout the test.

The maximum loss of thermoplastic material shall be 0.5 grams.

(M) Flash Point:

The thermoplastic material shall have a flash point not less than 246 °C 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 204 °C 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 eight

kilometers 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 eight kilometers 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 three meter 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 50 mm 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 13 °C, 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 204 to 227 °C.

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 300 meter 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 204 and 227 degrees C, 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 232 degrees C. Material temperatures exceeding 227 degrees C 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 227 degrees C. 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 2.25 mm. 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 1.5 mm. 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 300 millimeters 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 25 millimeters in 30 meters. The longitudinal deviation of a painted segment and gap shall not vary more than 150 millimeters in a 12-meter 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
100 millimeters	100 to 115 millimeters

200 millimeters	200 to 225 millimeters
Over 200 millimeters	± 25 millimeters

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 (-) 23 to (+) 82 °C. 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 211 ± 7 °C and thickness of 1.5 to 4.7 millimeters, the material shall set to bear traffic in not more than two minutes when the air and road surface temperature is approximately 10 ± 2 °C, and not more than ten minutes when the air and road surface temperature is approximately 32 ± 2 °C. 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 meter along the center line of the pavement stripe and will be based on a 100-millimeter wide stripe. Measurement for striping with a plan width greater or less than the basic 100 millimeters as shown on the plans or requested by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (millimeters) x Meters}}{\text{100 millimeters}}$$

No measurement will be made of the number of meters of skips in the dashed line.

Double marking lines, consisting of two 100 mm-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 100 millimeters 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 meter 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 meter complete in place for the total length of painted lines applied to the nearest meter, including surface preparation. If the Engineer determines that additional striping beyond the project limits are 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 it's deviation from a flat surface shall not exceed 1.3 millimeters.

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 1500 square millimeters.

The strength by compressive loading shall be at least 9.0 kilonewtons 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-mcd/lux**		
	Clear	**Yellow**	**Red**
0 Degrees Incidence	280	165	70
20 Degrees Incidence	110	65	30

Permanent reflective pavement markers shall be subject to an abrasion resistance test as follows:

Steel Wool Abrasion Procedure: Form a 25-millimeter 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 222 Newtons 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 88 and 150 millimeters, except that the radius of the 13 millimeters 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, millimeters	0.127
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 Lummous Reflectance (Y valve), minimum	 75 - 96 579 - 585 0.41
Compressive Strength, kilonewtons, minimum	6.7
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 four degrees Celsius, 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 2.67 millimeters 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 4 millimeters ± 0.4 millimeters. 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 11 mm ± 0.5mm on 25.4 mm 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 3050 mm 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 45 kilograms per meter and shall meet the requirements of ASTM A 1 pertaining to quality assurance.

Yield Point of the steel shall be 550 megapascals 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 4.5 kilograms per lineal meter, plus or minus five percent. The post shall be punched with continuous 9.5-millimeter diameter holes on 25.4 millimeter centers. The first hole shall be 25.4 millimeters 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 150 millimeter increments up to 3.75 meters as required for the installation location. The base posts shall be at least 1.06 meters in length, pointed at one end, and have at least eighteen holes in the base post, starting 25.4 millimeters from the top and continuing at 25.4 millimeter 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 not exceed 1.6 millimeters in any 900 millimeter length.

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 0.9 meters.

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 meter, to the nearest 0.05 meters for each post furnished and installed. The total length of all posts of the same type will be rounded to the nearest half meter. 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 1219 millimeters.

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), 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.

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 5 square meters 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, 25-millimeter 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 15 meters 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 meter 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 0.01 square meter. 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 meters by the maximum width in meters, 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 0.1 square meter.

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 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.

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 Standard 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 Pretimed Controller Assembly:

A controller assembly for operating traffic signals in accordance with a predetermined fixed-time cycle.

470.2.16 Red 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 backplate 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 (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.

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 equipment does not meet the requirements of the specifications.

2) The material or equipment is not in the best interest of Maricopa County Department of Transportation and the public.

3) The material or equipment past field performance has been unsatisfactory.

4) 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 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 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:

Maricopa County Department of Transportation Warehouse
2222 South 27th Avenue
Phoenix, Arizona 85009-6357

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 the Contractor, shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor will 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 delivery 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 Details 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.

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 road*way* 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.

Part 400 add the following new Section:

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 90º 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 76 millimeters 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 Standard Details 4711 and 4712. Pull boxes and covers shall be concrete gray color and rated for no less than 3630 kg over a 254 mm x 254 mm area and be designed and tested to temperatures of -45.6 degrees Centigrade. Material compressive strength shall be no less than 75,840 kPa. 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) 9.5 mm corrosion resistant metallic hex bolts with corrosion resistant metallic washers. The bolts shall be in accordance with the requirements of Traffic Signal Standard Detail 4711.

The words “TRAFFIC SIGNAL” shall be cast in the pull box covers in 25 mm 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 1.5 millimeter 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 three millimeters 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 150 mm.

Conduit embedded in concrete structures shall be securely attached to the reinforcing steel at intervals of approximately 305 mm. 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 13 mm 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
50 mm	241 mm
76 mm	330 mm

Conduit entering pull boxes shall terminate a minimum of 76 mm inside the box wall. The conduit shall be between 50 mm and 100 mm 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 100 mm 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 6 mm nylon rope or a No. 8 AWG bare copper wire installed as called for on the bidding schedule which extends 0.6 m 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 150 mm to 200 mm 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 .6 m 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 Details 4758 and 4759. Loop detection conduit stub-outs shall not be installed until completion of curb and gutter work. A 76 mm “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 610 mm 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 915 mm below final grade. When conduit cannot be installed at the minimum depth, it shall be completely encased in 76 mm 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 406 mm. 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 406 mm. 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 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 meter 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 meter, 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.

Part 400 add the following new Section:

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 Standard Details, 4720 and 4721.

The cabinet and service pedestal foundations shall conform to the requirements of Traffic Signal Standard 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 MAG Section 725.

472.2.3 ANCHOR BOLTS: All anchor bolts shall be in accordance with Traffic Signal Standard 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 Standard 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 Standard 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.

Signal and lighting pole foundations shall be set flush with the existing or new curb and sidewalk or flush with the finished grade where there is no curb or sidewalk, except in sloped areas 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 508 mm 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 7.6 meter coil of No. 4 AWG bare copper conductor shall be installed in accordance with Traffic Signal Standard Details. Anchor bolts, conduit and rebar cage shall be centered within the foundation, set at the specified height and plumb within ±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 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 Standard 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 Standard Details 4757, 4758, 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	LIMITS	TEST METHOD
Cone Penetration, TIF150g, 5 sec; 1/10 mm	35 max	ASTM,D3407, Sec. 5
Flow, 140F, SM; mm	5 max	ASTM, D3407, Sec. 6
Resilience, TIF	30% min	ASTM, D3407, Sec. 8
Softening Point	82.2°C min	ASTM, D2398
Ductility, TIF 5cm/min	30cm min	ASTM, D113
Mandril Bend	Pass	SEE NOTE BELOW
Pour Temperature	193°C	
Safe Heating Temperature	210°C	

NOTE: A sample of sealant is poured in a 3 mm thick by 25 mm wide and 102 mm long configuration on a glycerin coated brass plate using appropriate molds. The specimen is removed from the molds, placed in a freezer maintained at -18° ±2°C for one (1) hour. To test, remove the specimen from the freezer and immediately bend

over a 25 mm 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 º 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 75º ± 5º F and 50º ± 10º F relative humidity. Condition the mandril and specimens for 2 hours at 75º ± 2º 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 Standard 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 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 Standard 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 0.3 m 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 3 mm 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 193 degrees Centigrade 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 cable 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	LOOPS PER CHANNEL	LOOP CONNECTION	LOOP USE
1.8 m x 1.8 m	152 m or less	2-3	Series	Advance detection
1.8 m x 1.8 m	152 m or greater	1	N/A	Advance detection
1.8 m x 12 m	61 m or less	2-3	Series	Call detection
1.8 m x 12 m	61 m or greater	1-2	Series	Call detection
1.8 m x 15 m	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.

SECTION 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 Details and the requirements of this specification.

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 130 km/h 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 330MPa. A tapered rate of 11.7 mm change in diameter per meter 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 millimeters as indicated on the Standard Drawings. 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 25 millimeters 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 Drawings. 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 millimeters of material thickness.

(B) Standard Bases: Poles shall have standard bases fabricated from structural steel plates, as per the Traffic Signal Standard 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 3mm 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 330 MPa after fabrication. Mast arms shall be fabricated according to the thickness requirements shown on the Traffic Signal Standard Details. A tapered rate of 11.7 mm change in diameter per meter 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 Department.

Mast arms shall be bent to the dimensions and curvature shown on the Traffic Signal Standard Details.

A metal tag shall be permanently attached on the side of the mast arm near the base stating the manufacturers name, pole type per the Department's plan, mast arm or pole drawing number, length and millimeters of 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 Standard Details. A tapered rate of 11.7 mm in diameter per meter 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 Standard 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 millimeters.

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 Standard 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 furnished, Including signal and luminaire mast arms, base plates and all materials required, 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 Standard 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 Standard Details 4731 and 4798.
Electrical service equipment wiring and wiring devices shall be in conformance with NEMA, the NEC, Traffic Signal Standard 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.

475.3 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 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

After the installation and leveling of a 'P' cabinet an approved non-shrink type grout shall be placed between the cabinet and foundation.

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.

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.

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 Standard 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 305 mm lens size signal sections with the number of sections or combination of sections specified on the Traffic Signal Plan, Traffic Signal Standard 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 (I.T.E. Publication No. ST-008B), the Traffic Signal Plan and the provisions of these specifications.

(A) HOUSING: A standard 305 mm 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 38 mm 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 305 mm 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 305 mm signal sections shall be furnished with 310 mm to 310 mm 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 127 mm border backplates shall be provided for the 305 mm 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 Standard Detail 4778-2 shall be installed with all mast arm mounted 305 mm signal heads, as shown on the Traffic Signal Plan. The plumbizer elongated bolt hole shall be positioned to align with the bolt hole drilled 60 mm from the end of the tenon on the mast arm. The plumbizer shall be held in place with a 10 mm bolt with a nut and two (2) washers as per the Traffic Signal Standard Detail 4778-2. The plumbizer signal head mounting position shall be in accordance with the requirements of Traffic Signal Standard Detail 4778-1.

Pole top and sidemount mounting assemblies shall consist of 48.3 mm outside diameter (38mm 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 0.75 mm 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 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 contaminates 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 position 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 contaminates 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

Indication	Bulb Type	Lens Color	Initial Lumens	User Hours	Voltage Rating	Rated Wattage	Light Center Length
305 mm	AT21	Yellow	1750	6000	120	135	76 mm

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 129 km/h.

Signal lens shall be convex to minimize sunlight reflectance.

(D) Optical and Light Output Requirements:

The LED shall be manufactured using AlInGaP Technology or other LEDs with low susceptibility to temperature degradation (AlGaS LEDs will not be allowed).

The LED signal lamps will be provided in two colors: red, and green.

Each LED traffic signal lamp shall meet the minimum laboratory light intensity values, color (chromatically), and light output distribution as described in I.T.E. Standards as shown in Section 11.04, Table I 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, 1m 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.

476.2.5 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 279 mm high and 178 mm 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 457 mm wide, 406 mm high, and 229 mm deep. The top and bottom of the housing shall have openings to accommodate standard 38 mm 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 400 mm.

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.

476.2.6 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 assembles, 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 50 mm nominal mast arm tenion 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 contaminates 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 -29 degrees Centigrade 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:

Wattage	Lamp Voltage	Minimum Initial Lumens	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 -54 to +70 degrees Centigrade and 100 percent relative humidity. The PEC shall be a conventional glass-faced hermetically sealed 13 mm 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 Standard 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 Standard 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 of 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 manufacturers 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 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 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 60 degrees centigrade 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 cabinets and in pull boxes.

When IMSA cable is specified, wire insulation color assignment shall be in accordance with Traffic Signal Standard 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 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 900 millimeters of slack from the conduit end bell in the pull box.

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.

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 16 mm in diameter and 3 meters length. The rod shall be driven vertically into the ground to a minimum 2.7 meters 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 7.7 meters 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 900 millimeters. 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 4.5 meters 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

Part 400 add the following new Section:

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 130 km/h (80 mph) winds with a 30% gust factor, and withstand the effects of sand, dust, and hose-directed water per the hosedown 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 does not meet the requirements of the specifications.

