City of Joplin





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Director of Public Works

Changes in Red Effective June 1

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SECTION 0100 - DEFINITION OF TERMS

DEFINITION OF TERMS: Whenever the following terms, or pronouns in place of them, are used in the general requirements and provisions, plans, specifications, proposal and bond, the intent and meaning shall be interpreted as follows:

0100.1 **CITY:** The City of Joplin, Missouri, a municipal corporation.

0100.2 **DIRECTOR OF PUBLIC WORKS**: The Director of Public Works of the City of Joplin, Missouri, only [duly] appointed and holding office at the time of execution of a contract, or during the fulfillment thereof, or such persons or official [officials] as may succeed to the duties of the Director of Public Works. The Director of Public Works is the representative of the City of Joplin, Missouri. The Director of Public Works may appoint an inspector, or delegate his/her authority to subordinate, and [delegate this authority by appointing subordinates (e.g., Assistant Director of Public Works, project managers, inspectors, consultants) as representatives of the City of Joplin, Missouri.] any [Any] instructions issued by such representative [representatives] shall have the same force and effect as if given by the Director of Public Works in person. The Director of Public Works also holds the position of City Engineer and shall be referred to as the Engineer within these Specifications.

0100.3 **BIDDER**: Any individual, firm, association, or corporation submitting a proposal for the improvement contemplated, acting directly or through a duly authorized representative.

0100.4 **CONTRACTOR**: The bidder who shall be licensed in the City of Joplin, Missouri, furnish satisfactory bond and enter into a contract with the City of Joplin, Missouri.

0100.5 **THE CODE:** Any reference to the Code is interpreted to mean the Code of Ordinances of the City of Joplin, Missouri, adopted on April 1, 1998 by Ordinance No. 98-036 or any Ordinances superseding the above thereof.

0100.6 **SURETY**: The party who is bound with and for the Contractor to insure the payment of all lawful debts pertaining to and for the acceptable performance of the contract.

0100.7 **PROPOSAL**: The written offer submitted by the bidder in the required manner to perform the work contemplated.

0100.8 **SPECIFICATION**: The directions, provisions, and requirements contained herein as supplemented by such special provisions and supplemental agreements as may be necessary, describing the method and manner of performing the work, the quality and quantity of materials to be furnished under the contract.

0100.9. **PLANS**: All official drawings, or reproductions of drawings, made or to be made, pertaining to the improvement provided by the contract, or any work in connection therewith.

0100.10 **CONTRACT PRICE**: The sum of the products of the estimated quantities and the respective unit prices or the lump sum set forth in the proposal and the construction contract-agreement,

whichever is applicable to the particular project.

0100.11 **CONTRACT BOND**: The approved form of security furnished by the contractor and his/her surety as a guarantee that the contractor will execute the work in accordance with the terms of the contract and will pay all lawful claims.

0100.12 **NOTICE TO PROCEED**: A written notice from the Director of Public Works notifying the Contractor of the date which he/she is to begin the prosecution of the work for which he/she has contracted [that the prosecution of the contracted work shall begin]. The date set forth in this notice shall be considered the official starting date and the time of completion shall be computed from that date.

0100.13 **CHANGE ORDER**: Written authorization issued by the Director of Public Works as required for changes in the plans, specifications, or terms of contract. Such change orders shall be prepared on a specified form which shall set forth the nature of the change and the agreed-upon cost of same. The change order shall not be binding until such form is completed and signed by the contractor and the Director of Public Works.

0100.14 **A.S.T.M.** The American Society for Testing Materials.

0100.15 **AASHTO.** The American Association of State Highway Officials.

0100.16 **MODOT.** Missouri Highway and Transportation Department.

0100.17 **CRSI** Concrete Reinforced Steel Institute.

0100.18 **A.I.S.C.** American Institute Steel Construction.

0100.19 **P.C.A.** Portland Cement Association.

0100.20 **A.P.W.A**. American Public Works Association.

END OF SECTION

SECTION 0200 -PROPOSAL REQUIREMENTS AND CONDITIONS

0200.1 **SUBMISSION OF PROPOSALS**: All proposals shall be made on the prescribed form furnished to each bidder with the contract documents. Each bidder will be supplied one copy of the proposal form; this shall be placed in an envelope and deposited with the Director of Public Works at the time and place set forth in the Notice to Contractors.

0200.2. **IRREGULAR PROPOSALS**: Proposals may be rejected which are not submitted on the prescribed form entirely free from erasures, omissions or alterations of form. No bid will be considered which has been conditioned by the bidder. In case the bidder notes a requirement in any of the contract documents which he/she believes will require a conditioned or solicited alternate bid, he/she shall so notify the Director of Public Works in order that said Director may review the matter and amend these specifications or plans by addendum prior to the time of receiving bids.

0200.3. **BIDDER'S DEPOSIT WITH BID**: No proposal will be considered unless cash or certified check on a solvent bank or trust company for the amount set forth under each item advertised in the "Notice to Contractors" has been previously deposited with the Director of Finance, and his/her certificate therefore accompanies the proposal. A bid bond, by an incorporated surety company authorized to do business in the State of Missouri, in the amount specified will be accepted.

0200.4 **WITHDRAWAL OF PROPOSALS**: Bidders will be given permission to withdraw, modify or revise a proposal after it has been deposited with the Director of Public Works, provided the bidder makes his/her request in writing to said Director before the actual opening of the proposals. Telegrams or communications that are received or show evidence that they were delivered to said Director prior to the actual opening of bids for the items on which the proposals are submitted, will be accepted and corrections made in proposals in accordance with such telegrams or communications. All telegrams and other communications that alter or modify proposals shall be opened and read prior to the opening of the bid proposals. No proposal may be withdrawn, modified or revised after any bid has been opened for the item, or items, upon which the particular proposal is submitted.

0200.*5* **OPENING OF PROPOSALS**: Proposals will be publicly opened and read at the time and place stated in the "Notice to Contractors". Bidders, or their authorized agents, and the public are invited to be present.

0200.6 **DISQUALIFICATION OF BIDDERS**: More than one proposal from an individual, a firm, partnership, corporation or an association under the same or different names will not be considered. Reasonable grounds for believing that any bidder is interested in more than one proposal for the work contemplated will cause the rejection of all proposals in which such bidder is interested. Any or all proposals will be rejected if there is reason for believing that collusion exists among the bidders and no participation in such collusion will be considered in future proposals for the same work. Proposals in which the prices obviously are unbalanced will be rejected. No contract will be awarded except to a bidder who is financially responsible and capable of performing the type of work contemplated.

0200.7 **FAMILIARITY WITH THE WORK AND LAWS**: The submission of a proposal on the work

shall be considered as a representation that the bidder has carefully examined the site of the proposed improvement and the plans, specifications and other contract documents and that the bidder is fully informed concerning the conditions to be encountered, character, quality and quantity of work to be performed and materials to be furnished; also, that the bidder is familiar with all state laws, the City of Joplin Charter and all ordinances which in any way affect the prosecution of the work, or persons engaged or employed on the work, or the materials and equipment used in the work.

0200.8 **QUALIFICATIONS OF BIDDERS**: Prior to awarding the contract, the successful bidder must satisfy the Director of Public Works as to his/her competence to perform all the work required, and shall be licensed as a Contractor in the City of Joplin.

0200.9 **QUANTITIES:** The quantities shown on the estimate and in the proposal are approximate, and will not necessarily be used in establishing final payment. Each bidder shall make their own estimate of the quantities required and calculate his/her unit price bid accordingly. Payment on the contract will be based on actual number of units installed on the completed work.

END OF SECTION

SECTION 0300 -AWARD AND EXECUTION OF CONTRACT

0300.1 **WITHDRAWAL OF PROPOSAL**: After the opening of bids, no bidder may withdraw his/her proposal until thirty (30) days have elapsed after the date and time of opening bids.

0300.2 **RIGHT TO REJECT PROPOSALS**: The Director of Public Works reserves the right to reject any or all bids and to advertise for new bids.

0300.3 **AWARD OF CONTRACT**: After opening proposals the Director of Public Works may require the three (3) low bidders to submit a financial statement, experience record, and a listing of the equipment, immediately available for the prosecution of the work. As soon as practical after opening bids, an award will be made by the Director of Public Works to the lowest and best bidder. This award by the Director of Public Works shall require that all contract documents be executed in quadruplicate by the Contractor and his/her Surety and returned to the Director of Public Works within ten (10) days after the date of notice of award. If the award of contract by the Director of Public Works shall not be binding on the City until such award has been confirmed by the passage of an appropriate ordinance by the City Council, such fact will be recited in the construction contract agreement.

0300.4 **RETURN OF CERTIFIED CHECKS**: The Director of Public Works will authorize the Director of Finance to return all certified checks or cash deposits except those of three (3) lowest bidders that will be retained until the successful bidder has executed contract and bond.

0300.5 **PERFORMANCE AND MAINTENANCE BOND**: The successful bidder at the time of execution of contract shall furnish a surety bond, otherwise known as Performance Bond and a Maintenance Bond executed by an incorporated surety company authorized to do business in the State of Missouri, in amounts and for periods as may be set out in the construction specifications for each contract; such bonds guaranteeing that said bidder will well and truly perform the covenants contained in the contract and will pay for the work and labor of all laborers, sub-contractor teamsters, truck drivers, employed, and owners of equipment used on the work, and for all materials therein, and further guaranteeing the City of Joplin against faulty workmanship and materials incorporated in the work covered by the contract for a period of one year.

0300.6 **FAILURE TO EXECUTE CONTRACT**: Failure to give satisfactory security in a sum equal to the contract price of [or] failure to execute the contract within ten (10) days as specified shall be just cause for annulment of the award, or of the contract if executed and in the event of the annulment of the award of the contract because of such failure, it is agreed by the bidder that the certified check, or cash deposited with the Director of Finance shall become the property of the City of Joplin and will be retained, not as a penalty, but as liquidated damages.

0300.7 **SUBLETTING OF CONTRACT**: The contract or any portion thereof shall not be sublet except with the written consent of the Director of Public Works. No such consent shall be construed as making the City of Joplin a part to such subcontract, or subjecting said City of Joplin to liability of any kind to any subcontractor. No subcontract shall under any circumstances relieve the Contractor of his/her liability and obligation under his/her contract, and all transactions with the City of Joplin, acting through its Director of Public Works, must be through the General Contractor.

Subcontractors will be recognized and dealt with only as workers and representatives of the General Contractor and as such shall be subject to the same requirements as to character and competence as set forth in Section 0400.5 of this document.

END OF SECTION

SECTION 0400 - GENERAL PROVISIONS

0400.1 **SCOPE OF WORK**: The Contractor shall furnish all labor, materials, equipment, construction facilities, and supervision necessary to construct and complete the improvement as set forth in the plans and specifications, excepting only those marked "to be done or furnished by others" or "not in contract", the Contractor shall fully complete the project and leave the work and site in a neat and finished condition. A detailed description of the scope of work will be given in the construction specifications but such description shall not limit the responsibility of the Contractor to fully complete his/her contract in accordance with the full intent of all contract documents.

0400.2 **UNAUTHORIZED WORK**: Work done without lines and grades being given, work done beyond the lines and grades shown on the plans or as given, work done not shown on the plans or included in the specifications, except as herein provided, or any extra force account work done without written authority from the Director of Public Works will be considered as unauthorized and done at the expense of the Contractor. The Director of Public Works may order work so done, removed or replaced at the Contractor's expense.

0400.3 **PROSECUTION OF WORK**: The Contractor shall give his/her constant personal attention to the work, or shall provide a competent and reliable superintendent who shall have full authority to act for him, and who shall be acceptable to the Director of Public Works. The superintendent must be physically present on the job site at all times. The attendance on site of the superintendent shall be verifiable through the certified payrolls. The superintendent shall provide a mobile phone number that he may be reached 24 hours a day, seven days a week. If at any time the work is not progressing in a satisfactory manner to the Director of Public Works, the Contractor shall increase the force, tools and equipment as directed by the Director of Public Works, but the failure of the Director of Public Works to give such directions shall not relieve the Contractor of his/her obligation to complete the work at the time and in the manner specified in this contract. Should the prosecution of work, for any reason, be discontinued with the consent of the Director of Public Works, the Contractor shall notify the Director of Public Works in writing at least twenty-four (24) hours before again resuming operations.

0400.4 **OTHER CONTRACTORS:** The Contractor is required, as far as possible, to arrange his/her work and dispose of his/her materials so as not to interfere with the operations of other contractors engaged upon adjacent work. He/she shall also be required to join his/her work to that of others in a proper manner, in accordance with the spirit and intent of the plans and specifications, and to perform his/her work in the proper sequence in relation to that of other contractors.

0400.5 **CHARACTER OF WORKERS AND EQUIPMENT**: All subcontractors, superintendents, foremen and workers employed by the Contractor shall be careful and competent. The Director of Public Works may demand the dismissal of any person employed by the Contractor, in, about, or upon the work, who misconducts himself or is incompetent or negligent in the due and proper performance of his/her duty, or who neglects or refuses to comply with the directions given; and such person shall not be employed again without the written consent of the Director of Public Works. Should the Contractor continue to employ, or again employ any such person, the Director of Public Works may withhold all estimates that are or may become due, or the Director of

Public Works may suspend the work until such orders are complied with. The Contractor shall furnish such equipment as is considered necessary for the prosecution of the work in an acceptable manner and at a satisfactory rate of progress. Equipment used on any portion of the work shall be such that no unauthorized injury to adjacent property, roadways, walks or other highways will result from its use.

0400.6 **COOPERATION OF CONTRACTOR REQUIRED**: The Contractor will be supplied by the Director of Public Works with copies of the plans and specifications and he/she shall have available on the work at all times during the prosecution of the work one copy of each of said plans and specifications. He/she shall give the work his/her constant attention to facilitate the progress thereof and shall cooperate with the Director of Public Works in every possible way. He/she shall have at all times a competent and reliable representative on the work, authorized to receive orders and to act for him, in case of his/her absence.

0400.7 **LAWS TO BE OBSERVED**: The Contractor shall at all times observe and comply with all Federal and State laws, local by-laws, ordinances, and regulations which in any manner affect the prosecution of the work. The contractor and his/her surety shall indemnify and save harmless the City of Joplin, and all its officers, engineers, representatives, agents and employees against any claim or liability rising from or based on the violation of any such law, by-laws, ordinance, regulations, order or degree, whether by himself, his/her employee or her subcontractor.

0400.8 **PUBLIC CONVENIENCE AND SAFETY:** The Contractor shall at all times observe city ordinances relating to obstructing streets, maintaining signals, keeping open passageways and protection of same where exposed and generally obey all laws and ordinances controlling or limiting those engaged on the work; and said contractor and his/her surety hereby expressly bind themselves to indemnify and save the City harmless from all suits or actions of every name and description, brought against said city for or on account of any injuries or damages received or sustained by any party or parties from the acts, omissions, or negligence of said contractor or his/her servants or agents including subcontractors in doing the work herein contracted for, or by or in consequence of any negligence in guarding the same, or in any improper materials used in its construction, or by or on account of any act or omission of the said contract, or on account of any claims or amounts recovered for infringement of patent, trade mark, or copyright, or from any claims or amounts arising or recovered under the Workmen's Compensation Law. In case there is any money due the contractor, so much of the money due the said contractor as the Director of Public Works shall deem necessary to protect the City of Joplin will be retained by the City until such suit or suits, action or actions, claim or claims, injuries or damages, as aforesaid, shall have been settled and suitable evidence to that effect furnished to the Director of Public Works. The Contractor shall put and maintain sufficient lights at night, and shall erect and maintain suitable barricades, and take any and all other proper precautions to guard against damage or injury to persons or property, and streets and alleys shall be open to traffic at all times during construction except when special permission is granted by the Director of Public Works for temporary closing of such streets and alleys.

0400.9 **USE OF EXPLOSIVES**: The Contractor shall not blast any rock or other materials, or allow the same to be done in the prosecution of the work, unless he/she secures a blasting permit from the Director of Public Works. The Contractor shall use the utmost care so as not to endanger life or property, and whenever directed by the Director of Public Works the number and size of the charges shall be reduced. All explosives shall be stored in a safe manner and all such storage

places shall be marked "Dangerous Explosives", and shall be in charge of competent watchperson at all times. The provisions of the Fire Prevention Code of the City of Joplin, Missouri, concerning storage of explosives, shall be strictly obeyed. A blasting permit issued by the Joplin Fire Department is specifically required.

0400.10 **BLASTING**: Where blasting is necessary, suitable weighted plank coverings or mattresses shall be provided to confine all materials lifted by the blasting within the limits of the trench or other excavation, and to prevent injury to life and property. All excavated rock that cannot be shoveled as earth shall be kept separate from other excavated materials and shall not be mixed with other backfill material except as directed.

0400.11 **PRESERVATION AND RESTORATION OF PRIVATE PROPERTY, PUBLIC PROPERTY, TREES, LAND SURVEY MONUMENTS, ETC**: Contractor shall be responsible for the preservation of all public and private property, trees, land survey monuments, pole and pipe lines, etc., along and adjacent to the line of work and shall use every precaution necessary to prevent damage or injury thereto. Contractor shall use suitable precaution to prevent damage to pipes, conduits and other underground structures, and shall protect carefully from disturbance or damage all land survey monuments and property boundary markers.

The Contractor shall not enter upon private property for any purpose without obtaining the permission of the owner.

The Contractor shall not unnecessarily injure or destroy trees or shrubs in any right-of-way, and he/she shall not remove or cut them without proper authority. Contractor shall be responsible during the prosecution of the work for all damage or injury to property of any character, or to persons, resulting from any act, omission, neglect or misconduct in his/her manner or method of executing said work, non-execution of said work, or due to defective work or materials. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work, or in consequence of the non-execution thereof on the part of the contractor, said contractor shall restore, at contractor's own expense, such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring, as may be directed, or contractor shall make good such damage or injury in an acceptable manner. In case of failure on the part of the contractor to restore such property or to make good such damage or injury, the Director of Public Works may, upon forty-eight (48) hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary and the cost thereof will be deducted from any monies due, or which may become due the contractor under his/her contract.

The contractor shall preserve all land survey monuments **not** scheduled for removal as part of the project per plan documents. Land survey monuments shall include, but are not limited to: United States Public Land Survey System (USPLSS) corners, property boundary markers, right of way monuments, benchmarks, control points and reference marks set by the Engineer. If any existing land survey monuments are damaged, destroyed or disturbed by the contractor, the cost of replacement will be at the contractor's expense. Pursuant to the provisions of chapter 60, RSMo, section 60.355, the contractor shall retain the services of a Professional Land Surveyor licensed in the State of Missouri, who shall be responsible for restoring or reestablishing any damaged or destroyed survey monuments not scheduled for removal as part of the construction project. The contractor shall notify the City of any monuments damaged or destroyed by a utility, other contractor or any other outside party.

60.355. 1. No person, other than a registered land surveyor registered pursuant to chapter 327,

RSMo, shall knowingly move, remove, deface or destroy any corner of the United States Public Land Survey System, property boundary marker, bench mark or horizontal control monument.
2. Any person who violates the provisions of this section is guilty of a class B misdemeanor.
3. Any person who violates the provisions of this section is liable for the cost of reestablishment of permanent monuments or markers by a registered land surveyor. This section shall establish a civil cause of action in favor of any owner of real estate the boundaries of which are affected by a violation of subsection 1 of this section. Venue for such cause of action shall be in the county in which the violation occurs. Damages shall be limited to reasonable surveying costs and reasonable attorneys' fees.
When project plan documents call for the removal of an existing USPLSS corner, property boundary marker, right of way monument, etc., due to land clearing, construction, or similar operations, the Engineer, or a qualified agent, shall set suitable reference monuments so as to facilitate the re-establishment of the corner upon the completion of the project.

0400.12 **CONTRACTOR'S RESPONSIBILITY FOR WORK**: Until work is accepted by the Director of Public Works, it shall be in the custody and under the charge and care of the Contractor, and he/she shall take every necessary precaution against injury or damage to the work, by the action of the elements or from any other cause whatsoever. The contractor shall rebuild, repair, restore and make good, at his/her own expense, all injuries or damages to any portion of the work before its completion and acceptance. Issuance of any estimate or partial payment on any part of the work done will not be considered as final acceptance of any work completed up to that time.

0400.13 **TEST OF SAMPLES OF MATERIALS**: The Contractor shall furnish for approval such samples of materials proposed for use on the work as the Director of Public Works may require, and shall ship them prepaid to such person and address as the Director of Public Works shall direct. Samples shall be shipped in ample time to permit testing without delaying the work, and no materials of which samples are required, shall be used until the samples have been approved.

0400.14 **DIRECTOR OF PUBLIC WORKS TO BE REFEREE**: To prevent misunderstanding and litigation, the Director of Public Works shall decide any and all questions which may arise concerning the quality and acceptability of materials furnished and work performed, manner of performance, rate of progress of said work, the interpretation of the plans and specifications, and the acceptable fulfillment of the contract on the part of the contractor; and the Director of Public Works will determine the amount, quantity, character, classification and quality of the several kinds of work performed and materials furnished which are to be paid for under the contract, and such decision and estimate will be final, conclusive, and binding upon both parties; and such estimate, in case any questions arises, will be a condition precedent to the right of the contractor to receive any money due under the contract. Any doubt as to the meaning of the plans, specifications and contract will be explained by the Director of Public Works; all directions and explanations necessary to complete, explain or make definite the plans, provisions, specifications or contract, and to give them due effect, will be given by the Director of Public Works, and his/her findings shall be final and binding on both parties.

0400.15 **INSPECTION OF MATERIALS AND WORK**: The work will be conducted under the general direction of the Director of Public Works and is subject to inspection by his/her appointed inspectors to insure strict compliance with the terms of the contract. No inspector is

authorized to change any provision of the specifications without written authorization of the Director of Public Works, nor shall the presence or absence of an inspector relieve the contractor from any requirements of the contract.

0400.16 **CARE OF PIPES AND DRAINS AND PROVISIONS FOR WATER**: The Contractor shall provide for the flow of all watercourses, sewer, drains or channels interrupted during the progress of the work. Whenever water or gas mains or service pipes there from, or drains or other improvements are uncovered during the progress of the work, the contractor shall use care in protecting same and shall promptly notify the owners thereof and allow them reasonable time to make the necessary removal or alteration.

0400.17 **INFRINGEMENT AND PATENT SUITS**: The Contractor shall be liable for suits brought against the City by reason of infringement on the patent right of any material, method, machine or appliance on the work, and shall assume all liability resulting from such suits against the City.

0400.18 **REJECTION OF MATERIAL AND WORK**: If any work done and material furnished is found defective or not in accordance with the specifications, it shall be rejected and promptly removed from the work by the contractor, and other material furnished and work done in substitution thereof. Any defective material or workmanship may be rejected at any time before the final acceptance of the work, even though the same may have been previously overlooked.

0400.19 **CONTRACT TIME FOR COMPLETION OF WORK**: The contract time for the completion of work is specified in the construction specifications or contract documents. A working day is defined as any day when, in the opinion of the Director of Public Works, soil and weather conditions are such as would permit any then major operation for six (6) hours or over. If conditions are such as to stop work in less than this time, the day shall not be counted as a working day. Saturdays, Sundays, national holidays, and holidays legal in the State of Missouri shall be excluded from the count of working days unless the contractor utilizes such a day as a working day as indicated above. The count of working days shall start on the date the contractor starts construction operation and in any event not later than the date specified in the Notice to Proceed. The Director of Public Works shall be the sole judge of the number of working days to be charged under the contract. Upon request from the contractor in writing the representative of the Director of Public Works shall give written notice to the Contractor, or to his/her representative in charge of the work, of the number of working days he/she has determined there were in the weekly period covered by such notice. Any objection by the Contractor to such weekly decision shall be deemed waived, and shall not thereafter be made the basis of any claim, unless the Contractor shall, within three (3) days after receipt of such notice, file with the Director of Public Works his/her written protest setting forth his/her objections and specifying the reasons therefore. If the Contractor's objections to the working day count is made on the grounds that he/she is unable to work due to causes beyond his/her control, he/she shall state his/her reasons in writing, furnish proof to establish his/her claim, and state the approximate number of days he/she estimates he/she will be delayed. If a contract working time is defined in Calendar days then the contract days shall be determined as the number of actual days passing since the Notice to Proceed Date regardless of any legal holidays, inclement weather days or other non-working days.

0400.20 **LIQUIDATED DAMAGES**:

(a) Time is of the essence of all contracts. As delay in the prosecution of the work will inconvenience the public, obstruct traffic, interfere with business, and increase the cost to the City, it is important that the work be prosecuted vigorously to completion. Should the Contractor, or in case of default, the surety, fail to complete the work within the time stipulated in the construction specifications, or within such extra time as may be allowed in the manner set out in the preceding section, a deduction of an amount as set out in the Construction Specifications will be made for each and every calendar day that such contract remains uncompleted after the time allowed for the completion. The said amount set out in the Construction Specifications shall be the liquidated damages for loss to the City and the public due to obstruction of traffic, interference with business, and increased cost of engineering, administration, inspection, etc., after the expiration of the time stipulated in the Construction Specifications, or as amended as set forth in the preceding section, and will be deducted from any money due the Contractor under his/her contract, and the Contractor and his/her surety shall be liable for any liquidated damages in excess of amount due the Contractor. Permitting the Contractor to continue and finish the work or any part of it after the expiration of the stipulated time, or after any extension of the time shall in no way operate as a waiver on the part of the City or any of its rights under this contract.

(b) In any suit involving the collection of liquidated damages, the reasonableness of the amount per day stipulated in the Construction Specifications shall be presumed.

(c) If the City or any of its agents should cause a delay in any part of he/she work, or in the final completion of the job, this fact shall not void the provisions of the contract as to liquidated damages, but the Contractor shall be given such additional working days for the final completion of the job as the Director of Public Works may deem proper to compensate for such delay caused by the City or its agents.

0400.21 **ANNULMENT OF CONTRACT**: If the Contractor failed to begin the work within the time specified, or fails to perform the work with sufficient workers and equipment, or with sufficient materials to insure the prompt completion of said work, or performs the work unsuitably, or neglects or refuses to remove materials or perform anew such work as shall be rejected as defective and unsuitable, or discontinues the prosecution of the work, or from any other cause whatsoever does not carry on the work in an acceptable manner, or if the Contractor becomes insolvent or declares bankruptcy, or commits any act of bankruptcy or insolvency, or allows any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours; the Director of Public Works shall give notice, in writing, by registered mail, to the Contractor and his/her Surety, of such delay, neglect or default. If the Contractor or his/her Surety, after such notice, does not proceed to take over and complete the work under the direction of the Director of Public Works, then the Director of Public Works shall have full power and authority, without violating the contract or bond, to take over the completion of the work, to appropriate or use any or all materials and equipment on the ground that may be suitable and acceptable, to enter into agreements with others for the completion of said contract according to the terms and provisions thereof, or to use such other methods as in his/her opinion may be required for the completion of said contract in an acceptable manner. Such declaration of annulment must be confirmed and ratified by Ordinance before having any force or effect. For all costs and charges incurred by the City of Joplin together with the cost of completing the work, the Contractor and his/her surety shall be liable, and such cost may be deducted from any monies due or which may become due the Contractor. In case the expense so incurred by the City of Joplin is less than the sum which

would have been payable under the contract if it had been completed by the Contractor, then the Contractor will be entitled to receive the difference, and in case such expense exceeds the sum which would have been payable under the contract, then the Contractor and his/her Surety shall be liable and shall pay to the City of Joplin the amount of said excess.

0400.22 **PLANS AND SPECIFICATIONS**: The plans and specifications on file in the office of the Director of Public Works relating to any public work, and all plans which may be made by the Director of Public Works subsequent to the date of any contract, of an explanatory nature thereto, shall be a part of the contract and specifications.