2) The material or equipment is not in the best interest of Maricopa County Department of Transportation and the public.

1) The material or equipment past field performance has been deemed unsatisfactory.

4) 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:

Maricopa County Department of Transportation Warehouse
2222 South 27th Avenue
Phoenix, Arizona 85009-6357

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 is 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 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 reinitialization 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 in 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:

- A complete list of all equipment (by serial number) that have warranties extending beyond the one year warranty period, including spare equipment. Utilize Figure 480.1 or similar approved form; and
- All warranty paperwork extending beyond the one-year period, transferring ownership of the warranties to MCDOT.

Prior to final acceptance, furnish an inventory of spare parts.

Figure 480.1 –Equipment Warranties

Project Name
Equipment Warranties

Submitted by: _____

_____

Date:_____

Project No.:_____

Federal Project No.:_____

Spec Ref. No.	Description	Warranty Duration	Expiration Date	Date of Transfer	Other Information

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
50 mm (2”)	610 mm (24”)
62 mm (2½”)	760 mm (30”)
75 mm (3”)	910 mm (36”)
100 mm (4”)	1220 mm (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 1.2 m (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 1.8 mm (0.7”), with an integral coupling of 125 mm (5”) minimum length.

- PVC outerducts shall be Schedule 40 with an integral coupling of 125 mm (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 30 mm (1.2”). HDPE innerducts shall have a minimum wall thickness of 2.4 mm (0.1”). PVC innerducts shall have a minimum wall thickness of 1.6 mm (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 1.5 meters (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 138 kPa (20 psi).

481.2.2(B) MULTIDUCT WITH NO OUTERDUCT: Multiduct with no outerduct shall consist of multiple PVC or metal conduits locked together in formation using spacers no more than 1.5 meters (5’) apart.

PVC and metal conduit that comprise the multiduct shall be Schedule 40.

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 138 kPa (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 25 mm (1") letters.

Pull boxes and covers shall sustain a minimum vertical test load of 53,370 N, (12,000 lbs) applied over a 250 mm (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 75 mm (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 1.2 meter (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 knockouts.

Conduit spacers shall be used to arrange multiple conduits in the trench to provide a minimum of 12 mm (½") between conduits. The conduit spacers shall be used at intervals not exceeding 1.5 meters (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 in each conduit.

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 1m (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 150 mm (6") for one 100 mm (4") conduit, and 250 mm (10") for two 100 mm (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 30 m (100') in length, and at both ends if the steel sleeve is 30 m (100') or greater in length. The expansion fittings shall be installed a minimum of 0.9 m (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 1.0 Mpa (150 psi) concrete shall be installed in the bottom 0.6 m (24”) of the trench. The CLSM depth will vary at pull boxes to remain 150 mm (6”) 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	565 mm (22”)	860 mm (34”)	610 (24”)
More than 36*	710 mm (28”)	1115 mm (40”)	610 (24”)

* Covers 1115 mm (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°, 610 mm (2’) radius conduit bend or innerduct wrapped around and secured to a rigid form. Thread an appropriate length of 6.35 mm (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 30 m (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 23°C ± 2° (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 138 kPa (20 psi) or a water column of 3.65 meters (12'). The enclosure shall be sufficiently filled with water to completely cover the conduit joint within. A regulated air pressure of 138 kPa (20 psi) or a water column of 3.65 meters (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 690 kPa (480 psi). The coupling assembly shall not allow more than a 20 percent air pressure drop in 2 minutes from the initial pressure of 690 kPa (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:

Spare Parts Required	Quantity
Conduit and Innerduct Plugs	1 for every 10 pull box or cabinet entries*
Fiber Optic Pull Box Covers	1 for every 10 pull boxes**

* 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 TRAINING: When required, meet the training requirements of Section 480.6.

481.9 METHOD OF MEASUREMENT: Fiber optic conduit and multiduct will be measured by the meter for each type and size.

Testing, warranty, documentation, training and spare parts are considered incidental to the item requiring the work.

481.10 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, pigtails, 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.

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 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 2700 N (600 lbf) 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 890 N (200 lbf) 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 3 mm (0.12”) (approximate) PVC sheathing;
- Minimum bend radius of 320 mm (12”) following installation, 640 mm (25”) during installation;
- Minimum tensile strength of 444 N (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 3 mm (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 112 N (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 5 m (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 38 mm (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 300 mm (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 15 m (50 ft) of slack fiber optic cable per cable entry and stow it per the Plans. At each field cabinet, provide a minimum of 5 m (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 5 m (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 for each splice. Splices found to exceed 0.1 dB attenuation 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 (Siecor 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 string 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 3 mm (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:

Spare Parts Required	Quantity
Fiber optic jumper cables	1 for every 10
Fiber optic pigtails	1 for every 10
Fiber optic ST connectors	1 for every 10
Fiber optic SC connectors	1 for every 25
Fiber optic patch panels	1 for every 10
Fiber optic splice trays	1 for every 10
Underground splice closure	1 for every 10
Fiber optic fan-out kit	1 for every 10

482.7 DOCUMENTATION: Provide maintenance manuals for fiber optic cable and equipment per the requirements of Section 480.5.

482.8 TRAINING: When required, meet the training requirements of Section 480.6.

482.9 METHOD OF MEASUREMENT: Fiber optic cable will be measured by the meter 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.

Testing, warranty, documentation, training and spare parts are considered incidental to the item requiring the work.

482.10 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.

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, 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 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 certify all functional requirements listed herein for camera, lens, pan/tilt unit, camera control receiver, software, and communication protocols are met.

The total weight of pole mounted CCTV equipment shall not exceed 20 kg (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	DSP, color, solid state
Image Sensor	¼" or 1/3” interline charged coupled device (ICCD)
Lens mount	C-type lens mount or integrated camera/lens combination
Video output	NTSC composite video signal with 1.0 V peak-to-peak at 75 ohms
Resolution	460 horizontal, 350 vertical TV lines (minimum)
Effective pixels	768 horizontal, 494 vertical TV lines (minimum)
Signal to noise ratio	No less than 50 dB unweighted measured at the VOTR interface
White or color balance	Automatic or set to yield optimal results under various outdoor lighting conditions.
Shutter speed	1/60 per second to 1/10,000 per second.

Function/Feature	Requirement
Cable length supported between camera and cabinet mounted CCTV equipment	80 m (260') minimum
Digital zoom	4X minimum
Lens	Motorized zoom lens
Horizontal angle of view – Optical Zoom Only	≤ to 2.5° telephoto ≥ 45° wide angle
Zoom speed	Min to max focal length in <4 seconds
Focus	Automatic and manual adjustment
Iris	Automatic and manual adjustment in steps
Gain	Automatic gain control (AGC)
Sensitivity	Scene illuminated at 10 lux shall yield at least at least 80% video signal, with AGC and automatic iris on. Scene illuminated at 2 lux shall yield at least 30% video signal with AGC and automatic iris on.
Presets	24

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 speed (loaded)	7° pan/second and 3° tilt/second.
Presets	24

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)	18 kg (40 lbs)
Allowable load (stepper motor)	9 kg (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 132 mm (5.2”) outside diameter, or hemispherical dome no larger than 380 mm (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): CCR's may either be mounted in a cabinet or integrated with the pan/tilt and mounted within the environmental enclosure. CCR's mounted in a cabinet shall be designed to be rack mounted in two door cabinets, and shelf mounted in one door cabinets. Shelf mount CCR's shall have all connections, controls, and displays facing the front of the cabinet.

CCR's 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 0.9 m (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 13 mm (½”) woven copper ground wire.

483.2.9 CABLES: Use power and control cables that meet IMSA 20-1 specification requirements (latest revision).

Use coaxial cable that supports NTSC color video requirements and meet stranded 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: 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 10-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:

Spare Parts Required	Quantity
Camera and lens	1 for every 10
Pan/Tilt unit	1 for every 10
Environmental enclosure	1 for every 10
Mounting plate	1 for every 10
Camera control receiver	1 for every 10
Coaxial cable surge protector	1 for every 10
Power cable surge protector	1 for every 10
Low voltage control surge protector	1 for every 10
Coaxial cable [30 m (480') length, terminated w/BNCs]	1 for every 10 locations
Power and control cable [30 m (480') length with connectors]	1 for every 10 locations

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 TRAINING: When required, meet the training requirements of Section 480.6.

483.9 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, training and spare parts are considered incidental to the item requiring the work.

483.10 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.

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 3.2 mm (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 +57°C (135°F) or 19°C (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 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 AlInGap Technology or other LEDs with low susceptibility to temperature degradation (AlGaS LEDs will not be allowed). The display shall support letter heights of 270 mm (10.5”) to 800 mm (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 185 m (600') and at a distance of 600 times the character height by persons with 20/20 vision, an eye height of 1.07 m (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:

[Candela (on) - Candela (off)]/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 25 mm (1"). Square pixels shall have a nominal height and width of approximately 25 mm (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 0.9 m (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 150 mm (6”) of a handhole.

Ground the DMS case and contents to the DMS support structure 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 +21°C (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 27°C (80°F).

NTCIP compliance shall be certified using the NTCIP exerciser available from the FHA 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 300 mm (12”) upper case letters shall be read at a distance of 185 m (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:

Spare Parts Required	Quantity
Display module	1 for every 10 DMS
Driver	1 for each DMS
Power supply	1 for each DMS
Photoelectric sensor	1 for every 10 DMS
SCU	1 for every 10 DMS
Full set of replacement cables	1 for every 20 DMS
Cabinet keypad	1 for every 10 DMS
Replacement filters (set)	1 for every DMS

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 TRAINING: When required, meet the training requirements of Section 480.6.

484.9 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, training and spare parts are considered incidental to the item requiring the work.

484.10 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.

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 ±5% of actual speed, volume, and occupancy under the following conditions:

- Average traffic flow between 10 km/h and 120 km/h (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 0.80 km (0.5 mile);
- During rainfall up to 5 mm/hr (0.2”);
- When experiencing as much as 75 mm (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 200 m (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°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 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 0.9 m (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 30 to 130 km/h (20 mph to 80 mph), or the posted speed limit, whichever is less, at approximately 8 km/h (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:

Spare Parts Required	Quantity
Video detector	1 for every 10
Image processor	1 for every 10
Cables	1 for every 20 locations
Power surge protector	1 for every 10
Data surge protector	1 for every 10
Video surge protector	1 for every 10

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 TRAINING: When required, meet the training requirements of Section 480.6.

485.9 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, training and spare parts are considered incidental to the item requiring the work.

485.10 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.

Part 500 add the following new Section:

SECTION 502

DRILLED SHAFT FOUNDATIONS

502.1 Description:

502.1.1 General: The work under this Section shall include furnishing all materials and constructing reinforced concrete shafts formed within a drilled excavation. Each Drilled Shaft Foundation shall consist of a shaft section with or without casing left in place, as specified or requested, with or without a rock socket or bell footing. Each Drilled Shaft Foundation shall be constructed to conform with the details and dimensions shown on the Project Plans, and the requirements of these Specifications and the Special Provisions.

502.1.2 Installation Plan: The Contractor shall submit to the Engineer, for review and approval, a detailed Installation Plan. The Installation Plan shall be based on available geotechnical information. To assist in plan evaluation and upon request by the Engineer, the Contractor shall provide copies to the Engineer of the geotechnical information used to develop the Installation Plan. The Installation Plan shall contain the following information:

(1) Equipment: List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, sampling equipment, tremies or concrete pumps, casing, and any other equipment essential to the successful installation of the proposed Drilled Shaft Foundations. Information provided on each proposed equipment unit shall be sufficient to identify the unit in the current edition of the Rental Rate Blue Book.

(2) Personnel: List of all personnel to be committed to the installation of the Drilled Shaft Foundations on the project, and a summary of the relevant experience of each individual, including their involvement in the projects listed under (11).

The On-Site Supervisor in charge of the installation of the Drilled Shaft Foundations shall have not less than five (5) years of comparable in-charge experience with drilled shaft installations similar in nature and magnitude to the foundation requirements for the specified project. The On-Site Supervisor shall be on or immediately available to the project during all foundation construction activities.