0400.23 **ERRORS, OMISSIONS, ALTERATIONS**: The specifications and plans are intended to supplement each other so that any work shown on the drawings and not mentioned in the specifications, or vice versa, is to be executed the same as if mentioned in the specifications and set forth on the plans, to the true intent and meaning of said drawings and specifications. The Contractor shall check over the plans before beginning construction work and, if any errors or omissions are discovered, he/she shall call the attention of the Director of Public Works to them in order that the necessary corrections may be made. In no case shall the Contractor make such corrections without first consulting the Director of Public Works. In case any plans of a supplementary or explanatory nature are necessary or desirable, they will be furnished by the City from time to time as the work progresses. In case changes are made in the work either in increasing or decreasing the cost thereof, corresponding additions to or deductions from the amount to be paid the Contractor shall be made. Such changes in work, additions or deductions in scope of work, and adjustment of the contract price shall be considered valid and authorized when a change order has been issued by the Director of Public Works.

0400.24 **COST OF EXTRA WORK**: In case extra work not covered by the contract is deemed necessary to complete or perfect the project, the Contractor shall submit to the Director of Public Works a proposal stating in clear detail the scope of the extra work he/she promises to do. This proposal shall also include a statement of the Contractor's proposed manner or determining the cost or amount that he/she proposes as full settlement for the extra or additional work. The Director of Public Works may accept any of the below described means of computing the additional cost of doing extra work.

(a) If the proposal and contract contains unit prices that are applicable to the additional cost, they shall be used in determining the increase in cost.

(b) The Director of Public Works may accept a lump sum proposal from the Contractor.

(c) The additional or extra work may be done by force account in the manner described below:

1. The price paid the Contractor for extra work for which no unit price is named in the contract and for which no lump sum price can be agreed on shall be determined in the manner set forth below:

2. The actual cost of salaries or wages for all labor used on the "extra work" including the proper proportionate time of the foreman or foremen, but not including the time of a superintendent or office personnel.

3. The actual cost or value of all material or equipment incorporated into the "Extra Work".

4. Rental, at rates not exceeding the current rental rates then prevailing in the City of Joplin for all power drive equipment for the time or proportionate time such equipment is employed on the "Extra Work".

5. A fee of fifteen (15) percent of the sum of Items 1, 2 and 3 to cover superintendence, overhead expenses, rental, maintenance of tools, equipment, machinery, hand tools, bond and profit.

6. The total amount paid for extra work shall be the sum of 1, 2, 3 and 4, above, plus the amount which the Workmen's Compensation, Public Liability, Property Damage, Contingent Public Liability and Property Damage, Special Hazard and Social Security Insurance is increased by the performance of the "extra work".

Note: When force account "Extra Work" is authorized, accounting procedures for such work, satisfactory to the Director of Public Works, shall be installed.

0400.25 **ESTIMATED QUANTITIES**: If unit prices and estimated quantities are the basis of bidding on the base contract or any extras thereto, such quantities of work as shown on plans or stated in the proposal are only approximate, and during the progress of the work, the City may find it advisable, and it shall have the right to omit portions of the work and to increase or decrease quantities, and the City reserves the right to add or to take from any item as may be deemed necessary or desirable. Only actual quantities will be paid for and under no circumstances or conditions will the contractor be paid anything on account of anticipated profits upon the work, or any portion thereof covered by the contract which is not actually performed and which has not actually entered into the construction of said improvements.

0400.26 **MEASUREMENTS**: The actual amount of work to be done may be more or less than shown on the plans and specifications, but no variation will be made in the unit rates on that account. No extra or customary trade measurements of any kind will be allowed in measuring the work under the specifications; but the actual length, area, solid contents or number shall be considered.

0400.27 **TRADE MARKS**: If trade names are used in the construction specifications, they are used merely to establish a standard of quality, performance or economy of operation and the use of such trade name or trade names shall not be considered as restrictive against similar products of equal quality not named. Special consideration will be given to products manufactured within the corporate limits of the City of Joplin, Missouri, when such products meet the requirements of the specifications.

0400.28 **SUBLETTING:** The Contractor shall not sublet or assign his/her contract, or any part thereof, without the written approval of the Director of Public Works. No transfers shall, under any circumstances, relieve the Contractor or his/her bondsmen of their liabilities and obligations under this contract.

0400.29 **CLEANING SITE:** The Contractor shall not allow the site of the work to become littered with

trash and waste material but shall maintain the same in a neat and orderly condition through the construction period. The Director of Public Works shall have the right to determine what is or is not waste material or rubbish and the manner and place of disposal. On or before the completion of the work the Contractor shall, without charge therefore, tear down and remove all temporary structures built by him, and shall remove all rubbish of all kinds from any of the tracts or ground which he/she has occupied, and shall leave them in an orderly and neat condition.

0400.30 **CONTRACTOR AN INDEPENDENT CONTRACTOR**: It is expressly agreed and understood that the Contractor is in all respects an independent Contractor as to such work, notwithstanding in certain respects the Contractor, is bound to follow the director of the Director of Public Works, and that the Contractor is in no respect an agent, servant, or employee of the City.

0400.31 **CHANGE IN PLANS - BONDSMEN NOT RELEASED**: It is further stipulated and agreed that the liability of the surety shall not be affected by any extension of the time of the completion of said work which may be granted by Ordinance of the Council, or the changing of the plans and specifications, or the subletting of a part of the contract.

0400.32 **TAXES**: The City of Joplin, a tax exempt entity, will furnish a Missouri Project Exemption Certificate as described in Section 144.062 RSMo to the awarded contractor who in turn may use the certificate to purchase materials for a specific project performed for the tax exempt entity. Only the materials and supplies incorporated or consumed during the construction of the project are exempt. The certificate will be issued to the contractor for a specific project for a defined period of time.

0400.33 **CITY NOT LIABLE FOR DELAYS**: In no event shall the City of Joplin be liable or responsible to the Contractor or to any other person for or on account of any stoppage or delay of the work herein provided for, by injunction or other legal or equitable proceedings, or from or by or on account of any delay from any cause over which the City has no control.

0400.34 **WATER:** The Contractor shall furnish the water necessary for his/her operation or tests. The Contractor shall, at his/her own expense, install and maintain any water supply connections, piping and storage required for the prosecution of the work, but only at such locations and in such workmanlike manner as may be authorized by the City.

0400.35 **ELECTRICITY**: All electric current required by the Contractor shall be furnished at his/her own expense. All temporary lines shall be furnished, installed, connected, and maintained by the Contractor in a workmanlike manner satisfactory to the City, and shall be removed by the Contractor in like manner at his/her expense at the completion of construction.

0400.36 **TEMPORARY HEATING**: During construction operations, the Contractor shall furnish and install any temporary heating facilities required to provide heat for any trades whose installation work necessitates certain temperature requirements.

0400.37 **SHOP DRAWINGS**: The Contractor shall submit to the Director of Public Works for approval four (4) copies of all shop drawings called for under the various headings of these specifications,

or on the drawings. These drawings shall be complete and shall contain all required detailed information. If approved by the Director of Public Works or his/her representative, one set will be returned to the Contractor with the approval marked thereon.

0400.38 **GUARANTY:** Any equipment furnished pursuant to any specifications shall be guaranteed for a period of one year from the date of final acceptance thereof against defective materials, design and workmanship. Upon receipt of notice from the City of failure of any part of the guaranteed equipment during the guaranty period, the affected part or parts shall be replaced promptly with new parts by, and at the expense of the contractor.

0400.39 **CONSTRUCTION STAKING AND SURVEYING:** The Contractor shall employ a competent surveyor, whose work meets the approval of the Director of Public works. Staking work shall be in accordance with general accepted surveying practices and provisions of the contract.

All surveying work performed by the contractor shall be sufficient and accurate to construct the work in accordance with the contract documents. Any delays or additional costs to the project which result from insufficient or inaccurate staking shall be corrected at the expense of the contractor and at no additional charge to the City.

All surveying shall be documented by the contractor in a written form acceptable to the Engineer. During performance of work, all surveying documents shall be available and supplied to the Engineer upon request, at the contractor's expense. All documents shall be labeled with Job Name/Number, Contractor Name, Survey Party Chief and Date. Any deviation from staking requirements as set forth herein must be approved in writing by the Engineer. (*)Construction staking requirements for certain types of work can be found in their respective specification sections.

0400.40 **TIME FOR INSPECTION**: Any inspection required by the specifications to be made by the Director of Public Works will be made within three (3) days, by the Director of Public Works or his/her authorized representative, after receipt by him of notice from the Contractor that said work is ready for inspection.

NOTE: If the execution of the work requires the closing of city streets to through traffic, it shall be the responsibility of the contractor to notify the Director of Public works and the Fire and Police Department forty-eight (48) hours in advance. It shall further be the responsibility of the contractor to provide proper signs for detouring traffic ***in accordance with MUTCD****, and the Contractor shall make every effort to provide residents vehicular access to their homes and driveways, especially at night.*

END OF SECTION

SECTION 0500 -INSURANCE REQUIREMENTS

0500.1 CONTRACTOR'S INSURANCE: The Contractor shall not commence work under any contract until he/she has obtained all insurance required under this section and such insurance coverage has been approved by the Director of Public Works, or shall the Contractor allow any subcontractor to commence work on his/her subcontracts until all similar insurance required of the subcontractor has been so obtained and approved.

0500.2 PUBLIC LIABILITY AND PROPERTY DAMAGE INSURANCE: The Contractor shall take out and maintain during the life of this contract such public liability and property damage insurance as shall protect him and any subcontractor performing work covered by this contract, from claims for damages for personal injury, including accidental death, as well as claims for property damages, which may arise from operations under this contract, whether such operation be by himself or by any subcontractor or by anyone directly or indirectly employed by either of them and the amount of such insurance shall be as follows:

1. Public liability insurance in an amount not less than the limits of liability specified or required by Laws or Regulations, whichever is greater.

2. For injuries, including accidental death to any one person, and subject to the same limit for each person, in an amount not less than the limits of liability specified or required by Laws or Regulations, whichever is greater.

3. Automobile, Truck and Team Public Liability and Property Damage Insurance must be carried by each Contractor and/or Subcontractor where automobiles, trucks, or teams are used at the project site by such Contractor and/or Subcontractor where automobiles, trucks, or teams are used at the project site by such Contractor and/or Subcontractor where automobiles, trucks, or teams are used at the project site by such Contractor and/or Subcontractor.

0500.3 INSURANCE COVERING SPECIAL HAZARDS: The following special hazards shall be covered by rider or riders to the Public Liability and/or Property Damage insurance policy or policies herein elsewhere required to be furnished by the Contractor or by separate policies of insurance, in amounts as follows:
Operation each vehicle away from project site: the limits of liability specified or required by Laws or Regulations, whichever is greater.

0500.4 CONTINGENT INSURANCE: The Contractor shall provide contingent or Protective Public Liability Insurance in an amount not less than the limits of liability specified or required by Laws or Regulations, whichever is greater. If work is subcontracted, applicable to subcontractors as well in the event they sublet any of their work.

0500.5 EXCEPTIONS: The Director of Public Works may accept insurance covering a Subcontractor in character and amounts less than the standard requirements set

forth herein where such standard requirements appear excessive because of the character or extent of the work to be performed by the subcontractor.

0500.6 INSURANCE PROTECTING THE OWNER: The Contractor shall provide and maintain insurance to protect the City of Joplin, Missouri, against any and all claims for damages for personal injury, including accidental death, as well as from claims for property damage which may arise from operations under this contract whether such operations be by the Contractor or any of his/her subcontractors, or by any one directly or indirectly employed by the Contractor or his/her subcontractors. The minimum protection provided for this coverage shall be of the same character and the same amounts set forth in the preceding paragraphs E-1 (a) and (b) of this section. This coverage will be considered acceptable when provided in one of the following methods:

1. By issuance of original policy designating the Contractor and the City of Joplin, Missouri, as the insured parties under the provisions of the policy.

2. By endorsement to an original policy which endorsement shall extend to the City of Joplin, Missouri, the same coverage and protection stipulated in the paragraph above.

3. By separate contingent policy providing the required insurance coverage for the protection of the City of Joplin, Missouri.

0500.7 PROOF OF CARRIAGE OF INSURANCE: The Contractor shall furnish the Director of Public Works, prior to start of any operation on the project, satisfactory proof of carriage of the insurance required. The certificate must show the cancellation provision of the policy. No policy is acceptable to the owner that can be cancelled by the insurer in less than ten (10) days after the insured, including the owner, has received written notice of such cancellation. It is requested that each insurance certificate contain a clause substantially as follows:
"The policies referred to herein provide that they cannot be cancelled by the insurer in less than ten (10) days after the insured has received written notice of such cancellation."

0500.8 SCOPE OF PAYMENT: The Contractor shall receive and accept the compensation provided for in the contract as full payment for furnishing all materials, labor, tools and equipment, and for performing all work contemplated and embraced under the contract; also for all loss or damage arising out of the nature of the work, or from the action of the elements; also for all expenses incurred by, or in consequence of the suspension or discontinuance of the said prosecution of the work as herein specified, or from any unforeseen difficulties or obstructions for all risks of every description connected with the prosecution of the work until its final acceptance by the Director of Public Works. The compensation shall be considered as full payment for the completion of the work in an acceptable manner according to the plans and specifications, and it shall be understood that the Contractor and his/her Surety shall indemnify and save harmless Joplin from any suit, cost, or penalty, for any infringement of patent, trademark, or

copyright, which may be encountered in the prosecution of the said work. The payment of any current or final estimate or the acceptance of any portion of the work as provided in the standard specifications shall in no way or in no degree affect to the obligation of the Contractor who at his/her own expense, shall repair, correct, renew or replace any defects or imperfections in the construction, strength, or quality of materials used in or about the construction of the work under the contract, and this payment shall in no way affect his responsibility for all damages due or attributable to such defects or imperfections which may be discovered before the final acceptance of the whole work, and of which defects or imperfections, the Director of Public Works will be the judge.

DIVISION 1000

EARTHWORK

SECTION 1100 - CLEARING, GRUBBING AND DEMOLITION

1100.1 SCOPE: This section governs the furnishing of all labor, equipment, tools, and materials, and the performance of all work for clearing, grubbing, and demolition wholly, or in any part of locations shown on the plans; as provided for in the Special Provisions.

1100.2 MATERIALS, DEFINITIONS, AND EQUIPMENT:

1100.2.1 ***Clearing***: Clearing shall consist of removing all vegetable matter, such as trees, brush, down timber, rotten wood, rubbish, and other objectionable combustible materials, found on or above the surface of the site. It shall include removing wood buildings, fences, lumber, waste dumps, and trash, and the salvaging of such of the materials as may be specified and disposing of the debris.