At least one (1) Drill Operator, having not less than five (5) years of experience on the equipment that the Contractor proposes to use, working on drilled shaft foundation installations similar to those for the specified project, shall be on or available to the project during all foundation construction activities.

(3) Construction Sequence: Details of the overall construction operation sequence, and the sequence of shaft installation in bents or groups. Supporting justification shall be provided for all variations between the Contractor's proposed sequence of shaft installation, and shaft sequence requirements called out on the Project Plans.

(4) Shaft Excavation: Details of shaft excavation methods, including equipment and procedures for checking the location, alignment, and dimensions of each shaft excavation.

(5) Slurry: When slurry is required, details of the method proposed to mix, circulate and desand the slurry, and methods proposed to comply with the requirements of Sections 502-3.4(A) and 502-3.7(C), including disposal of the slurry.

(6) Excavation Cleaning: Details of methods to clean the shaft excavation.

(7) Steel Reinforcement: Details of reinforcement placement, including support and centering methods.

(8) Concrete Mixes: Details of concrete mix designs, and the mitigation of possible loss of slump during placement.

(9) Concrete Placement: Details of concrete placement.

(10) Casing: Details of casing dimensions, material, and splice details.

(11) Construction Experience: List of all drilled shaft construction experience by the Contractor on previous projects of a similar nature, from the present and covering the past 3 to 5 years, highlighting major features of the drilled shaft operations and installations, describing any complexities and/or problems, and their subsequent resolution.

(12) Additional Information: Other information shown on the plans or requested by the Engineer.

(13) Emergency Shaft Joints: Emergency horizontal construction joint method if unforeseen stoppage of work occurs.

(14) Safety Plan: List of safety equipment, and the Contractor's Safety Plan for the drilled shaft construction.

The detailed Installation Plan for the Drilled Shaft Foundations, complete with all required information relevant to the project, and any supplemental information the Contractor believes relevant, shall be submitted to the Engineer not less than four (4) weeks before the work on the drilled shafts is to begin. The Engineer will review the submittal package and return comments to the Contractor within ten (10) working days. No drilled shaft work shall be performed until the Contractor's final submittal has been approved by the Engineer. Such approval will not relieve the Contractor of responsibility for results obtained by use of the Installation Plan, or any other responsibilities under the Project Contract.

Based on the Contractor's experience, the project Contract Documents, and the Geotechnical and Foundation Report, including the Foundation Boring logs, if the Contractor reasonably concludes that slurry will not be required for shaft installation, information required under (5) Slurry may be omitted from the Installation Plan, subject to the approval of the Engineer. If it is subsequently determined that slurry will be required for shaft installation, the approval of the omission by the Engineer in no way relieves the Contractor of responsibility for constructing acceptable Drilled Shaft Foundations, in accordance with the requirements of Section 502.3.1(A).

The Contractor shall submit shop drawings in accordance with Section 105.2 for drilled shaft reinforcing steel, casings, and all other drilled shaft elements to remain in place and requiring prefabrication.

502.2 Materials

502.2.1 Concrete: Concrete shall conform to the requirements of Section 725 for the class and strength shown on the plans, with the following additions or modifications:

(A) Cement: Concrete placed in drilled shaft excavations containing slurry or water shall have a cement content between 390 and 450 kg/cubic meter.

(B) Aggregate: Maximum aggregate size shall be limited to 1/5 of minimum clear bar spacing (vertical and horizontal), not to exceed one inch (25mm).

502.2.2 Reinforcing Steel: Reinforcing steel shall conform to the requirements of Section 727. Welded splices will not be allowed, except as shown on the Project Plans.

502.2.3 Casing: The casing shall be steel, and may be of unit or sectional construction. The casing shall be of sufficient strength to withstand handling and driving stresses, to withstand the pressure of concrete and the surrounding earth, and to prevent seepage of water. Steel shall conform to the requirements of AASHTO M 270M/M 270 (ASTM A 709/A 709M), Grade 36 (Metric Grade 250), unless otherwise specified in the Special Provisions.

When telescoped casing is used, the Contractor shall not allow concrete to overfill any interior casing. Spillage shall be removed from the annulus, or the shaft shall be declared deficient.

Temporary casing shall be clean, inside and out, prior to placement in the excavation. All casing shall be handled so as to limit distortion to plus or minus two percent (2%) of the diameter. No side shear capacity will be allowed where an installed temporary casing becomes permanent. If conditions permit, and if approved by the Engineer, temporary casings may be corrugated and non-watertight.

The Contractor shall be responsible to compensate for loss of frictional capacity in the cased zone if temporary casing is abandoned in the shaft. Such modifications shall be at no additional cost to the County.

502.3 Construction Requirements:

502.3.1 General: The methods and equipment used shall be suitable for the intended purpose and materials encountered. Either the dry method, wet method, temporary casing method or permanent casing method, as defined by the current AASHTO Standard Specifications for Highway Bridges, Division II, Section 5, shall be used as necessary to produce sound, durable concrete foundation shafts free of defects, subject to approval of the Engineer. The permanent casing method shall be used only when required by the Project Plans and Special Provisions, or authorized by the Engineer.

(A) Installation Changes: If at any time during the construction of the drilled shafts, the Engineer determines that the equipment, materials, personnel, or procedures are such that defects in the work may occur, the Engineer may stop the work until appropriate changes are made by the Contractor. The Contractor shall also revise the Installation Plan, as approved by the Engineer. In no case shall the Contractor be relieved of responsibility for constructing acceptable Drilled Shaft Foundations.

(B) Adjacent Drilled Shafts: The successive installation of Adjacent Drilled Shafts shall not be allowed, to minimize any potential disturbance to newly cast drilled shafts. An Adjacent Drilled Shaft is defined as being any drilled shaft to be located within four (4) diameters of an installed shaft, measured center to center of shafts. Drilling for an Adjacent Drilled Shaft shall not be started within 48 hours of the completion of casting concrete for the installed drilled shaft, unless otherwise approved by the Engineer. The Contractor's sequence of shaft installation, detailed as required in Section 502.1.2(3), shall also conform to shaft sequence requirements called out on the Project Plans, unless otherwise approved by the Engineer in the Contractor's Installation Plan.

502.3.2 Confirmation Shafts: When called out on the Project Plans, or when required in the Contract Special Provisions, the Contractor shall construct a Confirmation Shaft. The Confirmation Shaft is constructed to determine the adequacy of the Contractor's equipment, materials, personnel, and procedures for completion of the Drilled Shaft Foundations, in accordance with the requirements of the Project Plans, these Specifications and the project Special Provisions, and the Installation Plan. The Confirmation Shaft normally will be the first production Drilled Shaft Foundation developed, subject to the approval of the Engineer.

The location of all Confirmation Shafts shall be as shown on the Project Plans, or as approved by the Engineer. All Confirmation Shaft holes and shaft installations shall be completed in the same manner as proposed for other similar production shafts. The Contractor shall revise drilled shaft installation methods and equipment, at any time during the installation of each Confirmation Shaft, as required. Such revisions may be made during the drilling of the Confirmation Shaft hole, and/or the placement of shaft reinforcement and concrete. Such revisions shall result in satisfactory installation of the Confirmation Shaft, COMPLETE IN PLACE, as approved by the Engineer.

When the Contractor fails to satisfactorily demonstrate the adequacy of his installation methods, procedures, or equipment; or when unforeseen conditions require revision, such as the need for slurry, the Installation Plan shall be revised. The next shaft to be constructed in accordance with the Contractor's approved installation sequence shall be designated as the Confirmation Shaft for the approved, revised Installation Plan, or the Confirmation Shaft shall be installed at a location approved by the Engineer.

When shown on the Project Plans, or when ordered by the Engineer in writing, the reaming of shaft bell footings or the development of shaft rock sockets at the specified Confirmation Shaft holes shall be required to establish installation feasibility in specific soil strata.

502.3.3 Excavation: The Contractor shall perform all excavation required for the shafts, rock sockets, and/or bell footings, through whatever materials encountered, to the dimensions and elevations shown on the Project Plans, or as approved by the Engineer. Unless otherwise shown on the Project Plans, the maximum deviation from plumb shall be not more than one and one-half percent (1 1/2%). The maximum permissible

variation of the longitudinal center axis of both the shaft hole and reinforcing steel cage, from the Project Plan location at the top of the Drilled Shaft Foundation, shall be five percent (5%) of the Project Plan shaft diameter, not to exceed 3 inches (76mm). The Contractor shall determine shaft hole verticality by plumb lines in dry excavations, and by Kelly bar position readings at 10' (3.0m) intervals in wet excavations, or as approved by the Engineer. The Contractor shall provide the Engineer with these readings for each drilled shaft constructed, to verify verticality. When bell footings or rock sockets are required, they shall be excavated so as to form a bearing area of the size and shape shown on the Project Plans.

Temporary surface casings may be used to aid shaft location and alignment, and to prevent sloughing of the top of the shaft excavation, if approved by the Engineer.

If satisfactory foundation materials are not encountered when a shaft excavation has been advanced to the Bottom of Shaft Elevation shown on the Project Plans, the bottom of the drilled hole may be lowered, at the direction of the Engineer. Any lowering of the Bottom of Shaft Elevation will be based on the completed Drilled Shaft Foundation complying with foundation design requirements. Reinforcing steel and shaft concrete shall not be placed in the shaft excavation until the revised, final Bottom of Shaft Elevation has been established, and the shaft excavation completed. Similarly, the raising of any Bottom of Shaft Elevation, from the elevation shown on the Project Plans, shall require approval by the Engineer.

When a Drilled Shaft Foundation includes a Rock Socket, the actual Bottom of Shaft Elevation in the field will be established by the shaft excavation encountering competent bedrock stratum, as determined by the Engineer or a geotechnical specialist. The required Rock Socket length will be verified by the Engineer, based on foundation design requirements. Reinforcing steel and shaft concrete shall not be placed until the Rock Socket length has been verified, and the drilled/cored socket completed.

If caving conditions are encountered, no further drilling will be allowed until a method of construction is employed that prevents excessive caving, and which is acceptable to the Engineer. If casing is proposed, the shell shall be clean and shall extend to the top of the drilled shaft excavation. The inside diameter of the casing shall be not less than the dimensioned size of the shaft on the Project Plans, unless approved by the Engineer. The outside diameter of the shaft shall not exceed the Project Plan dimension by more than 6 inches (150mm), unless the use of telescoping casing or surface casing is allowed by the installation plan.

If the Engineer determines that the amount of excavation caving is within acceptable limits and the Contractor elects to drill under the same methods and procedures, the shaft excavation shall be filled with concrete at no additional cost to the County, regardless of the extent. Any excavation beyond the dimensions shown on the plans where casings are not used shall be filled with concrete at no additional cost to the County.

If the use of drilling slurry is to be employed, either with or without the use of casing, the Contractor shall use a method of construction that allows completion of the drilled shaft in a continuous manner without any mixing between the shaft concrete and the drilling slurry.

Material excavated from drilled shafts, bell footings, and rock sockets, that is not placed elsewhere on the project, shall be disposed of as approved by the Engineer.

When the Project Plans indicate that Drilled Shaft Foundations are to be constructed within embankments, the embankments shall be constructed prior to drilling, except when approved otherwise by the Engineer.

After the completion of the drilled shaft excavation, and prior to the placement of the reinforcing steel cage and shaft concrete, all loose material shall be machine cleaned from the shaft. A flight auger or other equipment, approved by the Engineer, shall be used for cleaning dry excavations where slurry or ground water is not present. Where slurry or ground water is present, the excavation shall be cleaned with a clean-out bucket or similar type of equipment, as approved by the Engineer.

Each open shaft excavation shall be covered in a manner approved by the Engineer, at all times when there is no hole excavation activity and/or shaft construction activity at that hole.

Drilled shaft excavation inspections shall be performed by the Contractor and will be reviewed by the Engineer. The Contractor shall provide suitable facilities, equipment, and associated safety measures for required excavation inspections that enable the Engineer to safely and completely evaluate drilled shaft excavations for correct location, alignment, and dimensions.

Reinforcing steel cages and shaft concrete shall not be placed in the drilled shaft excavation until the Engineer has made an evaluation and given approval.

502.3.4 Drilling Slurry:

(A) General Requirements: The Contractor shall provide a specialist experienced in the slurry drilling process to design and monitor the slurry. The specialist shall be present at all times when the slurry method is used, and shall supervise the slurry inspection and testing required in Section 502-3.4(B). Only commercially prepared mineral slurries shall be employed when slurry is used in the drilling process. The slurry shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. During construction, the level of the mineral slurry in the shaft excavation shall be maintained at a level not less than 4 feet (1.2m) above the highest expected piezometric pressure head along the depth of the shaft. In the event

of a sudden significant loss of slurry to the hole, the construction of that foundation shall be stopped, until either a method to stop slurry loss or an alternative construction procedure has been approved by the Engineer.

The mineral slurry shall be premixed thoroughly with clean, fresh water. Adequate time, as prescribed by the mineral manufacturer, shall be allotted for hydration prior to the introduction of the mineral slurry into the shaft excavation. Slurry tanks of adequate capacity shall be required for slurry circulation, storage, and treatment. No excavated slurry pits shall be allowed in lieu of slurry tanks. No mixing of slurry shall be allowed in the drilled shaft excavation. Slurry shall not stand for more than four hours in the shaft excavation without agitation. If this is not possible, excavation sidewalls shall be cleaned to remove filter cake, and the slurry tested for compliance with Table 502-3.4(A). Slurry density shall be increased by adding barite only when sodium bentonite is the slurry mineral.

Desanding equipment shall be provided by the Contractor as necessary to control slurry sand content within the acceptable values shown in Table 502-3.4(A) at any point in the bore hole. Desanding will not be required for setting casing. The Contractor shall take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include agitation, circulation and/or adjusting the properties of the slurry. The Contractor shall dispose of all slurry off site at an approved disposal site.

TABLE 502-3.4(A):

TABLE 502-3.4(A)
(Sodium Bentonite or Attapulgite in Fresh Water)

Property, units	Range of Values*		Test Method
	At Time of Introduction of Slurry	In Hole at Time of Concreting	
Density, (kg/m^3)	1030 – 1107	1030 – 1200**	Density Balance
Yield Point, pascals	Bentonite 1.25 - 10	10 Maximum	Rheometer
	Attapulgite 2 –15	15 Maximum	Rheometer
Or			
Viscosity, seconds/liters	30 – 48	30 – 48	Marsh Cone
pH	8 – 11	8 – 11	pH Paper or pH Meter
Sand Content, % by volume	0 – 4	0 - 10	API Sand Content Kit

* Above 20 degrees Celsius
** 1360 kilograms per cubic meter maximum when using Barite.

(B) Slurry Inspection and Testing: The Contractor shall have suitable inspection and testing apparatus available at the site, including a sampling tool capable of extracting slurry samples at any depth within the drilled shaft excavations. All equipment required for tests specified in this Section shall be provided by the Contractor, and the tests shall be performed by the Contractor, under the observation of the Engineer.

Control tests using suitable apparatus shall be carried out by the Contractor on the mineral slurry to determine density, viscosity or yield point, pH, and sand content. A range of values for those physical properties is shown in Table 502-3.4(A); but in all cases, no less than the minimum values necessary to achieve and maintain stability of the drilled shaft excavation shall be utilized.

The Contractor shall do tests during the shaft excavation, in the presence of the Engineer, to determine slurry density, viscosity or yield point, and pH value, to establish a consistent working pattern. A minimum of four sets of tests shall be made during the first eight hours of slurry use. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use.

The Contractor shall ensure that heavily contaminated slurry suspension, which could impair the free flow of shaft concrete, has not accumulated in the bottom of the completed shaft excavation. Prior to placing concrete in the completed shaft excavation, the Contractor shall take slurry samples in the shaft excavation, from the base of the shaft excavation, and 10' (3.0m) above the base of the excavation. When any slurry samples are found to be unacceptable, the Contractor shall take whatever action is necessary to bring the mineral slurry within specification requirements. Shaft concrete shall not be placed until resampling and testing results produce acceptable values for density, viscosity or yield point, pH, and sand content.

Reports of all tests required above, signed by an authorized representative of the Contractor, shall be furnished to the Engineer on completion of each drilled shaft.

502.3.5 – Integrity Testing:

All drilled shaft foundations shall be constructed to allow integrity testing by a gamma-gamma logging device and by cross-hole sonic logging survey. Unless otherwise noted, the Contractor shall provide integrity testing using cross-hole sonic logging survey for all drilled shaft foundations. Testing by cross-hole sonic logging survey shall be performed no later than five days after placement of the drilled shaft concrete. Gamma-gamma confirmation testing may be included by the Contractor in addition to the cross-hole sonic logging survey at the contractor's option as part of the drilled shaft integrity testing.

The Contractor shall furnish and install 2½" (63mm), Schedule 80 PVC pipe for integrity testing. Each logging pipe shall be joined to provide a clean and unobstructed pipe opening from the top of the drilled shaft foundation to within one foot (0.3m) of each shaft tip or as shown on the Project Plans. All logging pipes shall be capped top and

bottom. Logging pipes shall be tied to the inside of the reinforcing cages in a longitudinal straight line, located as detailed on the Project Plans. The logging pipes shall be securely fastened to the reinforcing steel cage, to ensure that the pipes remain straight after handling and shaft concrete placement, to permit the logging device to pass from top to bottom of pipe. PVC pipes shall be filled with water prior to concrete placement. The Contractor shall provide the testing equipment, perform the inspection, and furnish test results to the Engineer.

If the testing indicates the presence of voids, intrusions, or zones of unconsolidated concrete in the Drilled Shaft Foundation, or if the Engineer determines that construction defects may have occurred, or if testing cannot be performed because of blockage of the tubes, the Contractor shall core-drill or otherwise determine the extent of any defects in the concrete, as approved by the Engineer. The Contractor shall repair, replace, or supplement the defective work in a manner approved by the Engineer, at no additional cost to the County.

After all inspection has been completed, all holes and test pipes in all Drilled Shaft Foundations shall be filled with a grout approved by the Engineer. Prior to filling the test pipes with grout, the Engineer shall have the option to perform independent inspection testing using a gamma-gamma logging device. The Engineer will pay the cost of optional testing performed by the Engineer.

502.3.6 – Reinforcing Steel, Cage Construction and Placement: The reinforcing steel cage for the drilled shaft, consisting of longitudinal bars and spiral reinforcement or lateral ties, shall be completely assembled and placed in the shaft excavation as a unit. The reinforcing steel cage shall not be installed in the shaft excavation until immediately before the placement of shaft concrete is to be started. The reinforcing steel cage shall be positioned in accordance with the details shown on the Project Plans.

All reinforcing cages shall be fabricated and supported to avoid damage during lifting and installing the cages. All temporary bracing and supports shall be removed from reinforcing cages prior to the final placement in the shaft excavation.

The reinforcing steel cage shall be adequately supported and anchored from the top, to prevent movement from the required location during the placement of shaft concrete, and for four hours after completion of concrete placement. The reinforcing cage shall not rest directly on the bottom of the excavation. Spacers shall be at sufficient intervals along the shaft to ensure concentric location of the reinforcing cage for the entire length of shaft. Only spacers approved by the Engineer shall be allowed, but in no case shall "dobies" or other rectangular "blocks" tied to the reinforcing cage be allowed.

If the Bottom of Shaft Elevation of a Drilled Shaft Foundation, with or without a Rock Socket, is lowered in accordance with Section 502.3.3, and the Project Plans indicate full depth reinforcement, the Engineer shall be notified to determine if extension and/or modification of the reinforcing cage is required. The Engineer will provide details for changes in the shaft reinforcing cage, if required. Such changes in the shaft reinforcing

steel cage will be paid for in accordance with Sections 109.4 and 109.5 of the Specifications.

If the Bottom of Shaft Elevation of the Drilled Shaft Foundation, with or without a Rock Socket, is raised in accordance with Section 502.3.3, the Engineer will determine if modification of the reinforcing steel cage is required. Such modification, other than shortening the reinforcing cage, will be paid for in accordance with Sections 109.4 and 109.5. If only shortening of the reinforcing cage is required, the Contractor shall shorten the cage at his expense, but will be paid for the full-length cage, as bid. All reinforcing cage cutoffs will become the property and responsibility of the Contractor.

The Contractor shall submit a written request to the Engineer for approval of any variation from the reinforcing steel splices specified in the contract documents.

502.3.7 Concrete Placement:

(A) General: The Contractor shall begin placement of shaft concrete within 24 hours after the completion of the drilled shaft excavation. All concrete shall be placed in accordance with Section 505 and as specified herein. If slurry-assisted excavation is used, concrete shall be placed the same day the excavation is completed.

Unless otherwise specified in the project Special Provisions, or as requested by the Engineer, the slump shall be between 5 and 6 inches (125 and 150 mm) for dry, uncased excavations. For all other shaft excavations, with water and/or using slurry and/or casing during excavation, the shaft concrete slump shall be 8 ± 1 inches (200 ± 25 mm) at the time shaft concrete placement begins.

Prior to shaft concrete placement, the Contractor shall make all necessary arrangements to ensure the uninterrupted delivery of concrete, so that all Drilled Shaft Foundations will be constructed without cold joints. During shaft concrete placement, from start to finish, the rate of rise of the top of concrete in the drilled shaft shall be at least 40’ (12m) / hour.

Tremie downpipes and pump pipes shall be made of steel; no aluminum shall be allowed. The inside diameter of the tremie pipe shall be at least 10 inches (250mm). The inside diameter of the pump pipe shall be at least 5 inches (125mm).

(B) Placement in Dry Excavations: For placement in dry excavations, shaft concrete may be placed by free fall, except in cohesionless soils or where other caving conditions exist. The Contractor shall place the shaft concrete so that during free fall, the concrete does not strike the reinforcing cage nor the excavation sidewalls. Where free fall cannot be used, concrete shall be placed through a suitable, clean downpipe.

Vibration of the shaft concrete for the full height of the shaft is not necessary to achieve proper consolidation of the concrete. However, the shaft concrete shall be vibrated in the top 10’ (3.0m) of the shaft.

For dry shafts, the maximum depth of water in the bottom of the drilled shaft excavation at the time of concrete placement shall be 3 inches (75mm).

(C) Wet Conditions, Placement under Slurry or Water: Shaft concrete placed under slurry or water shall be placed by tremie methods or by pumping. Care shall be taken to ensure that all the fluid and suspended solids are expelled from the shaft excavation during concrete placement.

Where shaft concrete is conveyed and placed by mechanically applied pressure, the equipment shall be of suitable type and shall have adequate capacity for the work. The concrete shall not flow over or through any piping, fittings or equipment which is fabricated of aluminum or aluminum alloys. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. Excessive segregation due to high velocity discharge of the concrete will not be permitted. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or segregation of the ingredients. Standby equipment shall be readily available to replace initial pumping equipment should a breakdown occur.

The Contractor's Installation Plan shall demonstrate the procedures used to determine when the tremie pipe is to be raised during shaft concrete placement. The procedure shall ensure that the opening of the tremie pipe will be deeper than 5 feet (1.5m) below the surface of the concrete at all times, and that a void will not be created by lifting the tremie when there is an insufficient head of concrete. A rapid raising or lowering of the tremie will not be permitted.

To prevent contamination of the shaft concrete placed initially, the lower end of the pump or tremie pipe shall be provided with either a valve, sealable cap, or plug ("pig"). The discharge end shall be placed at the bottom of the excavation prior to starting shaft concrete placement. If a plug is used, it shall be inserted at the top of the tremie pipe after the pipe has been set in place. Shaft concrete shall then be placed by pushing the plug ahead, with the plug separating the concrete from the drilling slurry/water. The bottom end of the tremie pipe shall not be lifted off the bottom of the shaft excavation until the pipe is completely filled with concrete. The first portion of the concrete flow that comes to the top of the shaft shall be displaced out of the shaft excavation until clean, fresh concrete is expelled.

Slurry ejected during shaft concrete placement may be reused provided that it is screened to remove gravel chips or other granular materials, and providing the slurry meets acceptance criteria. Slurry to be discarded shall be disposed of in a manner approved by the Engineer.

Concrete placed under slurry or water shall not be vibrated, except that the top 5 feet (1.5m) of the shaft shall be vibrated after the slurry or water and contaminated concrete

have been totally expelled from the shaft. If temporary casing is used, the vibration shall occur after the casing has been removed.