1100.2.2 ***Grubbing***: Grubbing shall consist of removing all stumps, roots, buried trees and brush, wood piling, wood curb planking, wood culverts, wood catch basins and drains, and wood stairs appearing on or below the surface of the ground which has not been included in Section 101.2A entitled "Clearing".

1100.2.3 ***Demolition***: Demolition shall consist of demolishing and removing or incorporating into embankment all non-vegetable matter appearing above, on, or below the ground surface. This shall include all material derived from the demolition of Portland cement concrete items such as base courses, curbs, curb and gutters, sidewalks, floors, steps, driveways, drainage structures of all sorts, guard fences, or other miscellaneous items such as foundations or walls of any work, and iron or steel items; and shall include all asphaltic items such as pavement and base courses.

1100.2.4 ***Trees*:** Vegetable growth six (6) inches in diameter and larger, measured three (3) feet above ground shall be classified as a tree.

1100.2.5 ***Brush*:** Vegetable growth less than six (6) inches in diameter, measured three (3) feet above ground shall be classified as brush.

1100.3 CONSTRUCTION DETAILS -LIMITS OF WORK:

1100.3.1 ***In Development Areas***: In developed and semi-developed areas where streets exist, the limits for clearing, grubbing, and demolition shall be as defined on the plans or in the Special Provisions, but in no case shall work extend beyond the limits of the right-of-way, city property lines, or easements.

1100.3.2 ***In Undeveloped Areas***: In undeveloped areas where improvements are very scattered or non-existent, clearing, grubbing, and demolition shall extend to the limits of the right-of-way, city property lines, or easement unless otherwise indicated on the plans or covered in the special provisions. In the case of streets, the limits shall include the area along intersecting streets and alleys for such distance as required to provide a clear area for the construction;

1100.3.3 ***Protection of Existing Facilities***: The Contractor shall be responsible for protecting any

improvement of any agency, public or private, in the vicinity of clearing, grubbing or demolition operations. When necessary the Contractor shall enlist the assistance of the affected agencies in the location of their utilities. The Contractor will not be responsible for the cost to any agency for assistance in the location of its facilities, but he/she shall be responsible for the cost of all damage to such facilities arising because of his/her carelessness or negligence.

1100.3.4 ***Progress of Clearing*****:** Clearing shall be carried well in advance of the construction operation so as not to delay the progress of the work. The refuse resulting from clearing may be hauled to a waste site secured by the Contractor or shall be burned or buried in such a manner as to meet all requirements of the State, County, and Municipal regulations regarding health, safety, and public welfare. When authorized by the Fire Department, the Contractor may dispose of such refuse by burning on the site of the project provided all requirements set forth by the Fire Chief are met. In all cases, the authorization to burn on the site shall not relieve the Contractor in any way from damages that may result from his/her operation. In no case shall any materials be left on the project site, shoved into abutting properties, or be buried in embankments or trenches on the site.

1100.3.5 ***Protection of Trees and Shrubs***: The Contractor shall leave in place and protect from damage during his/her operations all trees, shrubbery and flower beds designated by the Engineer. Where trees existing on the project site are not to be removed, it shall be the Contractor's responsibility to trim low limbs that will interfere with the normal operation of his/her equipment. The trimming shall be performed in a professional manner, prior to his/her machine operation as ordered by the Engineer.

1100.3.6 ***Progress of Grubbing*****:** Grubbing shall be kept abreast the "Clearing" as nearly as the sequence of operations will permit. Except as specified below, all stumps, roots, and other objectionable matter within the construction area shall be removed to a depth of at least twelve (12) inches below the sub-grade or the original ground, whichever is lower. All stumps, roots, and other objectionable matter within the right-of-way but outside of the limits of the construction area shall be cut off flush with the ground.

1100.3.6 ***Shallow Embankment Areas***: Within the specified limits of embankments that are two (2) feet or less in depth, all stumps, roots, and planking of all sorts shall be removed and disposed of. Piling and butts of utilities poles within the limit shall be removed to a minimum depth of two (2) feet below the sub-grade or the original ground, whichever is lower.

1100.3.7 ***Excavation Areas***: All stumps, roots, and other objectionable matter found within the side walls or bottoms of excavations and trenching areas shall be removed to a depth of not less than twelve (12) inches below the respective sidewalls, and completely removed from the respective bottom areas.

1100.3.8 ***Borrow Areas***: All stumps, roots, and other objectionable matter shall be removed from the borrow material which is to be used for embankment or fill material.

1100.3.9 ***Progress of Demolition***: Demolition work shall be carried on well in advance of the

construction operation. Miscellaneous foundations, masonry and concrete wall of all sorts, or other objects extending below ground shall be removed to a minimum depth of twelve (12) inches below sub-grade or the original ground, whichever is lower.

In removing items such as Portland cement concrete pavement, base courses, curbs, curb and gutters, or sidewalks, floors, and similar objects where portions of these objects are to be left in place, they shall be removed to an existing joint or to a new joint sawed to a true line and vertical face. Sufficient portions of such objects shall be removed to provide for the proper grade and connection to the new work.

When explosives are used in demolition, the Contractor shall use the utmost care to prevent injury to persons and property and shall meet all requirements of the City for handling explosives.

1100.3.10 ***Backfilling the Site***: The trenches, holes, and pits other than basement areas resulting from the operations of clearing, grubbing, and demolition on the site shall be backfilled with suitable material, placed and compacted as specified in Section 102 entitled "Grading: Backfilling of basement areas is included under Section 102.5 entitled "Embankment Grading".

1100.4 **MEASUREMENT**: No measurement will be made to determine the amount of work governed by this section, unless the project bid documents provide for unit pricing. The number of trees actually removed shall be the basis for payment for the tree removal and the actual quantity of trees shall be determined by the project bid quantities.

1100.4 **PAYMENT:** Payment for work performed in the operation of clearing, grubbing, and demolition of locations shown on the plans as provided for in the special provisions, shall be as listed in the proposal. The quantity for clearing and grubbing shall be paid as plan quantity. The cost of furnishing all labor, equipment, tools and materials, and the performance of all work of felling, cutting up, grubbing the stumps, and disposing of the debris as required to complete tree removal, as provided for in the Special Provisions, shall be included in the unit bid price per tree for the item listed in the proposal as:

Clearing & Grubbing	*L.S.*
Clearing & Grubbing	*S.Y.*
Tree Removal	*Each*
Tree Removal	*Per inch diameter*

END OF SECTION

1200.1 SCOPE: This section governs the furnishing of all labor, equipment, tools, and materials, and the performance of all work required for grading the project in coordination with all previous work performed, at the locations shown on the plans, in accordance with the requirements of applicable Sections and as provided for in the Special Provisions.

1200.2 MATERIALS, DEFINITIONS, AND EQUIPMENT:

1200.2.1 ***Grading***: Grading as used herein shall be construed to mean the performance of all excavation, embankment, and backfill in connection with the construction of all improvements.

1200.2.2 ***Excavation***: Excavation is defined as the removal of materials from the construction area to the lines and grades shown on the plans.

1. Unclassified Excavation: Unclassified excavation is defined as the removal of all material encountered regardless of its nature.

2. Earth Excavation: Earth excavation is defined as the removal of all material not defined as rock.

3. Rock Excavation: Rock excavation is defined as the removal of all rock ledges six (6) inches or more in thickness, and detached rock or boulders having a volume of more than one and one-half (1-1/2) cubic yards.

1200.2.3 ***Rock Ledges***: A rock ledge is defined as a continuous body of rock which may or may not include thin interbedded seams of shale or other soft materials less than twelve (12) inches thick. The vertical limit of each ledge shall be defined by interbedded seams of soft materials twelve (12) inches thick or thicker. The beds of soft interbedded material twelve (12) inches thick or thicker shall not be included in the measurement for "Rock Excavation", but shall be included in the measurements for "Earth Excavation".

1200.2.4 ***Embankment***: Embankment is defined as the placing and compacting of material in the construction area to the lines and grades shown on the plans.

1200.2.4 ***Suitable Embankment Material***: Material suitable for use as embankment material shall be entirely imperishable and shall be judged acceptable by the Engineer on the site. It is recommended that the portion of such material passing the No. 40 sieve has a liquid limit not exceeding forty (40) and a plastic index not exceeding twenty-five *(25)* when tested in accordance with the ASTM Designation D423-61T and D424-59, respectively.

1200.2.5 ***Unsuitable or Waste Material***: Material not suitable for use as embankment material shall include excess excavation material and waste material including muck, frozen material, organic material, topsoil, rubbish and rock larger than twenty-four (24) inches, maximum dimension.

1200.2.6 ***Structures***: Structures as used herein refers to bridges, culverts, basins, street drainage structures, headwalls, retaining walls, and similar construction.

1200.3 CONSTRUCTION DETAILS:

1200.3.1 ***Notification***: The Contractor shall be responsible for obtaining locations for all existing utilities and facilities as shown on the plans, or as confirmed as a result of a preconstruction conference attended by contractor representatives, public utility organizations, and other interested persons and concerns. Having obtained such notification, the contractor shall be responsible for the protection and preservation or such utilities and facilities.

Grading, excavation and backfilling for roadways, roadway intersections, sidewalks, shoulders, parking areas, airports, playgrounds, or other such improvements shall be made to the lines, grades, and cross-sections shown on the plans. During construction, the area shall be maintained in such condition that it will be well drained at all times.

Waste materials including organic material, trees, stumps, rubbish, and debris shall be removed from the site and disposed of as an incidental part of the grading work. Excess excavation material including muck, topsoil, and rocks larger than twenty-four (24) inches, maximum dimension, shall be paid for on the basis of the applicable unit bid price for excavation.

1200.3.2 ***Excavation-Grading***: This section covers all work in landscaping, roads and streets, runways, parking areas, playgrounds and other improvements.

All suitable material removed by excavation shall be used as far as practicable in the formation of embankments as required to complete the work. The Contractor shall sort all excavated material and stockpile when necessary, so as to provide suitable materials for embankments. The cost involved in sorting, stockpiling, or wasting of such material shall be included in the cost for excavation, or the cost for embankment, but not both, depending upon which is the basis for bidding as listed in the proposal.

Excavated material in excess of the amount needed to complete the grading shall be considered as waste material which shall be removed from the site, except that when and as permitted by the Engineer a portion of the waste which is suitable for embankment may be disposed of at the site by equitable distribution of the material to specified areas within the project limits. The contractor shall obtain written permission if the disposal or the property is to occur on private property or lands. The disposition of all waste material shall be considered as incidental to the performance of grading work.

In areas at the point of transition from cut to embankment, the excavation shall be made to the depth and extent shown, or as provided for in the Special Provisions. Excavations shall be well drained at all times.

1200.3.3 ***Embankment - Grading***: This section covers all embankment work in landscaping, roads and streets, runways, parking areas, playgrounds and other similar improvements. The embankments shall be formed with suitable materials, as herein defined, procured from excavations made on the project site, or from borrow pits as required to complete the grading work.

1. Starting the Embankment: Where embankments, regardless of height, are placed against hillsides or existing embankments, either of which have a slope steeper than one (1) vertical to six (6) horizontal, the existing slope shall be benches or stepped in approximately eighteen (18) inch rises as the new fill is brought up in nine (9) inch layers or lifts. Both the material bladed out and the bottom of the area cut into, as well as the embankment material being placed, shall be compacted to the required density. Material cut out, bladed into place, and compacted shall not be measured and paid for directly but will be considered as incidental work.

2. The existing surface upon which embankment material is to be placed shall have all unstable and unsuitable material, such as topsoil, peat, mulch, coal seams, disintegrated shale, rubbish, logs or stumps, and unconformed saturated soils, removed to the depths shown before starting the embankment work.

3. Where embankments two (2) feet or less in depth are to be placed on areas covered by existing pavement, the existing pavement shall be removed and the clearly ground surface shall be compacted at optimum moisture to the specified density. Where embankments greater than two (2) feet in depth are to be placed on areas covered by existing pavement, the existing pavement shall be broken into pieces not larger than twenty-four (24) inches maximum dimension, left in place and the embankment started thereon.

1200.3.4 ***Placing Earth Embankment***: Earth shall be placed in successive horizontal layers distributed uniformly over the full width of the embankment area. Each layer of material shall not exceed nine (9) inches in thickness (loose state) and shall be compacted to not less than the required density before the next layer is placed thereon. As the compaction of each layer progresses, continuous blading will be required to level the surface and to insure uniform compaction. Embankment construction shall not be performed when material contains frost, is frozen, or a blanket of snow prevents proper compaction.

1200.3.5 ***Placing Rock Embankment***: Successive horizontal layers of rock embankment not exceeding twenty-four (24) inches in depth, shall be made by placing the larger stones uniformly over the embankment area, and between which shall be added small stone fragments, sand, earth or gravel to fill all voids. Rocks, boulders, or old rubble walls too large to permit placing in twenty-four (24) inch layers shall be broken as necessary, or placed so that proper compaction is obtained around them. Each layer shall be thoroughly compacted before the next layer is placed.

The larger rocks shall be withheld in the top twelve (12) inches or more of the

embankment and only crushed stone or earth used in this layer as ordered by the Engineer. The crushed stone shall be well graded from three (3) inches down to form a dense mass when compacted.

1200.3.6 ***Compacting the Embankment***: Before placing any embankment, the surface of the existing ground shall be prepared as heretofore specified, moistened as required, and the top six (6) inches compacted to the density specified.

The density of all embankment and surfaces upon which embankment is to be placed, shall be at the 95 percent of density, or as noted on the plans or in the Special Provisions, of the maximum density for the respective materials to optimum moisture as determined by the test for Moisture-Density Relations of Solids, ASTM Designation D 698.

Embankment material shall be placed with water content within the tolerance of the moisture range for each type of material at a percent of maximum density as specified by the Engineer and as shown on the respective moisture density curves, determined as specified above.

All the work involved in either adding moisture to, or removing moisture from embankment materials to within these moisture limits shall be considered incidental to the completion of the grading operation.

During the progress of the work, in-place density of the embankment shall be determined by the Standard Method of Test for Density of Soil in Place, ASTM Designation D1556, as ordered by the Engineer. The City shall pay for such testing.