502.3.8 Casing Removal: During removal of any casing, a sufficient head of not less than 5 feet (1.5m) of fluid concrete in the tremie pipe shall be maintained above the level of concrete in the shaft (outside the tremie pipe), except at the top of the shaft. All contaminated concrete shall be removed from the shaft. Temporary casings shall be removed while the concrete slump is not less than 4 inches (100mm). The Contractor shall maintain a minimum 5 foot (1.5m) head of concrete in the casing as it is being removed. Movement of the casing by exerting downward pressure and tapping to facilitate extraction, or extraction with a vibratory pile hammer will be permitted. Casing extraction shall be at a slow, uniform rate with the force in-line with the shaft axis.

Due care shall be exercised to prevent upward movement of the shaft concrete and reinforcing steel during casing extraction. Upward movement beyond one inch (25m), excluding movement due solely to tension on the top anchoring system, may indicate serious concrete separation or necking problems at the bottom of the casing. The Contractor shall be responsible for corrective action which may include leaving the casing in place and compensating for the loss of frictional capacity in the resulting cased zone.

502.4 Method of Measurement: Drilled Shafts and accepted Confirmation Shafts will be measured to the nearest 0.1m, from the top elevation of each completed Drilled Shaft Foundation to:

(A) The elevation of the surface of the rock stratum, when Rock Sockets are used, or
(B) The Bottom of Shaft Elevation shown on the Project Plans, or
(C) The elevation of the shaft-bell juncture, when Bell Footings are used,

or as determined in the field by the Engineer or a geotechnical specialist.

The length of Rock Sockets will be measured to the nearest 30 mm from the actual surface elevation of the rock socket bedrock stratum to the actual Bottom of Shaft Elevation, as shown on the Project Plans, or as determined in the field by the Engineer or a geotechnical specialist.

Bell Footings will be measured by the unit each, for each configuration of Bell Footing constructed.

502.5 Basis of Payment: The accepted quantities of Confirmation/Drilled Shafts and Rock Sockets, measured as provided above, will be paid for at the contract unit price per linear unit for each diameter designated in the Project Bidding Schedule, COMPLETE IN PLACE for placement in Dry Excavations. The contract unit price shall include all excavation; drilling; metal casing; steel reinforcing; Portland cement concrete; any needed forming, curing and finishing; exposing in-place shaft concrete and the

subsequent repair of shaft foundations; furnishing all materials, equipment, and labor for splicing of reinforcing steel; and conduit for integrity testing.

No additional payment will be made for metal casing that is to remain in place, or for temporary casing left in place.

No supplemental payment will be made for Confirmation Shafts; the cost of the confirmation process is considered as included in the overall cost of constructing production Drilled Shaft Foundations, including all Confirmation Shafts.

Bell Footings will be paid for at the contract unit price per each, for each configuration of Bell Footing constructed and accepted.

Payment for Obstructions will be made in accordance with the provisions of Section 109.4. Obstructions are defined as either material or objects of excessive dimensions that could not be reasonably inferred from the Geotechnical and Foundation Report, including the Foundation Boring Logs. Drilling tools lost in shaft excavations will not be considered Obstructions.

Payment for integrity testing will be made at the contract unit price bid for each shaft tested. The contract unit price shall include furnishing all equipment and labor for conducting, analyzing, interpreting, and reporting test results.

Drilled Shaft Wet Conditions Extra Cost (Contingency Item) is an additional payment made for each drilled shaft installed under wet conditions. This contingency payment will only be made with the approval of the Engineer when warranted by ground water intrusion into the drilled hole, which requires application of special wet drilling methods such as those that use slurry. This payment will be in addition to the base bid for Drilled Shafts and shall be full compensation for all additional work and materials required for installation of drilled shafts under wet conditions.

SECTION 505

CONCRETE STRUCTURES

Section 505 is supplemented with the following:

505.1 DESCRIPTION:

505.1.1 MINOR STRUCTURES:

Concrete structures such as cattle guards, catch basins, median barriers, headwalls, and other small miscellaneous structures of sizes that can readily be precast as units,

and furnished and installed in place, are hereby defined as Minor Structures. Such Minor Structures, at the option of the Contractor, may be either constructed of cast-in-place concrete, or furnished as precast units. Precast units shall be fabricated in accordance with shop drawings submitted by the Contractor and approved by the Engineer, in accordance with the requirements of Section 105.2

505.2 SUBGRADE FOR CONCRETE STRUCTURES:

Precast Concrete Minor Structures shall be founded in accordance with the requirements of Section 206.4.5.

505.3 FORMS:

Forming plans for cast-in-place bridge decks and cast-in-place bridge superstructures shall be prepared in accordance with the requirements of Section 105.2.

505.4 FALSEWORK:

Falsework construction and erection shall not commence until the Contractor has received written approval of the sealed final falsework shop drawings.

505.4.1 Falsework Design:

Falsework design shall be in accordance with the requirements of Section 105.2.

505.5 PLACING REINFORCING

The Contractor will be allowed the following tolerances when placing, tying and supporting reinforcing steel:

(1) In slabs and beams, horizontal bars shall be within six millimeters measured vertically, of the position indicated on the plans.

(2) In vertical walls, columns, wings, and similar members, clearance from the forms shall be within six millimeters of the clearance shown on the plans.

(3) In slabs or walls, long runs of bars may vary up to 50 millimeters in spacing; however, the specified number of bars shall be placed.

505.5.2 Bending Reinforcement:
Revise section 505.5.2 to read:

Bending of reinforcing steel shall conform to the requirements of the current edition of the AASHTO Standard Specifications for Highway Bridges, Division I, Article 8.2.3 – HOOKS AND BENDS.

Bars shall not be bent nor straightened in a manner that will injure the material. Bars with kinks or unspecified bends shall not be used.

505.5.4 Dowels

505.5.4.1 Dowel Placement: Dowel placement shall consist of drilling or coring dowel holes in concrete, furnishing and placing anchoring materials, and placing reinforcing steel dowels in accordance with the details shown on the Project Plans, and the requirements of the project Special provisions and these Specifications.

Dowel holes shall be cored where dowels are to be placed:

(A) in bridge decks and other thin concrete sections, and the depth of the dowel hole shown on the project plans projects to 3 inches (75mm) or less from the opposite face of the concrete section, or

(B) within 4 inches (100mm) from an existing concrete edge.

Cored holes shall be intentionally roughened after coring.

All holes shall be blown clean with compressed air, prior to applying the anchoring material.

The diameter of the holes for the dowels shall be 1/8“ (3mm) larger than the diameter of the dowels to be placed. The depth of the holes for the dowels shall be as shown on the Project Plans.

The anchoring materials for the dowels shall be an epoxy adhesive conforming to the requirements of Section 505.5.4.2, unless otherwise specified on the Project Plans and/or the project Special Provisions, or as approved by the Engineer.

505.5.4.2 Anchoring Materials: Epoxy materials shall be used for anchoring dowels. The Contractor shall submit Certificates of Compliance or Analysis, complete with supporting documentation, to the Engineer for all epoxy materials to be used for anchoring dowels on a specific project, in accordance with the requirements of Section 106.2. The epoxy materials shall be provided by the Contractor in general conformance with the requirements of Section 1015.1 – General Requirements of Section 1015 – EPOXY MATERIALS of the current Arizona Department of Transportation (ADOT) Standard Specifications for Road and Bridge Construction, amended to date.

Epoxy resin base anchoring adhesive shall be used for anchoring dowels in concrete. High viscosity, or non-sag epoxies in the form of a gel, shall be used for horizontal or near-horizontal applications, where flow out of the anchoring hole is a problem. Low and medium viscosity epoxies may be used in vertical anchoring holes that open upward. The anchoring product shall specifically be designed for the designated application, according to the manufacturer’s product literature.

Epoxy resin base anchoring adhesive shall provide the specified minimum tensile pullout resistance, when tested in accordance with Arizona Test Method 725, as

modified in accordance with Section 505.5.4.3 of these specifications. The pot life of the anchoring material shall be determined in accordance with AASHTO T 237, Part I. The determined pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater.

505.5.4.3 Dowel Strength Requirements: The epoxy resin base anchoring adhesive shall provide the following minimum pullout resistances:

#4 (13M) dowels:	12.0 Kips (53.4 kN)
#5 (16M) dowels:	18.6 Kips (82.7 kN)
#6 (19M) dowels:	26.4 Kips (117.4 kN)
#7 (22M) dowels:	36.0 Kips (160.1 kN)

Arizona Test Method (ATM) 725 is a Tensile Proof Dowel Test, developed by ADOT to specifically test #6 (19M) reinforcing steel dowels anchored in Portland cement concrete with an epoxy adhesive. When testing reinforcing steel dowel sizes for County projects, the anchoring hole (ATM 725: PREPARATION – 4.(a)) shall be modified as follows; the rotary hammer drill bit size (ATM 725: APPARATUS – 2.(a)) shall be modified accordingly:

#4 (13M) dowels:	5/8“ (15.9mm) diameter x 8” (200mm) long
#5 (16M) dowels:	3/4” (19.1mm) diameter x 10” (250mm) long
#6 (19M) dowels:	7/8” (22.2mm) diameter x 12” (300mm) long
#7 (22M) dowels:	1” (25.4mm) diameter x 14” (350mm) long

The Contractor may opt to conduct pullout tests with hole lengths other than those required above, based on the adhesive manufacturer’s product literature and recommendations; however, test results shall demonstrate that the tested system provides the required pullout resistances.

505.6 PLACING CONCRETE

No concrete shall be placed in any forms supported by falsework until the Contractor’s Professional Engineer has inspected the completed falsework, and has issued a properly sealed and signed certificate that the falsework has been constructed according to the approved falsework drawings.

505.6.1 Joints: is revised to read **505.6.1 Construction Joints in Major Structures**.

505.6.3 Bridge Deck Joint Assemblies

505.6.3.1 Description: This work shall consist of furnishing and installing expansion devices including the seals, anchorage system, and hardware in accordance with the project plans and these specifications.

505.6.3.2 Materials: Elastomer Seals shall be of the Compression Seal or Strip Seal type, and shall conform to the requirements of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction Section 1011-5.

Steel shapes and plates shall conform to the requirements of ASTM A36/A36M, or ASTM A588/ A588M.

505.6.3.3 Construction Requirements:

(1) General: Deck joint assemblies shall consist of elastomer and steel assemblies which are anchored to the concrete at the deck joint. The seal armor shall be cast in the concrete. The completed assembly shall be properly installed in the planned position, shall satisfactorily resist the intrusion of foreign material and water, and shall provide bump-free passage of traffic. For each size of seal on a project, one piece of the seal material supplied shall be at least 450 millimeters longer than required by the project Plans. The additional length will be removed by the Engineer and used for materials testing. Certificates of Compliance conforming to the requirements of Section 106.2 shall also be submitted by the Contractor.

(2) Shop Drawings: Prior to fabrication, the Contractor shall submit shop drawings to the Engineer for approval, in accordance with the requirements of Section 105.2. The shop drawings shall show complete details of the method of installation to be followed, including a temperature correction chart for adjusting the dimensions of the joint according to the ambient temperature, and any additions or rearrangements of the reinforcing steel from that shown on the project plans.

Deck joint assemblies for pretensioned and post-tensioned prestressed concrete superstructures shall be installed at the narrowest joint opening possible to allow for long-term superstructure shortening.

(3) Elastomer Seals: Seals shall conform to the requirements hereinbefore specified.

(4) Welding: All welding and inspection of welding for structural steel, except for tubular structures, shall be performed in accordance with the requirements of the ANSI/AASHTO/AWS D1.5-88 Bridge Welding Code. All other references to the American Welding Society (AWS) Structural Welding Code AWS D1.1-80 and the AASHTO Standard Specifications for the Welding of Structural Steel Highway Bridges are deleted.

The use of electro-slag welding process on structural steel will not be permitted.

(5) Armor: All steel for cast-in-place deck joint assemblies shall conform to the requirements hereinbefore specified.

(6) Galvanizing: All steel parts of strip seal assemblies shall be galvanized after fabrication, in accordance with the requirements of ASTM A123 and A153, unless ASTM A588/A588M steel is used. Bolts shall be high strength, conforming to the requirements of ASTM A325M, with a protective coating of cadmium or zinc, followed by a chromate and baked organic coating conforming to the requirements of ASTM F1135, Grade 3, 5, 6, 7, or 8 and Color Code A.

Steel parts of compression seal assemblies do not require galvanizing, plating, or painting.