1200.3.7 ***Excavation Under-Grade***: Where, by virtue of changed conditions, materials are encountered below grade that are deemed unsatisfactory by the Engineer for use in the work, they shall be removed to the lines and grades he/she may order. When the resulting space underlays a specified embankment section, it shall be filled with the same material specified for the embankment. When the resulting space is made in an excavation section, it shall be backfilled with crushed stone of the size and gradation ordered by the Engineer.

1200.3.8 ***Slides in Grading Work: Grading for Pavement***: Slides in the side slopes, after construction to the lines and grades shown on the plans, shall be repaired by the Contractor at the contract unit price stipulated in the proposal for the class of grading involved. If no price is stipulated, the work shall be done and paid for as "Extra Work" in accordance with the section entitled "Extra Work" as provided for in the general provisions. If slides or undercutting in excavation or embankment slopes occur as a result of any action of the Contractor, they shall be repaired at his/her own expense before final acceptance by the City.

1200.3.9 ***Finishing***: Finishing shall be started when the construction has progressed sufficiently to permit the finishing operation to be continuous. The entire project area shall be left in a finished and neat appearing condition. The graded surface shall be made free of rock, concrete, and brick, or fragments thereof, or rubbish, and shall be finished to the lines, grades, and cross-section shown on the plans, including shoulder, berm and sidewalk

spaces. The Contractor shall repair any damaged surface, and shall not use any finishing equipment that will leave a marred surface. The area between the back of curb and the limit of construction shall have black dirt spaced to the depth of no less than 4 inches. The black dirt shall be free of stone, roots, and foreign debris. Should the quality of black dirt not meet with the approval of the engineer, the contractor shall find another source. The final surface shall be smooth and suitable for seeding. When the sub-grade preparation is included as a part of the finishing, the work shall be performed according to the requirements of the Section 1300 entitled "Sub-Grade Preparation", and shall be considered incidental to finishing the grading work.

1200.3.10 ***Cleanup:*** Cleanup shall follow the work progressively, and final cleanup shall follow immediately behind the finishing. The Contractor shall remove from the site of the work all equipment, tools, and discarded materials, and other construction items.

The entire right-of-way or easement shall be left in a finished and neat condition. Cleanup shall be considered as incidental to the completion of the grading work.

1200.4 MEASUREMENT: Measurement will be made to determine the amount of excavation, or the amount of embankment, but not both, depending upon which amount is the basis for bidding, as listed in the proposal. Measurements will be made to determine the amount of under-grade excavation ordered by the Engineer, and this amount will be included in the final amount of excavation or embankment, whichever the proposal shall stipulate as the basis for payment. Measurement of removal of unsuitable material and replacement of unsuitable material shall apply where individual removal areas are 200 square feet or less in area. If individual areas are greater than 200 square feet in area then bid prices for embankment and excavation shall be applied.

1200.5 PAYMENT: Payments under this section shall be made on the basis of the final amount of excavation, or the final amount of embankment, whichever the proposal shall stipulate, and such payment shall constitute full compensation to the Contractor for furnishing all labor, equipment, tools, and materials, and the performance of all work required for grading, complete, in accordance with the requirements of the Contract Documents, and are included in the lump sum bid price, or in the unit bid price for item listed in the proposal as:

	DESCRIPTION	**UNIT OF PAY**
1	Unclassified Excavation	Cubic Yard
2	Earth Excavation	Cubic Yard
3	Rock Excavation	Cubic Yard
4	Embankment	Cubic Yard
6	Crushed Stone Backfill	Cubic Yard
7	Crushed Stone Backfill	Ton
8	Imported Fill	Cubic Yard
9	Removal of Unsuitable Material	Cubic Yard
10	Backfill of unsuitable material	Cubic Yard

END OF SECTION

SECTION 1300 –SUBGRADE PREPERATION

1300.1 SCOPE: This section governs the furnishing of all labor, equipment, tools, and materials, and the performance of all work for the sub-grade preparation, complete, at locations shown which have been previously graded in accordance with the requirements of Section 1200 entitled "Grading", preparatory to constructing pavements for streets, alleys, runways, parkings, or sidewalks, and the construction of curb, curb and gutters, as provided for in the Special Provisions. *NOTE: This Section does not include the construction of any base courses.*

1300.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

1300.2.1 ***Sub-Grade***: Sub-grade is defined as a well graded and compacted surface, constructed as specified herein to the grades, lines, and cross-section shown, bladed and compacted to the specified density, preparatory to constructing pavements, or other improvements thereon.

1300.2.2 ***Sub-Grade Preparation***: Sub-grade preparation is the repeated operation of fine grading and compacting the sub-grade until the specified lines, grades, and cross-section are obtained, and the materials are compacted to the specified depth and density.

1300.2.3 ***Equipment***: The sub-grade preparation shall be completed by the use of motor graders, steel wheel rollers and an approved template, string line or other approved method as furnished by the Contractor.

1300.3 CONSTRUCTION DETAILS:

1300.3.1 ***General***: All underground work contemplated, including clearing, grubbing and demolition, shall be completed in accordance with the requirements of Section 1200 entitled "Grading", prior to commencing any sub-grade work. The sub-grade surface shall be brought to the specified lines, grades, and cross-section by repeatedly adding or removing material and compacting to the specified density with a suitable roller to perform these operations. Tolerance allowed on all lines, grades, and cross-sections shall be plus or minus 0.04 foot

.

1300.3.2 ***Compacting the Sub-Grade for Pavements***: The sub-grade for pavements, except sidewalk pavement, shall be compacted to a density of at least ninety-five *(95)* percent of the maximum density for the material use as determined by ASTM Designation D-698, for a depth of at least six (6) inches below the finished sub-grade elevation, and within the tolerance of the moisture for the type of material at ninety-five (95) percent of maximum density as shown on the moisture-density curve obtained. Any further compacted layers shall be accomplished in the same manner as specified.

1300.3.3 ***Compacting the Disturbed Sub-Grade for Sidewalks***: The sub-grade for sidewalk pavements shall be compacted to a density equivalent to the density of the immediately surrounding undisturbed soil for the material used determined by ASTM Designation D-698 for a depth of at least six (6) inches.

1300.3.4 ***Protection and Maintenance of Sub-Grade***: The newly finished sub-grade shall be repaired from action of the elements. Any settlement or washing that occurs prior to the acceptance of the work shall be repaired and the specific lines, grades, and cross-section re-established. The Contractor shall protect all pavements, curbs, curb and gutters, gutters and sidewalks from his/her sub-grade operation with an earth cushion, timber planking, or both where tractors, graders, rollers, or other equipment are required to pass, or turn around. All resulting damage shall be repaired. Any damaged work which cannot be repaired to the satisfaction of the Engineer shall be replaced by the Contractor at his/her own expense.

1300.3.5 ***Cleanup***: Cleanup shall follow the work progressively. Final cleanup shall follow immediately behind the completion of the sub-grade. The Contractor shall remove from the project site all rubbish equipment, tools, and surplus or discarded material, and temporary construction items. Debris from cleanup shall be removed from the project site.

1300.4 MEASUREMENT: No measurement will be made to determine the amount of sub-grade preparation as governed by this section.

1300.5 PAYMENT: No separate payment will be made for sub-grade preparation. The cost of furnishing all labor, equipment, tools, and materials, and the performance of all work in the sub-grade preparation, shall be included in the lump sum bid price, or in the unit bid prices for items listed in the proposal as provided for in Section 1200 entitled "Grading".

END OF SECTION

SECTION 1400 - UNTREATED COMPACTED AGGREGATE

1400.1 <u>SCOPE</u>: This section covers the materials for the construction of a base for asphaltic concrete pavement, Portland Cement Concrete Pavement, shoulders, and other purpose, when shown in the contract plans.

1400.2 <u>MATERIALS, DEFINITIONS AND EQUIPMENT:</u> The base course material shall consist of crushed stone aggregate. **The aggregate shall not contain more than 15% deleterious rock or shale.** The abrasion loss shall be no more than 40 percent when subjected to 500 revolutions in a Los Angeles abrasion machine as determined by ASTM Designation C- 131. That fraction passing the one-inch (1") screen and retained on the No. 4 screen will have a loss not greater than 15 percent by weighted average at 5 cycles of ASTM Standard C-88 soundness test. The specified gravity shall not be less than 2.54 (S.S.D. Bulk). That fraction of the material passing the one-inch (1") screen and retained on flat and elongated particles (flat being a ratio of 1/3 between thickness and least width, elongated being a ratio of 1/3 between the least width and length). The material shall consist of angular particles with not less than 90 percent of particle count having two or more fractured surfaces. The gradation in percentages weight passing square mesh screens shall be as follows:

Screen Size	Percent Passing
1-1/2 Inch	100
1 Inch	60-100
1/2 Inch	30-65
No. 4	20-50
No. 10	15-40
No. 40	5-22
No. 200	0-15

In addition to the above gradation limits, the material shall be of such gradation from coarse to fine within these limits that it will not vary from one limit on one screen to the opposite limit on the adjacent size screen. That fraction of the material passing the No. 40 screen shall have a plasticity index not in excess of 8 when tested in accordance with ASTM Designations C-l77, C-136, D-422, D-423, and D-424.

1400.3 <u>CONSTRUCTION DETAILS</u>:

1400.3.1 ***Sub-grade***: Prior to placement of base course material, the previously prepared sub-grade surface shall be cleared of all foreign substances and restored in shape, tolerance and density as specified in Section 1200 entitled "Sub-Grade Preparation".

1400.3.2 ***Material Placement:*** Immediately in advance of spreading the mixture, the sub-grade shall be sprinkled in the amount specified by the Engineer. After sprinkling the sub-grade, the mixture shall be uniformly spread by blades in successive layers of courses to such depth that when compacted, the base will have the minimum thickness specified or as otherwise directed by the Engineer.

1. The Contractor may construct the base in any number of layers that he/she chooses,

except that in no case shall any individual layer have a compacted thickness of more than four (4) inches. Each layer shall be compacted as hereinafter specified before any succeeding layer is placed. The top one-half (1/2) inch of the base may be constructed of material having a maximum size of 1/2 inch with 15 to 50 percent passing the No. 40 sieve and not more than 35 percent passing the No. 200 sieve. Compacting of such a top course shall be obtained by rolling with pneumatic-tired or flat-wheeled rollers, or both, as may be required to obtain the specified density.

2. After spreading a layer of mixture, water in an amount sufficient to insure the desired compaction shall be added and uniformly mixed with the aggregate in a manner to prevent segregation. Excess moisture shall be avoided. If, for any reason, the mixture and sub-grade become too wet to permit satisfactory work, they shall be allowed to dry to a moisture content which will permit satisfactory work.

3. The mixture shall meet the required specifications immediately before compaction operations are commenced. If, for any reason, segregation occurs in excess of ten (10) percent variation from the gradation required under the above paragraph "Material" or the materials become contaminated, such segregation or contaminated materials shall be removed and replaced with suitable materials at the expense of the Contractor. The limited segregation of ten (10) percent variation will be ascertained by a sieve analysis made of a maximum of 100 pound sample taken from in-place base course. However, when crushed stone is used, segregated surface areas may be corrected by adding limestone screenings of such gradation and quantity as required to fill the surface voids and firmly bind the loose material in place. Screenings so used in correcting segregated surface areas will be measured and paid for as a part of the aggregate base material.

4. Compaction of aggregate base material shall be secured by rolling with sheep's foot, pneumatic-tired smooth-wheeled rollers or vibratory equipment as required. Shaping and compacting shall be carried on continuously until a true, even and uniform surface of proper grade and cross section is obtained, and until the density of the complete base is at least ninety-five *(95)* percent of maximum density as determined by the Tentative Methods of Test for Moisture-Density Relations of Soils Using 5.5 lb. Hammer and 12 In. Drop (ASTM Designation D-698, Method D). The proper moisture content shall be maintained by wetting the surface as required during shaping and compacting operations. Final rolling shall be accomplished by use of a self-propelled smooth-wheeled roller weighing two (2) to five *(5)* tons.

5. Tolerance allowed on all lines, grades, and cross-sections shall be plus or minus 0.2 foot.

1400.4 <u>MEASUREMENT & PAYMENT:</u> When listed in the proposal, payment for this item will be made on the basis of the unit bid price per ton or per square yard, as listed in the bid proposal, and shall be full payment for the prescribed gradation of material in placed, compacted to the widths and thickness shown on the contract plans.

NOTE: If paid by the ton, the payment will be made on the basis of certified weight tickets, issued by the material vendor or by weights obtained from certified public scales or from certified contract or operated scales with all tickets certified by the City.

1	Crushed Stone Base	Cubic Yard
2	Crushed Stone Base	Square Yard
3	Crushed Stone Base	Ton

END OF SECTION

SECTION 1500 - CEMENT STABILIZED AGGREGATE BASE

1500.1 SCOPE: This section covers the materials for and the construction of a Portland cement stabilized aggregate base to conform to the lines, grades, thickness profile and typical cross-section as shown on the plans.

1500.2 MATERIALS, DEFINITIONS AND EQUIPMENT

1500.2.1 ***Aggregate:***

1. Crushed aggregate for use in cement-treated base shall be free from vegetable matter and other deleterious substances and shall be produced by the mechanical crushing of limestone obtained from an approved source. The percentage composition of the dry crushed aggregate, by weight, and as determined by laboratory sieves shall be uniformly graded from coarse to fine, and shall conform to the following limits of gradations:

PERCENT PASSING SIEVES	**SIEVE SIZES**
100	2-Inch
95-100	1-1/2 Inch
70-95	3/4 Inch
50-70	No. 4
30-50	No. 10
10-25	No. 40
5-15	No. 200

Sand may be substituted as required to obtain proper gradation.

2. That fraction of material retained on the No. 4 sieve shall not contain more than 20 percent by weight of flat or elongated particles, flat being a particle with an average thickness less than one-third its minimum width, elongated being a particle with an average width less than one-third its maximum length, and that fraction retained on the No. 4 screen shall be composed of particles with not less than 75 percent having two or more fractured faces.

3. In addition to the above gradation limits, the material shall be of such gradation from coarse to fine within these limits, that it will not vary from one limit on one screen, to the opposite limit on the adjacent size screen, and that fraction of the material passing the No. 40 screen shall have a plasticity index, not in excess of 8 when tested in accordance with ASTM Designations C-i 17, C-136, D-422, D-423, and D-424.