(7) Joint Preparation and Installation: At all joint locations, the Contractor shall cast the bridge decks and abutment backwalls with a formed blockout, sized to accommodate the pre-assembled joint assembly. The joint assembly will be anchored in the concrete to be placed with the secondary pour in the blockout. Prior to the secondary pour, the surface of the existing concrete in the blockout shall be coated with an approved adhesive specifically formulated for bonding new concrete to old concrete.

Installed armor assemblies shall be covered or otherwise protected at all times prior to installing the elastomer portion of the joint assembly. The elastomer shall be installed at such time and in such manner that it will not be damaged by construction operations.

The seal element shall be installed subject to these specifications and approval of the Engineer. Immediately prior to the installation of the seal element, the steel contact surfaces of the joint armor shall be clean, dry, and free of oil, rust, paint, or foreign material. Any perforation or tearing of the seal element due to installation procedures or construction activities will be cause for rejection of the installed seal element.

During the installation of all proprietary deck joint assemblies, the manufacturer's representative shall be present. As a minimum, the representative shall be present during the placement of the joint assembly in the deck blockout, prior to the secondary concrete pour, and shall also be present during the installation of the seal element.

505.6.4 Water Stops

Water stops of rubber or plastic, shall be placed in accordance with the details shown on the project plans. Where movement at the joint is provided for, the water stops shall be of the type permitting such movement without damage. Water stops shall be mechanically spliced, vulcanized, or heat-sealed to form continuous watertight joints, in accordance with the manufacturer's recommendations, and as approved by the Engineer.

505.6.5 Longitudinal Joints between Precast Bridge Deck Units

After erection of the units and at the time requested by the Engineer, the longitudinal shear key joints between units shall be thoroughly packed with a pre-packaged nonshrink grout or a sand-cement grout with an expansion agent approved by the

Engineer. The Contractor shall then transversely connect the deck units with the connection rods, stressing and anchoring them as shown on the project plans.

505.8 CURING

The Contractor shall use the wet burlap method for the water cure of all concrete in bridge decks and approach slabs, unless otherwise authorized by the Engineer.

505.10 DIMENSIONAL TOLERANCES:

The maximum allowable tolerances or deviations from dimensions shown on the project plans or the approved shop drawings shall be as follows:

505.10.1 Cast-in-Place Concrete

(A) Variation from plumb in the lines and surfaces of columns, piers, abutment and girder walls:

In any 3 meter or less length: 10 millimeters
Maximum for the entire length: 25 millimeters

(B) Variation in cross-sectional dimensions of columns, piers, girders, and in the thickness of slabs and walls:

+ 6 millimeters
- 3 millimeters

(C) Girders alignment (deviation from straight line parallel to center line of girder measured between diaphragms):

3 millimeters per every 3 meters in length

(D) Variation in footing cross sectional dimensions in project plans:
+ 50 millimeters
- 13 millimeters

(E) Variation in footing thickness:

Greater than specified - No Limit
Less than specified - 5 percent of specified thickness up to a maximum of 25 millimeters

(F) Subgrade Tolerances:

Slab poured on subgrade excepting footing thickness:
+ 6 millimeters

-19 millimeters

(G) Girder Bearing Seats:

Deviation from plane surface (flatness): ± 3 millimeters in 3 meters.

Deviation from required elevation:
+ 6 millimeters
- 3 millimeters

(H) Cast-in-Place concrete box girder superstructures:

Deviation in overall depth:
+ 6 millimeters
- 3 millimeters

Deviation in slab and wall thickness:
+ 6 millimeters
- 3 millimeters

Deviation of post-tensioning ducts:
± 6 millimeters

505.10.2 Minor Precast Concrete Structures:

Precast units that do not comply with the dimensional tolerances specified herein will be rejected. Precast units that show evidence of cracks, pop outs, voids or other evidence of structural inadequacy, or imperfections that will reduce the aesthetics of the unit after final placement, will be rejected. The maximum allowable tolerances or deviations from the dimensions shown on the drawings shall be as follows:

(A) Over-all dimensions of member: ± 6 millimeters per 3 meters, maximum of ± 19 millimeters.

(B) Cross-sectional dimensions: Sections 150 millimeters or less ± 3 millimeters

Sections 450 millimeters or less and over 150 millimeters ± 5 millimeters

Sections 900 millimeters or less and over 450 millimeters ± 6 millimeters

(C) Deviations from straight line:

Not more than 6 millimeters per 3 meters

All exposed, sharp corners of the concrete shall be filleted 20 millimeters with a maximum allowable deviation of ± 3 millimeters.

505.11 MEASUREMENT:

505.11.1 Reinforcing Steel:

Reinforcing steel will be measured in kilograms, based on the total computed weight for the size and length of bars, or for the area of welded wire fabric, as shown on the Project Plans or as approved by the Engineer.

Unit bar weights for deformed and plain billet-steel bars will be the nominal unit weights specified in AASHTO M 31M/M 31 (ASTM A 615/A 615M).

Area unit weights for steel welded wire fabric will be calculated based on specified wire spacings and unit weights for specified wire types and sizes. Unit weights for plain wire shall be based on the nominal areas specified for Wire Size Numbers in AASHTO M 32M/M 32 (ASTM A 82). Unit weights for deformed wire shall be the nominal unit weights specified for Deformed Wire Size Numbers in AASHTO M 225M/M 225 (ASTM A 496).

If the area unit weights for steel welded wire fabric are specified on the Project Plans or in the Special Provisions, both the Contractor and the Engineer shall independently calculate the area unit weight, using specified wire spacings, types and sizes, and the criteria in the preceding paragraph. Any apparent discrepancy between the specified and calculated area unit weights shall be resolved by the Engineer prior to the Contractor placing the order for the steel welded wire fabric.

Lap splices made for the convenience of the Contractor will not be included in the measurement for payment.

Reinforcing steel for Minor Structures, as defined in Section 505.1.1, will not be measured, but will be considered incidental to the specified method of payment, unless otherwise called out on the Project Plans or specified in the Special Provisions.

Dowel Placement will be measured by the unit each.

505.11.2 Concrete:

When concrete is scheduled for payment on the basis of cubic meters, the calculation of the quantity of concrete for payment will be made only to the neat lines of the structures as shown on the plans. The quantity will be based on the concrete having the specified plan lengths, widths/depths, and thicknesses. However, all concrete shall be placed to line and grade within the tolerances specified in Section 505.10, or as approved by the Engineer as being reasonable and acceptable for the type of work involved. No volumetric deductions will be made for rounded or beveled edges, space occupied by reinforcing steel, metal inserts, or openings 0.5 square meters or less in area.

The quantity of concrete will be calculated considering any mortar used to cover construction joints as being concrete. The cost of cement used in any mortar for covering construction joints, patching, or other uses in the structure being constructed, in excess of that required for the design mix of the adjacent concrete, shall be absorbed in the cost of the item of work of which said mortar is a part.

505.11.3 Deck Joint Assemblies:

Deck joint assemblies will be measured to the nearest tenth of a meter. Measurement will be made along the centerline of the joint, at the surface of the roadway, from face-to-face of curb or barrier. No measurement will be made for that portion of the deck joint assembly required by plan details to extend through the barrier face or curb; that portion of the joint assembly will be considered incidental to the sealing of the joint.

505.11.4 Bridge Railing, Curbs, Barriers, and Approach Slabs

Bridge Pedestrian Fence and Curb, Bridge Pedestrian Fence and Parapet, and Bridge Fence and Parapet will be measured to the nearest tenth of a meter, from end post to end post.

Bridge Traffic and Pedestrian Rail will be measured to the nearest tenth of a meter, determined from the outside dimensions of the rail.

Bridge Concrete Barrier will be measured to the nearest tenth of a meter.

Barrier Concrete Barrier Transition will be measured as a unit for each constructed.

Reinforced Concrete Approach Slab will be measured to the nearest square meter.

505.12 PAYMENT

505.12.1 Reinforcing Steel: The accepted quantities of reinforcing steel, of the type indicated on the Project Plans or specified in the Special Provisions, and measured in conformance with Section 505.11.1 will be paid for at the contract unit price per kilogram, complete in place.

The accepted quantity of dowels placed will be paid for at the contract unit price for Dowel Placement, which shall be full compensation for the work, complete in place. Steel reinforcement furnished for the dowels will be measured and paid for under the pay item Reinforcing Steel.

No measurement or direct payment will be made for dowels which are required to replace existing reinforcing steel that is damaged as a result of the Contractor's operations; the Contractor shall furnish and place such dowels at his own expense.

505.12.2 Concrete: Payment for Portland cement concrete structures will be made in conformity with the terms of the contract and will be based on unit prices and/or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, materials, tools and equipment, preparation of subgrade for placing of concrete, and doing all work required to construct the structures in conformity with the plans and specifications.

An adjustment in the contract unit price, to the nearest cent, will be made for the quantity of concrete represented by the results of cylinder strength tests that are less than the specified 28-day compressive strength. Strength tests will be conducted in accordance with Section 725.10 of the Uniform Standard Specifications. The adjustment in contract unit price, if the concrete is accepted, will be based on the schedule in Section 725.11.

The contract unit price for structural concrete shall include full compensation for all items incidental to providing a concrete structure complete in place, including waterstops, roadway drains, scuppers, metal inserts, and bearing pads.

505.12.3 Minor Concrete Structures and Accessories:

The accepted quantities of:

Minor Structures	Each
Deck Joint Assemblies	0.1 Meter
Bridge Pedestrian Fence and Curb	0.1 Meter
Bridge Pedestrian Fence and Parapet	0.1 Meter
Bridge Fence and Parapet	0.1 Meter
Bridge Traffic and Pedestrian Rail	0.1 Meter
Bridge Concrete Barrier	0.1 Meter
Bridge Concrete Barrier Transition	Each
Reinforced Concrete Approach Slab	Square Meters

will be paid for at the unit price and/or lump sums as set forth in the proposal. The contract unit price shall include full compensation for all labor, materials, tools and equipment necessary to provide the concrete structure or accessory complete in place, including all concrete, reinforcing steel, and items embedded in the concrete, such as anchor bolts, grates and frames, metal inserts, etc.

SECTION 506

PRECAST PRESTRESSED CONCRETE MEMBERS

Section 506 is supplemented with the following:

506.1 DESCRIPTION:

Elastomeric Bearing Pads shall conform to the requirements of the current edition of the AASHTO Standard Specifications for Highway Bridges, Division II – Construction, Article 18.4.5, and shall be Grade 3, 60 durometer elastomer, unless otherwise specified in the Special Provisions.

Prestressing of all precast concrete I-girder, box beam, voided and solid slab bridge members shall be by the pretensioning method only.

Prior to initiating girder fabrication, shop drawings for the proposed precast concrete members shall be submitted in accordance with Section 105.2, and approved by the Engineer.

506.2 CONCRETE:

506.2.1 Reinforcing Steel: Non-prestressed reinforcement shall conform to the provisions of Section 727; placement shall conform to the provisions of Section 505.5.

506.2.2 Dimensional Tolerances: Precast Prestressed Concrete Bridge Members that do not comply with the dimensional tolerances specified herein will be rejected. Precast members that show evidence of cracks, pop-outs, voids or other evidence of structural inadequacy, or imperfections that will reduce the aesthetics of the member after final placement, will be rejected.

(2) Precast Prestressed Concrete I-girders: The maximum allowable tolerances or deviations from dimensions and details shown on the project plans and shop drawings shall be as follows:

Girder Length	± 19 mm
Width (flanges and fillets)	+ 10 mm, -6 mm
Girder Depth (overall)	+13 mm, -6 mm
Width (web)	+ 10 mm, -6 mm
Depth (flanges and fillets)	± 6 mm
Bearing plates (center to center)	±3 mm per 3 meters but not greater than ± 19 mm
Horizontal alignment (deviation from straight line parallel to centerline of girder)	3 mm per every 3 meters in length
Stirrup bars (deviation from top of girder)	+ 6 mm, - 19 mm
Position of strands	± 6 mm for strands and center of gravity of strand group
Longitudinal position of deflection points for deflected strands	± 250 mm
Position of handling devices	± 150 mm
Bearing plates (center to end of girder)	± 6 mm
Side inserts (center to center and center to end of girder)	± 13 mm
Girder ends (deviation from square or designated skew)	Horz. ± 6 mm Vert. ± 3 mm per 300 mm of beam depth
Bearing area deviation from plane	± 3 mm
Stirrup bars (longitudinal spacing)	± 25 mm
Position of weld plates	± 25 mm

(3) Precast Prestressed Concrete Box Beams, Voided Slabs, and Flat Slabs: The maximum allowable tolerances or deviations from dimensions and details shown on the project plans and shop drawings shall be:

Member Length	± 19 mm
Member Width (overall)	± 6 mm
Member Depth (overall)	± 6 mm
Width (web)	± 10 mm
Depth (top slab)	± 6 mm
Depth (bottom slab)	+ 6 mm - 3 mm
Horizontal alignment (deviation from straight line parallel to centerline of member)	3 mm per every 3 meters in length
Camber differential between adjacent members	Not greater than 19 mm
Position of strands	± 6 mm for center of gravity for strand group
Stirrup bars (longitudinal spacing)	± 25 mm
Position of handling devices	± 150 mm
Member void position	± 13 mm from end of void to center of tie hole, + 25 mm adjacent to end block.
Member ends (deviation from square and/or designated skew)	± 13 mm
Bearing area deviation from plane (straight edge through middle half)	± 3 mm
Dowel tubes (spacing between centers of tubes, and centers of tubes to the ends and sides of members)	± 13 mm
Tie rod tubes (spacing between centers of tubes, and centers of tubes to ends of members)	± 13 mm
Tie rod tubes (spacing from centers of tubes to bottom of member)	± 10 mm
Position of side inserts	± 13 mm

506.3 PRESTRESSING STEEL:

Prestressing Steel Strand for precast concrete bridge members shall conform to the requirements of AASHTO Specification M 203M/M 203 (ASTM A 416) for Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement, and shall be Low-Relaxation Strand, Grade 270.

506.6 PRESTRESSING:

Unless otherwise shown on the project plans, the stresses in the prestressing strands shall not exceed those specified in the current edition of the AASHTO Standard Specifications for Highway Bridges, Division I – Design, Section 9.15.1.

When concrete has not been placed within 72 hours of the tensioning of the prestressing strands, all strands shall be re-tensioned prior to placing concrete.

Prestressing steel at the end of the members shall be cut and bent in accordance with details on the project plans. Exposed strand ends shall not be coated, but shall be clean and free of all rust, corrosion, dirt, scale, oil, grease, and other deleterious substances, in accordance with Sections 506.3 and 506.7 of these Specifications, before encasement in the cast-in-place concrete pier and abutment diaphragms of the superstructure.

506.8 SAMPLES FOR TESTING:

Sampling and testing of prestressing strand for bridge members shall conform to the specifications of AASHTO M 203.

506.9 HANDLING:

Precast prestressed concrete bridge members shall not be transported from the fabricating yard to the bridge site until attaining full design compressive strength, and not less than seven (7) days after the total transfer of prestressing force.

506.10 PAYMENT:

A partial payment of one-half the contract unit price, administered in accordance with the provisions of Section 109.7(A), will be allowed for stockpiled precast prestressed concrete bridge members that have been approved by the Engineer for conformance with the project plans and these specifications.

An adjustment in the contract unit price, to the nearest cent, will be made for precast prestressed concrete bridge members having cylinder strength test results less than the specified 28-day compressive strength. Strength tests will be conducted in accordance with Section 725.10 of the Uniform Standard Specifications. The adjustment in contract unit price, if the precast prestressed concrete bridge member is accepted, will be based on the schedule in Section 725.11.

Part 500 add the following new Section:

SECTION 507

CONCRETE STAIN

507.1 Description: The work under this Section shall consist of furnishing a water-repellent penetration stain and other materials, and staining the following exposed concrete surfaces:

1) All concrete surfaces of bridge superstructures, including:
   - For Cast-in-place Post-tensioned Box Girders: Complete bottom(s) and sides, from parapet to parapet
   - For Precast I-Girders: Fascia girders and overhangs, from top of inside face of bottom girder flange to deck parapet; bottom flanges of interior girders, including flange sides; faces of pier and abutment diaphragms; and bottoms of interior diaphragms. Excluded from staining are all vertical faces and fillets of interior girders and diaphragms, and the bottom of the deck slab; nominal overspray above the areas to be stained will be acceptable.
   - For Precast Box Beams/Voided Slab & Slab Units: Complete bottom(s) and sides, from parapet to parapet.
   - For Steel Girders: Overhangs from edge of steel girder top flange to parapet; faces of cast-in-place abutment diaphragms.
2) All surfaces of bridge piers, columns, exposed concrete pile bents, abutments, and parapet walls; concrete retaining walls; Mechanically Stabilized Earth (MSE) with precast concrete fascia panels; and Sound Walls; to at least one foot (300 mm) below finished grade.
3) All surfaces of bridge barriers and the sides and tops of permanent barriers not adjacent to the traveled way; and
4) Excluded from staining are the
   - Top side of decks, from barrier-to-barrier or curb-to-curb.
   - Sidewalks
   - Inside of curbs
   - Downdrains

in accordance with this Section, unless called out otherwise on the Project Plans or specified otherwise in the Special Provisions.

The work shall include the preparation of the surfaces to be stained, the protection and drying of the stain coatings, and the protection of pedestrian, vehicular, and other traffic under and near the work from stain spatter and disfigurement.

507.2 Materials

507.2.1 General Requirements: Prior to application of the penetrating stain, the Contractor shall furnish the Engineer with independent laboratory test reports, which certify compliance of the stain with each of the specified physical, chemical, and performance requirements.

Stain will be sampled and tested on a lot basis. At least one sample, not less than one quart (0.95 Liter) in size, will be taken and tested. Random samples may be taken at the discretion of the Engineer.

The water-repellent penetrating stain shall be ready-mixed at the manufacturer's plant.

Water-repellent stain shall be furnished in new, unopened, air-tight containers which are clearly labeled with the exact title of the stain, Federal Specification number (when applicable), name and address of manufacturer, date of stain manufacture, and the lot or batch number. The containers shall conform to U.S. Department of Transportation Hazardous Material Shipping Regulations.

Precautions concerning the handling and the application of the stain shall be shown on the label of stain containers.

507.2.2 Physical And Chemical Requirements: The water-repellent penetrating stain shall be a semi-opaque colored toner, containing methyl methacrylate-ethyl acrylate copolymer resins or isobutyl methacrylate resin, inorganic oxide toning pigments suspended in solution at all times by a chemical suspension agent and solvent, and shall conform to the following:

Property	Requirement	Test Method
Resin:	Methyl methacrylate - ethyl acrylate copolymer resin or isobutyl methacrylate resin	ASTM D 2621
Solvent:	Xylene or other hydrocarbon base compatible with the type of resin utilized.	ASTM D 3271
Viscosity:	55(±5) Krebs Units for methyl methacrylate-ethyl acrylate copolymer resin stains or 67(±8) Krebs Units for isobutyl methacrylate resin stain products.	ASTM D 562

Solids:	By weight - Total Composition 32.0 - 45.0%	ASTM D 2369
Gloss:	Angular reflectance shall not exceed 10 at 60 degrees	ASTM D 523
Grind:	7 = scatter back to 6	ASTM D 1210
Pigment to Resin Ratio:	Not more than 1.2:1.0, or less than 0.7:1.0, as determined by combined evaporation/solvent extraction procedures.	ASTM D 4451 ASTM D 2369 ASTM D 2698
Water Content:	Not more than 1.00 percent by volume	ASTM D 4017
Drying Time:	Dry to Touch - Max. 2 Hrs. Dry to Recoat - Max. 5 Hrs.	ASTM D 1640
Density:	8.2 lbs/US Gal. minimum (0.983 kg/Liter minimum)	ASTM D 1475

The stain shall exhibit no settling or color variation. The use of vegetable or marine oils, paraffin materials, stearates, or organic pigments in any part of the stain formulation will not be permitted.

The Contractor shall provide a maximum of three samples of each color to be considered for the specified concrete structures and surfaces. The colors of each stain shall approximate that of the Paint Numbers as specified by Federal Standard 595a, when applied to 1) a concrete test specimen and to 2) the surface of the structures to be stained. Specific Paint Numbers required will be called out on the Project Plans or in the Special Provisions. The Contractor shall prepare test samples as specified in Section 507.3 for each color, after which time the Engineer will select one sample for each color for use with all applicable concrete structures and surfaces.

507.2.3 Performance Requirements:

(A) Resistance to Accelerated Weathering: The stain shall show no appreciable change in color or appearance after 2500 hours, when tested in accordance with ASTM G 53.

(B) Resistance to Sulfide Staining: The stain shall show no discoloration after 15 minutes immersion in saturated hydrogen sulfide solution when tested in accordance with ASTM D 1712. The test specimen shall be treated cement asbestos board or an approved equal.

(C) Resistance to Peeling and Flaking: When penetrating stain is applied to concrete test specimens or to final concrete surfaces, and subjected to the following cross-cut tests within 12 to 24 hours after application, removal of the stain shall be limited to small flakes of coating detached at the cross-cut intersections, such that less than 5% of the test area is affected.

All inspection testing of applied stain finishes on concrete test specimens and final concrete surfaces will be performed by the Engineer, using the following apparatus and procedures. The Contractor is to have the stain manufacturer's representative observe cross-cut testing, as deemed appropriate:

Test Apparatus and Materials: The Engineer will use 1) a sharp utility razor knife, 2) a single-edge razor blade scraper, and 3) two-inch (50mm) wide, transparent pressure-sensitive tape (No. 3750-G Scotch Brand Tape by 3M Corp. is suitable for this purpose) to perform all tests.

Cross-Cut Tape Test: Vertical and horizontal cross-cuts will be made, through the stain film to the substrate, with the utility razor knife. Cuts shall be approximately two inches (50mm) in length and 1/4 inch (6mm) apart in both directions, forming a lattice pattern covering an area approximately two inches (50mm) square. Before applying the pressure-sensitive tape, the cross-cut area will be inspected for any flaking and peeling of the stain film from the substrate, resulting from cutting the lattice pattern.

One end of a six-inch (150mm) length of pressure-sensitive tape will be placed to cover the cross-cut area. The tape will be smoothed in the area of the cross-cuts, and then rubbed firmly with the blunt end of the razor knife, to attain maximum adhesion. Within 90 seconds (+ 30 seconds) of application, the tape will be removed by gripping the free end and pulling it off rapidly (not jerking), back upon itself, as close to an angle of 180 degrees as possible. The cross-cut area will then be inspected again for any flaking and peeling of the stain film from the substrate, this time resulting from the adhesion of the tape to the stain film.

Cross-Cut Scrape Test: Vertical and horizontal cross-cuts will be made, through the stain film to the substrate, with the utility razor knife. Cuts shall be approximately two inches (50mm) in length and 1/4 inch (6mm) apart in both directions, forming a lattice pattern covering an area approximately two inches (50mm) square. Before scraping the cross-cut area, the area will be inspected for any flaking and peeling of the stain film from the substrate, resulting from cutting the lattice pattern.

The cross-cut area will then be scraped with the razor blade scraper, and the area inspected again for any separation and flaking and peeling of the stain film from the substrate, resulting from the scraping.

507.3 Construction/Application Requirements: All water-repellent penetrating stain shall be applied by an Arizona Licensed Painting Contractor, acceptable to both the manufacturer and the Engineer.

The method of application, the rate of application, the number of coats of application, and the surface temperature range of application shall all be in accordance with the manufacturer's written recommendations. A copy of these recommendations shall be furnished to the Engineer, prior to application of the stain.

The Contractor shall furnish a maximum of three samples of concrete, each with one of the specified penetrating stains applied. Each sample shall measure 2 feet by 2 feet (600mm x 600mm) and shall have a surface similar in pattern and texture to that to be used on the work. When new concrete is to be stained, the samples shall be cast at the same time as the new concrete. The stain(s) shall be applied to the samples, using the same methods that will be used to stain the work. The samples shall be placed at the project site, and left for two weeks for observation. At this time, the Engineer will select one color for use with all applicable concrete structures and surfaces.

All inspection testing of the stain finishes on the samples will be performed by the Engineer. Such testing will consist of the same cross-cut tests specified herein under Section 507.2.3(C) – Resistance to Peeling and Flaking, to verify penetration and adhesion of the stain finish. No stain shall be applied on the project until the final sample stain finish has been approved by the Engineer in writing.