4. Fly Ash and ground granulated blast furnace slag shall not be used.

1500.2.2 ***Portland Cement***: Portland cement shall comply with the latest specifications for Portland cement ASTM C-150 Type 1. One barrel of cement shall be considered to weigh 376 pounds.

1500.2.3 ***Water:*** Water shall be free from substances deleterious to the hardening of the soil cement.

1500.3 CONSTRUCTION DETAILS:

1500.3.1 ***Mixing***: The mixing shall be accomplished by an approved plant of the batch or continuous flow type. The plant shall be equipped with feeding and metering devices that will add the aggregate, cement and water into the mixer in the specified quantities. The aggregate and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform and intimate mixture of aggregate, cement and water is obtained. The Portland cement content shall be maintained at a rate of seven percent (7%) by weight of the over dry weight of the aggregate. The water shall be maintained in accordance with the limits specified under (C) below.

1500.3.2 ***Spreading***:

1**.** The mixture shall be hauled to the roadway in trucks. The mixture shall be placed on the moistened sub-grade in a uniform layer not to exceed four (4) compacted lifts by an approved spreader method. Tailgate dumping and blade spreading will be permitted only when it has been demonstrated that the equipment operators are sufficiently skilled and use methods that will keep material segregation to a minimum. End dumping in poles requiring blade moving of the material over the sub-grade for other than basic shaping operations will not be permitted. Not more than 30 minutes shall elapse between the placement in adjacent lanes and sections at any location except at construction joints. The placement shall be uniform in thickness and surface contour, and in such quantity that the completed base will conform to the required grade and cross-section.

2. Where the required thickness of base is more than six (6) inches, the mixture shall be spread and compacted in two or more layers of approximately equal thickness, the maximum compacted thickness in any one layer not to exceed six (6) inches. Work on each layer shall be performed in a similar manner, except that a curing seal shall not be applied to a lower layer; in lieu thereof, the surface of the compacted material shall be kept moist until covered with the final layer. The exposed area of the lower layer shall not be greater at any time than can be covered with the final layer during that same day[1]s operation.

3. Width of lanes placed by the spreading equipment shall be varied so that longitudinal lines between lanes of the upper and lower courses will not be placed one above the other, but will be offset or broken by not less than twelve (12) inches. Not more than 90 minutes shall elapse for temperatures under 85 degrees F. and 60 minutes for temperature over 85 degrees F. between the start of moist mixing and the start of compaction and all compaction on each lift shall be completed within 30 minutes after starting.

1500.3.3 ***Compaction***:

1. At the start of compaction, the percentage of moisture in the mixture, based on oven-dry weights, shall not be more than two percentage points below nor more than three percentage points above the specified optimum moisture content as determined by ASTM

D-1556, and shall be less than that quantity which will cause the mixture to become unstable during compaction and finishing.

2. At no cost to the contractor, the City will determine the amount of mixing water to be added to obtain the optimum moisture for the mix design as the work progresses, and the City will make field tests to check the Contractor's compliance with these specifications.

3. Within two hours the loose mixture shall be uniformly compacted to ninety-five *(95)* percent of maximum density as determined by ASTM D-698. Additional water, if required, shall be applied during compaction at the rates and quantities ordered by the Engineer. Only distributing equipment that will assure even and controlled application of all water required shall be used.

1500.3.4 ***Finishing***: After compaction, the surface shall be shaped to the required lines, grades and cross-section. If necessary, during shaping operations, the surface of the base shall be lightly scarified to remove any large cuts or irregularities left by the equipment. The resulting surface shall then be compacted to the specified density at the optimum moisture content.

1500.3.5 ***Construction Joints***: At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face. Large, wide areas shall be built in a series of parallel lanes of convenient length and width meeting the approval of the Engineer. Straight longitudinal joints shall be formed at the edge of each day's construction by cutting back into the complete work to form a true vertical face free of loose or shattered material.

1500.3.6 ***Curing***:

1. After cement treated base has been compacted and finished, it shall be covered with a bituminous curing seal. This seal shall be applied within eight (8) hours after the final compaction of the section completed in any one day. If the seal is not applied immediately upon completion of the day's work, the entire surface completed that day shall be kept moist until the curing seal has been applied.
2. Bituminous material for curing seal on the cement-treated base shall consist of liquid asphalt as approved by the engineer.

3. The bituminous seal shall be applied by an approved asphalt distributor. The rate of application shall be between 0.10 and 0.20 gallons per square yard of surface area. The exact rate of application shall be determined by the Engineer. The curing seal shall be applied in such manner and in sufficient quantity to provide a membrane over the entire surface.

4. If necessary, before the bituminous seal is placed, water shall be applied by a pressure distributor in an amount sufficient to thoroughly moisten the surface of the cement-treated base.

1500.3.7 ***Traffic***: Completed portions shall be closed to all traffic at least five *(5)* days after placing the seal coat. This period of closure may be lengthened or shortened by the

Engineer after due consideration of traffic, degree of cure and sub-grade conditions.

1500.3.8 ***Maintenance***: The Contractor shall be required, within the limits of his/her contract, to maintain the base in good condition until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Contractor at his/her own expense and repeated as often as may be necessary to keep the area continuously intact. Faulty work shall be replaced for the full depth of treatment. Any low areas shall be remedied by replacing the material for the full depth of treatment or wedging with asphaltic concrete prior to placing the surface course, rather than by adding a thin layer of the same material to the completed work.

1500.3.9 ***Cold Weather Precautions***: No cement-treated base shall be placed on frozen sub-grade. No base shall be placed if it is apparent that the mixture will be subjected to freezing during the next 48-hour period.

1500.4 MEASUREMENT AND PAYMENT: When listed in the proposal, measurement and payment will be made on the basis of the unit bid price per ton of material in place or on square yards of completed base as listed in the bid proposal. The tonnage quantities will be determined from certified weight tickets, issued by the material vendor.

1	Cement Subgrade Stabilization	Cubic Yard
2	Cement Subgrade Stabilization	Ton

END OF SECTION

SECTION 1600 - TUNNELING, BORING OR JACKING

1600.1 SCOPE: This section governs the furnishing of all labor, materials and equipment, and the performance of all operations necessary for the construction of tunnels complete with lining, bulkheads, and sand fill at locations shown on the plans or where constructed at the Contractor's option when approved to pass other utilities, streets, or obstructions without open excavation.

1600.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

1600.2.1 ***Classification of Excavated Materials:***

1. Rock is defined as being sandstone, limestone, chert, granite, silstone quartzite, slate, shale occurring in its natural undisturbed state, hard and unweathered, or similar material in masses more than one and one-half (1-1/2) cubic yard in volume, in ledges six (6) inches or more in thickness. Should rock be encountered in two or more ledges, each ledge being more than six (6) inches thick and with interlaying strata of earth, clay, shale, or gravel not more than twelve (12) inches thick in each stratum, the entire volume between the top of the top ledge and bottom of the bottom ledge will be classified as rock.

2. All materials not classified as rock shall be classified as earth. Chert (joint flint rock) broken by intermittent clayey partings or clay seams or stratified chert cemented with clay seams (hardpans) shall be interpreted as earth.

1600.2.2 ***Tunnel Liner*****:** Where segmented tunnel liner system is used, it shall be designed and stamped by a professional engineer. The minimum factors of safety shall be as follows:

Critical element	F.S.
Seam strength	3.0
Wall buckling	2.0
Installation stiffness	3.0

1600.2.3 ***Spacers*****:** No sand fill or redwood skids may be used. All pipe shall be installed with pre-manufactured commercial spacers as approved by the Public Works director or his representative.

1600.2.4 ***Steel Casings***: Steel casings for bored or jacked construction shall be steel pipe conforming to ASTM A139 with a minimum diameter as shown on the plans.

Minimum wall thickness shall be in accordance with the following table:

	Nominal Wall Thickness	
Casing Diameter	Under Railroad	All other Uses
(Inch)	(In)	(In)
16	0.312	0.188
18	0.3 12	0.250
20	0.375	0.250
22	0.375	0.250
24	0.406	0.281
26	0.438	0.281
28	0.469	0.312
30	0.469	0.312
32	0.500	0.3 12
34	0.500	0.344
36	0.500	0.344

1600.3 <u>CONSTRUCTION DETAILS</u>:

1600.3.1 ***General***: Before starting work, complete details of the method of operation and liner materials to be used shall be submitted to the Engineer. The cast iron pipe sewer, in the area to be tunneled, bored or jacked, shall be completed before the construction of adjacent portions of the same sewer lateral. The purpose of this requirement is to allow for slight discrepancies in alignment and grade which may occur in the tunneled, bored or jacked installation, so minor adjustments in the adjacent sewer can be made. Tunnel sections shall provide grading and jointing of the pipe installed therein. All bracing, shoring and sheeting necessary for the construction of the tunnel and the proper protection of workers therein shall be furnished and installed by, and at the expense of, the contractor. All tunnel backfill shall be of proper condition and moisture content to compact readily. The maximum allowable deviation in alignment and grade of sewer pipe shall be as shown on the construction plans.

1600.3.2 ***Excavation***: Excavate by approved methods applicable to materials encountered. Boring operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. Include dewatering and chemical soil stabilization or grouting if necessary due to existing field conditions. Conduct excavation in a manner to prevent disturbing overlying and adjacent material.

1600.3.3 ***Carrier Pipe***: A minimum of 3 sets of spacers shall be used for each length of carrier pipe. Spacers shall be located by the joints at each end and at the middle of the pipe. Carrier pipe shall be pulled or pushed through so as to not disturb the integrity of the joints.

1600.3.4 ***Lining:*** Assemble liner plates immediately following the excavation. Advance casing continuously with excavation. When liner plates are being installed, care shall be taken to maintain alignment, grade and circular shape of the tunnel. All voids between liner and surrounding earth shall be filled with grout forced in under pressure. The grout shall consist of two parts of sand to one part of Portland Cement, mixed with sufficient water to maintain a freely pouring consistency. As the pumping through any hole is stopped, it shall be plugged to prevent the backflow of grout. After lining installation is complete, it

shall be cleaned of all debris and all leaks which allow flowing or seeping water into tunnel shall be stopped.

1600.3.5 ***End Seals***: Construct end seals after sewer pipe has been permanently placed inside casing, tested and approved. Brick shall be in accordance with ASTM C32, Grade SS or SM and mortar in accordance with ASTM C270.

1600.4 <u>MEASUREMENT AND PAYMENT</u>: Measurement and payment will not be made separately, but shall be included in the item it pertains to.

<u>END OF SECTION</u>

SECTION 1700 - TRENCHING

1700.1 SCOPE: This Section covers excavation, fill, and compaction of earth and rock for utility trenches in public right-of-way and in sewer easements. Topics include acceptable materials, imported materials, topsoil stripping, dewatering, disposal of excess material, cleanup, placement of fill, preparation of pavement subgrade, plating, and compaction requirements.

1700.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

1700.2.1 ***Classification of Excavated Materials:***

1. Rock is defined as being sandstone, limestone, chert, granite, siltstone quartzite, slate, shale occurring in its natural undisturbed state, hard and unweathered, or similar material in masses more than one and one-half (1-1/2) cubic yard in volume, in ledges six (6) inches or more in thickness. Should rock be encountered in two or more ledges, each ledge being more than six (6) inches thick and with interlying strata of earth, clay, shale, or gravel not more than twelve (12) inches thick in each stratum, the entire volume between the top of the top ledge and bottom of the bottom ledge will be classified as rock.

2. All materials not classified as rock shall be classified as earth. Chert (joint flint rock) broken by intermittent clayey partings or clay seams or stratified chert cemented with clay seams (hardpans) shall be interpreted as earth.

1700.2.2 ***Bedding Material:*** Bedding material shall be crushed stone, or crushed gravel having a gradation as specified in the Sanitary Sewer and Storm Sewer Sections, or per the manufacturer's specifications .

1700.2.3 ***Backfill:*** The backfill material for open cuts within Public Right of Way shall be a dense gradation of crushed stone or gravel similar to the material specified for bedding. Compaction shall be as required for each backfill

1700.3 CONSTRUCTION DETAILS :

1700.3.1 ***Excavation:*** The excavation shall consist of the removal of any and all material below ground level necessary in order to carry out the installation and construct required by the plans and specifications and shall include: (1) Additional excavation required for bedding; (2) All sheeting, shoring, bracing, protection of adjacent property and underground conduits or structures and preparation of the sub-grade; (3) The cost of diversion of surface water, pumping, draining, or otherwise dewatering of excavation; and (4) The subsequent handling and disposal of such material not used in the backfill.

1700.3.2 ***Progress of Work***: The excavation shall not be performed any further ahead of the bedding and pipe laying than is necessary to permit a continuous operation.

1700.3.3 ***Grades:*** The elevation of the bottom of the trench shall be continually checked for

proper sub-grade. Excavations made below proper sub-grade elevation shall be refilled only with bedding material thoroughly compacted at the contractor's expense.

1700.3.4 ***Shoring*****:** The Contractor shall, at his/her own expense, shore up, protect, and insure from injury all buildings, retaining walls, viaduct piers and footings, storm sewers, sanitary sewers, gas lines, water lines, fences, curbs, trees or other property liable to be injured during the progress of the work, and he/she will be held responsible for all damage which may occur by reason of prosecution of the work. Where the material is of such a character or other conditions are such as to render it necessary, the sheeting shall be closely driven and to such depth below the lowest point of the final excavation as may be directed. The Contractor shall be held responsible for the sufficiency of all sheeting and bracing used and for all persons injured or property damaged as the result of improper quality, strength, placing, maintaining, or removing the same. No extra compensation will be made for sheeting and bracing whether left in place or not. The contractor shall meet all safety requirements set for by the Occupational Health and Safety Administration regarding trenching and excavation safety. http://www.osha.gov/Publications/trench_excavation_fs.html

1700.3.5 ***Dewatering:*** The Contractor shall furnish and operate sufficient pumps and appliances, and shall provide all materials, labor, etc., required to prevent interference with any work by water, ice or snow. Damage of any kind resulting from insufficient pumping facilities or similar lack of proper conduct of the work shall be made good by the Contractor at his/her own expense. No water shall be allowed to run into or over any concrete work or pipe, or into or through any pipe, unless by special permission in writing by the Engineer. When leaks or springs are found which, in the opinion of the Engineer, affect the safety or usefulness or satisfactory operation of any of the permanent work, he/she may direct special provisions to be taken and payment here fore as directed by the Engineer.

1700.3.6 ***Trench Width***: The width of the trench at the top of the pipe shall provide at least six (6) inches clear space on each side of the pipe to permit tamping the bedding material, unless otherwise noted on project plans or approved per pipe manufacturers specifications.

1700.3.7 ***Variations in Plan*****:** The locations of sewers and structures as shown on the Contract Drawings have been selected to provide the least possible interference with or the crossing of existing utilities and above-ground obstructions. The Owner reserves the right to make minor variations in the location of these items during construction to meet any changed conditions discovered during the construction, and no extra payment will be allowed the Contractor for shifts in alignment. Necessary arrangements shall be made by the Contractor with all persons, firms, corporations owning or using any poles, pipes, tracks, or conduits, etc., affected by the construction on this project to maintain and protect such facilities during construction with the cost of any such protection paid by the Contractor and included in the contract price.

1700.3.8 ***Bedding*****:** The bedding and backfill material immediately around the pipe shall be as specified in the typical drawings, bedding item for Storm and Sanitary Sewers, or per the

manufacturer's specifications.

1700.3.10 ***Backfill under Roads:*** The backfill material for sewers constructed in open cut within Public Right of Way shall be a dense gradation of crushed stone or gravel similar to the material specified for bedding. Compaction shall be as required for each backfill. Six (6) inches of black dirt, with seed and mulch, will be placed in grassy areas.

1700.3.11 ***Backfill:*** The backfilling shall follow closely behind the pipe laying operation, but NOT until inspected by the Engineer and the location of all connections recorded. In all cases the pipe shall be backfilled the same day as laid. Except as specified under backfill in Right of Way, the backfill material may be suitable earth material from the excavation. No frozen material shall be used in the backfill. Care shall be taken to avoid injury to the pipe or structures or producing unequal pressures thereon. For a depth of at least twelve (12) inches over top of granular material, the backfill material shall be clean earth and shall not contain any stones. The backfill shall be compacted in layers approximately six (6) inches in thickness and each layer shall be thoroughly compacted with mechanical tampers before the succeeding layer is placed. Tamping over and near the pipe must be carefully done to prevent injury to the pipe. The top four (4) inches of the backfill shall be made with topsoil and graded as required on the plans. All surplus excavation material not used in backfilling shall be disposed of by the Contractor. Upon receipt of written notice from the Engineer, any settlement of the backfill below the original ground surface shall be remedied by the Contractor for a period of one (1) year after the final completion and acceptance.

1700.3.12 ***Pavement Repair:*** Pavement Repair: In general, this work shall conform to the requirements of section **1700.3.12** of the City's standard specifications.

This work shall consist of removal, wholly or in part, and satisfactory disposal of materials. The contractor shall over cut the repair area 12" in width to undisturbed earth, compact two inches (2") of base rock as specified in City Standard Section 1300-Subgrade Preparation, and install 10 inches (10") of Portland cement concrete. The contractor will follow the City's Standard Specifications; Section 3100-Portland Cement Concrete in accordance with city standard 3000 for all street repairs unless otherwise directed by the City that the repair must be a hot mix asphalt repair. Compaction tests shall be performed on all excavation area as deemed necessary by the engineer, additional material shall be removed and replaced with base rock. The base rock shall be placed in 4" layers and compacted as specified above. When a street repair is made next to another repair or butts up to existing concrete pavement, the contractor shall use dowels to transverse the construction joints at a minimum of 12" spacing. All construction joints and control joints shall be to the City's standard as stated in section 3100.4.26-28. The contractor shall be responsible for workmanship and materials, and shall remedy or repair any defects for a period of three years after the final acceptance of the work is completed per City Ordinance Section 106-08. As directed by the city full depth concrete may require tinting with Black Dye to match surrounding pavement. Joint / crack sealer from MoDOT approved list shall be applied to all joints (typical attached)

The contractor may utilize a flowable fill design instead of the ¾" clean rock aggregate to fill in the trench for the utility cut, as directed by city engineer.

In addition to restoring the utility repair the contractor shall provide and design traffic control plans that are in accordance and meet MUTCD guidelines. Traffic control for arterial & collector streets are being provided by another contractor.

The following are specific requirements requested for the work on this project. Additional work may be added to the scope:

1. The contractor shall design traffic control plans for lane closures and detours necessary for utility cuts located on the residential streets of the City of Joplin. The City of Joplin will review and approve all plans. Traffic control for arterial and collector streets will be provided by another contractor. All traffic control items, arrow boards and message boards shall be in compliance with the MUTCD standards and shall be subject to review and approval of the City of Joplin.

2. The contractor will supply and deliver all necessary traffic control devices to the utility cut site. The utility contractor will coordinate the timing with the city traffic control contractor. The traffic control contractor will be responsible for any major relocations or shifting of traffic control during the utility cut repair process. The traffic control contractor shall also remove all traffic control upon completion.

3. The contractor shall design if necessary, supply and deliver all traffic control devices as requested by the City of Joplin Traffic Engineer, which may or may not include all projects. The residential streets contractor shall be considered a sole source provider.

Vandalism

The contractor shall protect all new concrete work from vandalism as needed. The contractor shall be responsible for the removal and replacement of vandalized concrete.

Compaction Test

All compaction tests will be performed by a qualified engineering firm. Results and recommendations regarding additional excavation and backfilling shall be made by a registered professional engineer in Missouri. The city will maintain a list of approved engineering firms from which the contractor will choose. The contractor shall pay the engineering fee for services provided and the contractor shall be reimbursed at the rates on file with the city. The contractor shall pay the engineering fee for services provided and the contractor shall be reimbursed at the rates on file with the city.

Utility Valves & Manholes

Contractor will adjust valves and manholes per the specific utility company and City standard specifications. Any questions or concerns will be handled through the Engineering Office for the City of Joplin. All adjustment materials will be provided by the City or utility company and shall be incidental to repair of the pavement.

Measurement and Payment

Portland cement concrete pavement shall be measured in square yards of the specified thickness as described above in the scope or as otherwise directed by the City. The width for measurement shall be from the outside edge of completed pavement and length shall be the actual measurement along roadway corridor. If excavation is required below the specific thickness based on compaction tests, excavation and backfilling will be paid by cubic yard**.**

1700.4 MEASUREMENT AND PAYMENT: When listed in the proposal as a separate, measurement and payment will be made on the basis of the unit price of linear foot at a specified depth as depth in linear feet measured from existing ground and length measured along centerline of pipe.

1	Trenching, X depth to XX depth.	L.F.
2	Pavement Repair	L.F.

END OF SECTION

DIVISION 2000
ASPHALT WORK
AND INCIDENTAL CONSTRUCTION

SECTION 2100 - ASPHALT PRIMING AND TACK COAT

2100.1 SCOPE: This section covers the requirements for all labor, equipment and materials for the application of an asphalt material as a primer to a prepared pavement, granular base or sub-base. The type and grade of asphalt primer to be used shall be the type and grade specified in the contract.

2100.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

2100.2.1 ***Asphalt Primer***: The asphalt tack shall be Emulsified Asphalt (SS-1, SS-1H, CSS-1 or CSS-1H) as specified in the MODOT Standards, Latest edition

2100.2.1 ***Asphalt Tack Coat:*** The asphalt tack shall be Emulsified Asphalt (SS-1, SS-1H, CSS-1 or CSS-1H) as specified in the MODOT Standards, Latest edition

2100.2.2 ***Sand Cover*****:** Sand cover, if used, shall be any clean, granular mineral material meeting the following gradation requirements. When tested with laboratory sieves, 100 percent shall pass the No. 4 sieve and not more than 2 percent shall pass the No. 200 sieve. Maximum moisture content of the sand shall be 3 percent by weight.

2100.2.3 ***Approval of Materials*****:**
1. Asphalt materials shall be approved by the Engineer prior to use in the work, provided, however, that the Engineer may accept a certified analysis by the refinery laboratory when a copy of the certified analysis accompanies each shipment of asphalt to the project. The Engineer will reserve the right to make check tests of the asphalt received on the job and, if the system of certified analysis proves to be unsatisfactory to the Engineer, he/she may discontinue this arrangement.
2. The Contractor or asphalt supplier shall furnish the Engineer with data on the temperature--viscosity relationship of each asphalt to be used on the project. These data shall cover the range of temperatures and viscosities within which the asphalt may be used.
3. Copies of all freight bills and weigh bills shall be furnished to the Engineer as the work progresses.

2100.2.4 ***General Equipment Requirements*****:** The equipment used by the Contractor shall include a power broom or a power blower, or both; mechanical or self-propelled aggregate spreading equipment that can be adjusted to

accurately spread the specified amounts per square yard; a pressure distributor meeting the requirements as specified in Section 2100.2.5 entitled "Pressure Distributor", and equipment for heating the asphalt material. Other equipment may be used in addition to, or in lieu of, the specified equipment when approved by the Engineer.

2100.2.5 ***Pressure Distributor***:
1. The pressure distributor shall be designed and operated to distribute the asphalt material in a uniform spray without atomization, in the amount and between the limits of temperature specified.
2. It shall be equipped with a tachometer having a dial registering feet of travel per minute. The dial shall be visible to the truck driver, so he/she can maintain the constant speed required for application at the specified rate.
3. The pump shall be equipped with a bitumeter having a dial registering gallons per minute passing through the nozzles. The dial shall be readily visible to the operator.
4. Means for indicating accurately the temperature of the asphalt material at all times shall be provided. The thermometer well shall not be in contact with the heating tube.
5. The normal width of application of the spray bar shall not be less than twelve (12) feet, with provision for the application of lesser width when necessary. A hose and nozzle attachment shall be provided for applying asphalt material to patches and areas inaccessible to the spray bar.
6. The distributor shall be provided with heating attachments, and the asphalt material shall be circulated during the entire heating process.

2100.3 CONSTRUCTION DETAILS:

2100.3.1 ***Preparation of Existing Surface***: Immediately before applying the prime coat, the area to be surfaced shall be cleaned of all loose material. The existing surface shall be prepared by wetting, if necessary, blading and rolling unless otherwise specified. These operations shall be continued until a smooth, uniform, and compact surface is obtained.

2100.3.2 ***Application of Asphalt Primer and Tack***:
1. Application of the asphalt tack shall be made uniformly at the rate of 0.02 to *0.08* gallons per square yard, as specified by the Engineer, with the pressure distributor. The asphalt primer shall be applied at a rate of 0.2 to 0.5 gallons per square yard at the temperature specified by the Engineer.
2. Application shall be made when the base or subbase is thoroughly cured and solid. Application shall be made when the surface is dry or but slightly damp and, unless otherwise permitted by the Engineer, when the air temperature in the shade is not less than 50 degrees F.
3. The spray bar shall be cut off instantaneously at each construction joint to create a straight line and full application of asphalt primer up to the joint. If necessary, to prevent dripping, a drip pan shall be inserted under the nozzles when the application is stopped.
4. A hand spray shall be used to apply asphalt primer necessary to touch

up all spots unavoidably missed by the distributor.
5. At no time shall tack be tracked onto existing roadway. All material tracked off site shall be cleaned before work resumes.
6. Temperature of material shall meet MoDOT requirements (sect. 1015.5)
7. After application of Prime Coat, at least 24 hours shall elapse before paving operations take place.

2100.3.3 ***Application of Sand Cover***: After application of the asphalt primer, at least twenty-four (24) hours shall elapse before applying sand cover, if required by the Engineer. If the asphalt primer has not been completely absorbed by the surface 24 hours after application just sufficient sand shall be spread over the surface with a mechanical spreader to blot up the excess asphalt. The rate of application shall be specified or approved by the Engineer.
NOTE: Prior to placing an asphalt paving course, all loose sand shall be swept from the primed surface.

2100.3.3 ***Traffic Control***: Traffic shall not be permitted on freshly sprayed asphalt until such time as the surface is blotted with sand, or as directed by the Engineer.

2100.4 MEASUREMENT: The unit of measurement for "Asphalt Primer "or "Asphalt Tack Coat" shall be the gallon. The quantity to be paid for shall be the total number of gallons of asphalt primer measured at 60 degrees F. actually applied to the prepared surface. The unit of measurement for "Sand Cover" shall be the ton. The quantity to be paid for shall be the total number of tons of sand cover actually applied to the primed surface.

2100.4 PAYMENT: If a quantity is provided for in the bid documents, "Asphalt Primer" or "Asphalt Tack", of the type and grade specified, and "Sand Cover" used and measured as provided in Section 2100 will be paid for at the unit price bid, per gallon and per ton respectively. This price will be full compensation for furnishing all materials, equipment, tools, labor and work incidental thereto. If the item is not listed as a separate bid item then it will considered subsidiary to the most nearly corresponding asphaltic concrete item.
When listed in the proposal, payment will be made for each item listed in the proposal listed as follows:

Asphalt Primer (type and grade)	per gallon
Asphalt Tack(type and grade)	per gallon
Sand Cover	Per ton

END OF SECTION

SECTION 2200 - ASPHALTIC CONCRETE SURFACE AND

BASE

2200.1 SCOPE: This section covers the requirements for all labor, equipment, materials, and quality of work for the construction of asphalt concrete base and/or asphalt concrete surface. The Contractor shall cooperate with other Contractors, public utility companies and other parties involved in arranging a schedule and prosecute the work in a manner satisfactory to the Engineer.