All new concrete shall be finished and cured in accordance with the requirements of the Specifications, the MCDOT Supplement, and the Special Provisions, prior to the application of the stain.

Before the stain is applied, all concrete surfaces to be stained shall be sandblasted, and then cleaned in accordance with the stain manufacturer's written recommendations, to remove all dirt, dust, curing agents, form release agents, efflorescence, scale, and other foreign substances which could be detrimental to the stain penetration or color. All sandblasting shall be performed in strict compliance with regulations of local and governing authorities. All concrete surfaces to be stained shall be clean, completely dry, and free of frost and other foreign substances at the time of the application of stain.

The Contractor shall provide such protection as is necessary to prevent damage to the work, property, and persons, as a result of the cleaning and staining operations.

After the structure has been prepared for the application of stain, and prior to stain application, the Contractor and the stain manufacturer’s representative shall inspect the surfaces to be stained. The manufacturer’s representative shall notify the Engineer in writing that the surfaces are satisfactory for the stain to be applied. The Contractor shall not start applying the stain without specific approval from the Engineer.

All random inspection testing of the completed stain finish will be performed by the Engineer. Such testing shall consist of the same cross-cut tests specified herein under Section 507.2.3(C) – Resistance to Peeling and Flaking, to verify penetration and adhesion of the stain finish. Any stained areas that show evidence of peeling or flaking

shall be sandblasted and cleaned as previously specified, and refinished to match the stain finish of the surrounding concrete surfaces. The Contractor shall restain all damaged test inspection areas.

507.4 Measurement: Measurement for Concrete Stain will be by the lump sum, as a single, complete unit of work, unless otherwise specified in the Special Provisions and contract documents.

507.4 Payment: Payment for the accepted area of Concrete Stain, as specified in this Section, the Project Plans, and the Special Provisions, will be made at the contract lump sum price. The contract lump sum payment will include the costs of all independent laboratory tests and reports; supplying samples; sandblasting and cleaning surfaces; furnishing and applying water-repellent penetrating stain; restaining damaged test inspection areas; sandblasting, cleaning, and refinishing previously rejected areas of applied stain; providing a manufacturer's representative as specified herein; and protecting all traffic under and near the work from stain spatter and disfigurement.

SECTION 601

TRENCH EXCAVATION, BACKFILLING AND COMPACTION

601.4 .3 Backfill:

Section 601.4.3 add the following:

Backfill material for pipes, pipe-arches, or arches made of metal shall have a value of resistivity not less than 2000 ohm-cm or of the value shown on the project Plans. When resistivity is not shown on the Plans, the backfill material shall have a value of resistivity not less than that of the existing in-place material or 2000 ohm-cm, whichever is less. Backfill material for all metal pipe installations shall have a pH value between 6.0 and 9.0 inclusive. Backfill material for all concrete or plastic pipe installations shall have a pH value between 6.0 and 12.0. Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

Trenches within existing paved areas shall use ½ sack CLSM for backfill unless use of an alternative material has received prior approval.

SECTION 603

INSTALLATION FOR HIGH DENSITY POLYETHYLENE PIPE

Section 603.4.2 is modified as following:

Controlled low strength material (CLSM) shall be used for bedding of HDPE. The CLSM shall be ½ Sack per Section 728 unless otherwise noted. Placement of the CLSM bedding shall be per Section 604 and extend to 0.3 m above the pipe crown line.

Part 600 add the following new Section:

SECTION 635

CONCRETE LINED IRRIGATION DITCH

635.1 Description: Work under this Section consists of constructing cast-in-place Concrete Lined Ditch (CLD) in conformance with the details shown on the project plans, the applicable provisions of Section 505, and these Specifications.

635.2 Materials: Concrete shall be air-entrained Class B Portland cement concrete conforming to the requirements of Section 725. All other materials incorporated in the CLD installation shall conform to the project plans, to the project Special Provisions, to the MAG Standard Details, and/or to appropriate Part 700 materials specifications.

635.3 Construction: Subgrade for the concrete ditch shall be shaped to conform to the elevations and dimensions shown on the project plans. The subgrade shall be compacted in accordance with the requirements of Section 301.3 (C), except that the depth of compaction shall be 300 millimeters below the flow line of the completed ditch.

The CLD shall be slip-formed, or cast as approved by the Engineer.

The finished surface of the concrete shall be free from rock pockets and surface voids, and shall be comparable to the finish obtained by the use of a long-handled steel trowel, as approved by the Engineer. Transverse grooves 3 millimeters in width and 16 millimeters in depth shall be made in the placed concrete lining at intervals of 3 meters, and maintained to the required dimensions until the concrete has set.

The placed concrete shall be cured by the use of a white-pigmented membrane-forming compound (AASHTO M-148 Type 2) conforming to the requirements of Section 726.

635.4 Measurement: Measurement for this work will be by the meter of Concrete Lined Ditch.

635.5 Payment: Payment for this work shall be made at the contract unit price per meter for Concrete Lined Ditch. Such payment will be full compensation for the item, complete in place, including all necessary materials, excavation, subgrade preparation, concrete, labor, and equipment.

SECTION 717

ASPHALT- RUBBER

Replace all of Section 717 of the MAG Standard Specifications with the following:

717.1 Description: The work under this section shall consist of furnishing, proportioning and mixing all the ingredients necessary to produce an asphalt-rubber material.

717.2 Materials:

717.2.1 Asphalt-Rubber:

Asphalt Cement: Asphalt cement shall conform to the requirements of Section 711.

Rubber: Rubber shall meet the following gradation requirements when tested in accordance with Arizona Test Method 714. Type B shall be used unless otherwise specified.

Sieve	Percent Passing	
Size	Type A	Type B
2.36 mm (#8)	100	
2.00 mm (#10)	95 - 100	100
1.18 mm (#16)	0 - 10	65 - 100
600 μm (#30)		20 - 100
300 μm (#50)		0 - 45
75 μm (#200)		0 - 5

The rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of wire or other contaminating materials, except that Type A rubber shall contain not more than 0.1 percent fabric and Type B shall contain not more than 0.5 percent fabric. Calcium carbonate, up to four percent by weight of the granulated rubber, may be added to prevent the particles from sticking together.

Certificates of Compliance conforming to Arizona State Department of Transportation Standard Specifications for Road and Bridge Construction Section 106.05 shall be submitted. In addition, the Certificates shall confirm that the rubber is a crumb rubber, derived from processing whole scrap tires or shredded tire materials; and the tires from

which the crumb rubber is produced is taken from automobiles, trucks, or other equipment owned and operated in the United States. The Certificates shall also verify that the processing does not produce, as a waste product, casings or other round tire material that can hold water when stored or disposed of above the ground.

717.2.2 Asphalt-Rubber Proportions: The asphalt-rubber shall contain a minimum of 20 percent ground rubber by the weight of the asphalt cement.

717.2.3 Asphalt-Rubber Properties: Asphalt-rubber shall be Type 1 unless otherwise specified and conform to the following:

Property	Requirement		
	Type I	**Type 2**	**Type 3**
Grade of base asphalt cement	**PG 64-16**	**PG 58-22**	**PG 52-28**
Rotational Viscosity*; 177°C (351°F); Pascal seconds (cps)	1.5-4.0 (1500-4000)	1.5-4.0 (1500-4000)	1.5-4.0 (1500-4000)
Penetration; 4°C (39°F), 200g, 60 sec. (ASTM D 5); dmm (in), min	10 (0.04)	15 (0.06)	25 (0.10)
Ductility; 4°C (39°F), 1 cpm (ASTM D 113); cm (in), min.	5 (2)	5 (2)	5 (2)
Softening Point; (ASTM D 36); °C (°F), min.	57 (135)	54 (129)	52 (126)
Resilience; 25°C (77°F) (ASTM D 3407); %,min	25	20	15
* The Viscometer used must be a Haake Viscometer, Model VT – 04, Rotor No. 1, or viscometer correlated.			

717.2.4 Asphalt-Rubber Design: At least two weeks Prior to the use of asphalt-rubber, the Contractor shall submit an asphalt-rubber design prepared by an approved laboratory. Such design shall meet the requirements specified herein. The design shall show the values obtained from the required tests, along with the following information: percent, grade and source of the asphalt cement used; and percent, gradation and source(s) of rubber used.

717.3 Construction Requirements:

717.3.1 Mixing of Asphalt-Rubber: The temperature of the asphalt-cement shall be between 191°C (375°F) and 218°C (425°F) prior to the addition of rubber. No agglomerations of rubber particles in excess of 50 millimeters in the least dimension shall be allowed in the mixing chamber. The ground rubber and asphalt-cement shall be accurately proportioned in accordance with the design and thoroughly mixed prior to the beginning of the one-hour reaction period. Reaction time may be decreased to 45-minutes if documentation is provided that the physical properties of the mix design requirements are consistently met using a 45-minute reaction period. The Contractor shall document that the proportions are accurate and that the rubber has been uniformly

incorporated into the mixture. Additionally, the Contractor shall demonstrate that the rubber particles have been thoroughly mixed such that they have been "wetted." The occurrence of rubber floating on the surface or agglomerations of rubber particles shall be evidence of insufficient mixing. The temperature of the asphalt-rubber immediately after mixing shall be between 177°C (350°F) and 204°C (400°F). Reaction time shall start after all of the material for the batch has been mixed and the minimum reaction temperature of 177°C (350°F) has been achieved.

Prior to use, the viscosity of the asphalt-rubber shall be tested by the use of a rotational viscometer, which is to be furnished by the Contractor or supplier. The Contractor shall provide a qualified person to perform the testing.

717.3.2 Handling of Asphalt-Rubber: Once the asphalt-rubber has been mixed, it shall be kept thoroughly agitated during periods of use to prevent settling of the rubber particles. During the production of asphaltic concrete the temperature of the asphalt-rubber shall be maintained between 163°C (325°F) and 191°C (375°F). However, in no case shall the asphalt-rubber be held for more than 10 hours at these temperatures. It shall be allowed to cool to a temperature of 121°C (250°F) or less and held at that temperature for not more than four days. The process of cooling and reheating shall not be allowed more than one time for a batch of asphalt rubber binder.

For each load or batch of asphalt-rubber, the Contractor shall provide the Engineer with the following documentation:

(A) The source, grade, amount and temperature of the asphalt cement prior to the addition of rubber.

(B) The source and amount of rubber and the rubber content expressed as percent by the weight of the asphalt cement.

(C) Times and dates of the rubber additions and resultant viscosity test.

(D) A record of the temperature, with time and date reference for each load or batch. The record shall begin at the time of the addition of rubber and continue until the load or batch is completely used. Readings and recordings shall be made at every temperature change in excess of 11°C (52°F), and as needed to document other events which are significant to batch use and quality.

SECTION 725

PORTLAND CEMENT CONCRETE

725.1 GENERAL: Change Table 725-1 (Concrete Classes Minimum Requirements) to revise strength requirements as follows.

TABLE 725			
Concrete Classes Minimum Requirements			
Class of Concrete	Min. Cement Content kg/m³	Minimum Compressive Strength (1)	
		At 14 Days MPa	At 28 Days MPa
AA	360	22.1	27.6
A	310	16.6	20.7
B	280	13.8	17.3
C	250	11.1	13.8

SECTION 727

STEEL REINFORCING

Section 727 is supplemented with the following:

727.1 General: All reinforcing steel shall be deformed, and conform to the current requirements of AASHTO M 31M/M 31 (ASTM A 615/A 615M) – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

Reinforcing steel bars shall be Grade 60 (Metric Grade 420).

Revise requirements for the bending of steel to read:
Bending of reinforcing steel shall conform to the requirements Section 505.5.2.

727.2 Wire Reinforcement: Wire reinforcement shall conform to the current requirements of AASHTO M 32M/M 32 (ASTM A 82) – Steel Wire, Plain, for Concrete Reinforcement.

727.3 Wire Mesh Reinforcement: Wire mesh reinforcement shall conform to the current requirements of AASHTO M 55M/M 55 (ASTM A 185).

SECTION 738

HIGH DENSITY POLYETHYLENE PIPE & FITTINGS FOR STORM DRAIN & SANITARY SEWER

Section 738.1 is modified as following:

HDPE pipe will be of the sizes 200 mm through 1200 mm diameter. Sizes greater than 1200 mm diameter shall not be used within Maricopa County rights-of-way without specific approval from MCDOT.