2200.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

2200.2.1 ***Approval of Materials:***
1. No material shall be used until it has been checked or tested for compliance with specifications and been approved by the Engineer. Representative samples of all materials proposed for use under these specifications shall be submitted to the Engineer by the Contractor, at the Contractor's expense for test and for the preparation of trial mixes to determine the job-mix formula. All tests necessary for determining conformance with the requirements specified herein will be performed under the supervision of the Engineer without cost to the Contractor.
2. Asphalt materials shall be approved by the Engineer prior to use in the work, provided, however, that the Engineer may accept a certified analysis by the refinery laboratory when a copy of the certified analysis by the refinery laboratory accompanies each shipment of asphalt to the project. The Engineer will reserve the right to make check tests of the asphalt received on the job, and if the system of certified analysis proves to be unsatisfactory to the Engineer, he/she may discontinue this arrangement.
3. The Contractor or asphalt supplier shall furnish the Engineer with data on the temperature-viscosity relationship of each asphalt to be used on the project.
4. These data shall cover the range of temperatures and viscosities within which the asphalt may be used. On the basis of these data, the Engineer will specify the temperature at which the material shall be used.
5. The Contractor shall not remove asphalt material from tank cars or storage tanks until the initial outage in temperature measurements have been taken, nor shall he/she release cars or tanks until the final outage has been taken by the Engineer.
6. Copies of all freight bills and weigh bills shall be furnished to the Engineer as the work progresses.

2200.2.2 ***Surface Asphaltic Concrete Mix Design Criteria:*** All commercial streets, arterials and collectors shall conform MODOT Standard Mix BP-1,BP-**2**, **SP125/190 . Mix design criteria will be project specific and specified on plans and/or special provisions.**

2200.2.3 ***Base Asphalt Concrete Mix Design Criteria :*** Refer to MODOT Section 401 Missouri Standards and Specifications for Highway Construction for mix design requirements.

2200.2.4 ***General Equipment Requirements***: All equipment furnished by the Contractor shall meet the requirements of Section 2200 and shall be maintained in acceptable mechanical condition. Equipment shall be serviced and lubricated away from the paving site; units that drip fuel, oil and grease shall be removed from the project until such leakage is corrected.

2200.2.5 ***Asphalt Mixing Plants***: Plants used by the Contractor for the preparation of the asphalt paving mix shall conform to all of the requirements specified in Section 2200.2.6 entitled "Requirements for all Plants". All batch mixing plants shall meet the additional requirements in Section 2200.2.7 entitled "Special Requirements for Batch Type Plants", and all continuous mixing plants shall conform to the additional requirements in Missouri Standards and Specifications for Highway Construction.

2200.2.6 ***Requirements for all Plants:***

1. Uniformity: The plants shall be designed, coordinated, and operated to produce a uniform mix within the job-mix tolerances as covered in Missouri Standards and Specifications for Highway Construction.
2. Equipment for Preparation of Asphalt: Tanks for storage of asphalt shall be provided with a device for controlled heating of the material to temperature requirements set forth in Section 2200.3.4 entitled "Proportioning and Mixing". Heating shall be accomplished so that no flame shall come in contact with the heating tank. A circulating system of adequate size to insure proper and continuous circulation of asphalt between storage tank and mixer during the entire operating period shall be provided. The discharge end of the circulating pipe line shall be kept below the surface of the asphalt in the tank while the pump is in operation. Storage tank capacity shall be sufficient to hold enough asphalt for at least one day's run.
3. Cold Aggregate Feeder: The plant shall be provided with an accurate mechanical means for feeding the mineral aggregate into the dryer to secure a uniform production and a constant temperature. The feeder or feeders shall be capable of delivering, in pre-set conditions the maximum number of aggregate sizes required. When more than one cold elevator is used, each shall be fed as a separate unit and the individual controls shall be integrated with a total master control.
4. Dryer: The plant shall include a rotary drum dryer that will continuously agitate the mineral aggregates during the heating and drying process. It shall be capable of continuously supplying aggregate to the mixing unit operating at capacity, to provide a mix at the temperature specified in Section 2200.3.4 entitled "Proportioning and Mixing", and at a moisture content not in excess of *0.5* percent.
5. Screens: Plans screens capable of separating all aggregates to the sizes required for proportioning, and having normal capacity slightly in excess of the full capacity of the mixer or the dryer, shall be provided. The Contractor shall expose the screens for inspection at the request of the Engineer. The plant screens shall have efficiency such that the bins shall have not more than the following percentages of undersize and oversize:

	Undersize Percent	Oversize Percent
1	---	10
2	15	10
3	20	5
4	20	0

These screen tolerances shall not invalidate the job-mix tolerances specified in Missouri Standards and Specifications for Highway Construction.

6. Bins: Bins shall be divided into compartments arranged to insure separate storage of the appropriate fractions of aggregates. Each compartment shall be provided with an overflow pipe that will prevent any backing up of material into other compartments or bins or against the screens. The overflow material shall be wasted. Bins in continuous mix plants shall be equipped with reliable devices to indicate the level of aggregate, especially in the lower quarter of the bins. When mineral filler is required, additional dry storage shall be provided and provision shall be made for proportioning it into the mix.

7. Asphalt Control Unit: Means shall be provided to obtain the required percentage of asphalt in the mix within the tolerances specified, either by weighing, metering, or measuring volumetrically. Where the quantity of asphalt is controlled by metering, provision shall be made for the amount of asphalt delivered through the meter to be readily checked by weight. Steam jacketing or other insulation which will maintain the specified temperature of asphalt in pipelines, meters, weigh buckets, spray bars, flow lines or other containers shall be provided.

8. Thermometric Equipment: An armored thermometer reading from 200 degrees to 400 degrees shall be fixed in the asphalt feed line at a location near the discharge valve at the mixer unit. One pyro-metric thermometer will be supplied in the sand bin and in the intermediate aggregate bin. The plant shall be further equipped with an approved dial-scale, mercury actuated thermometer, a recording electric pyrometer, or other thermometric instrument having an accuracy of ± 5 degrees, placed at the discharge chute of the dryer to register automatically, or indicate, the temperature of the heated aggregate. Any thermometric instrument used shall be sensitive to a rate of temperature change not less than 10 degrees F. per minute. The Engineer shall have the right to test the accuracy of thermometric instruments for better control of the asphalt, aggregate and mix temperatures. He/she may direct the immediate repair or replacement of any instrument yielding inaccurate or inconsistent readings.

9. Dust Collector: The plant shall be provided with a dust collector, designed to waste, or return in a constant and uniform flow to the hot elevator by mechanical means, all or part of the material collected. Prior to permitting the return of such collected, the Engineer will examine the characteristics of the dust in relation to the mix requirements, and will designate the quantity to be returned. The plant shall have a mixer cover

and such additional housing as may be necessary to insure the proper control of dust.

10. Safety Requirements: Adequate and safe stairways to the mixer platform and guarded ladders to the plant units shall be provided. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be well guarded and protected. Ample and unobstructed space for the operator shall be provided on the mixing platform. A clear and unobstructed passage shall be free from drippings from the mixing platform. A ladder, or platform, shall be so located at the truck loading space to permit easy and safe inspection or sampling of the mix as it is delivered into the truck. Overhead protection shall be provided where necessary.

2200.2.7 *Special Requirements for Batch Type Plants*:

1. Plant Scales: Scales for any weight box or hopper may be of either the springless dial or beam type and shall be of an established make and design accurate to within 0.5 percent of the indicated load.

Dial scales shall be designed, constructed and installed in such manner as to be free from vibration. All dials shall be so located as to be plainly visible to the operator at all times. The numbers on the dial shall be large enough to be read at a distance of 25 feet. The end of the pointer shall be set close to the face of the dial to minimize parallax. The scale shall be provided with adjustable pointers for marking the weight of each material to be weighed into the batch. When scales are of the beam type, there shall be a tare beam for balancing the hopper and a separate beam for the aggregate from each hot bid. A telltale dial shall be provided that will start to function when the load being applied is within 100 pounds of the weight desired. Each beam shall have a locking device designed and so located that the beam can easily be suspended or put into action. Scales for the weighing of asphalt shall conform to the requirements for aggregate scales, except that beam scales shall consist of a full capacity beam and a tare beam. The minimum gradation shall be not greater than two pounds and there shall be attached a telltale device which will start to function when the load being applied is within 25 pounds of the weight desired. Dial scales for weighing the asphalt shall read to the nearest pound. All scales for weighing the asphalt shall have a capacity of not more than 10 percent of the normal capacity of the mixer.

Scales shall be tested and sealed as often as the Engineer may deem it necessary to insure their accuracy. All weighing equipment shall be well constructed and designed to permit easy realignment and adjustment. Weighing equipment that easily gets out of adjustment shall be replaced when so ordered by the Engineer. The Contractor shall provide and have available at least ten 50-pound standard weights for frequent testing of all scales. For each scale, a suitable cradle, or platform, shall be provided for applying the test load so that the load is distributed uniformly. The test weights shall be kept clean and stored near the scales.

Volumetric proportioning of heated and screened aggregates will be permissible provided the volumetric system is standard equipment furnished for the plant.

The scales used for checking volumetric proportions shall be

accurate within 0.5 percent of the check test load.
2. Weight Box or Hopper: Equipment shall include a weight box or hopper, large enough to hold a full batch without hand raking or running over, for accurately weighing each bid size of aggregate. The weight box or hopper fulcrums and knife-edges shall be so constructed that they will not readily be thrown out of alignment. Gates on both bins and hopper shall prevent leakage when they are closed. An interlocking device which prevents the opening of more than one gate at a time shall be provided. Proportioning of aggregates and charging of mixer shall be performed as to blend the aggregates thoroughly and prevent segregation in the mixer. Automatic plants may proportion all aggregates by simultaneous measuring if a weight hopper with a separate compartment for each bin size, calibrated by weight, is used.
3. Asphalt Measuring Equipment: Asphalt measuring equipment provided on the plant shall accurately measure into each batch the required amount of asphalt within a tolerance of plus or minus two (2) pounds. When an asphalt bucket is used, it shall be non-tilting type provided with a loose sheet-metal cover. The capacity of the asphalt bucket shall be at least 10 percent in excess of the weight of asphalt required for a one-batch mix. The plant shall have a steam-jacketed, quick closing, non-dripping, charging valve. The length of the discharge opening or spray bar shall not be less than three-fourths (3/4) of the length of the mixer and it shall discharge directly into the mixer. The discharge system shall be designed and arranged to deliver the asphalt the full length of the mixer in a thin, uniform sheet or in multiple streams or sprays.
When a volumetric meter is used, it shall automatically meter the asphalt into each batch. The dial to indicate the amount of asphalt shall have a capacity of at least 10 percent in excess of the weight or gallons of asphalt required in one batch. The meter shall be constructed so that it may be locked at any dial setting and will automatically reset to this reading after the addition of the flow or asphalt to each batch. The dial shall be in full view of the mixer operator. The flow of asphalt required for one batch shall be discharged in not more than 15 seconds after the flow has started. The size and spacing of the spray bar opening shall provide a uniform application of the asphalt the full length of the mixer. The section of the asphalt flow line located between the charging valve and the outlet shall be used for checking and testing the accuracy of the meter.
4. Mixer Unit for Batch Method: The plant shall include a batch mixer and a batch capacity of not less than 2,000 pounds. It shall be capable of producing, uniformly, a mix within the job-mix tolerances established in Missouri Standards and Specifications for Highway Construction. Deviation in size of batches will be permitted to provide for mixing batches down to 20 percent below and up to 15 percent above the rated capacity in the mixer, provided the quality of the mix is not impaired. The clearance of the blades from all fixed and moving parts shall not exceed 3/4 inch. The paddles shall be set to insure a completely uniform mixture. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust. The mixer shall be so constructed as to prevent leakage of contents.

5. Time Lock and Batch Counter: The mixer shall have an accurate time control to lock the weight box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. The time lock shall also lock the asphalt bucket throughout the dry and wet mixing periods. Control of the timing shall be flexible, permitting adjustment of cycles up to three (3) minutes in five-second intervals. A mechanical batch counter, designed to register only completely mixed batches, shall be installed.

2200.2.8 ***Special Requirements for Continuous Mixing Plants:***

1. Gradation Control Unit: The plant shall include means for accurately proportioning each bin size of aggregate either by weight or by volumetric measurement. When gradation control is by volume, the unit shall include a feeder mounted under the bins. Each bin compartment shall have an accurately controlled mechanically adjustable gate to form an opening for volumetrically measuring the material drawn from it. The opening shall be rectangular and provided with a lock. Indicators shall be provided on each gate to show the gate opening in inches. Mineral filler, if specified, shall be proportioned separately from a hopper equipped with an adjustable feed which may be accurately and conveniently calibrated and which shall be interlocked with the aggregate and asphalt feeds.

2. Weight Calibration of Aggregate Feed: Samples shall be taken and weighed as a means of calibrating gate openings. Material shall be fed out of a bin through the individual opening and bypassed to a leak proof test box. The material from each compartment shall be taken separately. The plant shall be equipped to handle conveniently test samples weighing not less than 200 pounds. A platform scale shall be provided by the Contractor to weigh the test samples to an accuracy of plus or minus *0.5* percent of the indicated load.

3. Synchronization of Aggregate and Asphalt Feed: Positive interlocking control shall be assured between the flow of aggregate from the bins and the flow of asphalt from the meter or other proportioning device. This shall be accomplished by interlocking mechanical means or by any positive method approved by the Engineer. The aggregate bins shall be provided with signal devices and controls which will warn of low levels and thereby lead to stopping the flow of all aggregate and asphalt to the mixer when the aggregate in any one bin is so low that the feeder will not operate at set capacity. The asphalt storage system shall be provided with signal devices and controls which will warn of low levels of asphalt and which will stop the entire plant operation when the asphalt storage level is lowered to the point of exposing the feed end of the asphalt suction line.

5. Mixer Unit for Continuous Method: The plant shall include a continuous mixer of the twin pug-mill type capable of uniformly producing a mix within the job-mix tolerance specified in Missouri Standards and Specifications for Highway Construction. The paddles shall be of a type adjustable for angular position of the shafts and reversible to restart the flow of the mix. The clearance of the paddles from all fixed and moving parts shall not exceed 3/4 inch. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights

inscribed on a permanent gauge.

2200.2.9 ***Pavers and Laydown Machines*****:**

1. Mechanical self-powered pavers shall be capable of spreading the mix, within the specified tolerances, true to the line, grade, and crown indicated on the plans. A motor patrol may be used for the leveling course, if so directed by the Engineer. Pavers shall be equipped with quick and efficient steering devices and shall be capable of traveling both forward and in reverse. They shall be equipped with hoppers and distributing screws that place the mix evenly in front of adjustable screeds. They shall be equipped with either a vibrating screed or with a tamping bar immediately preceding a static screed. Screed and auger extensions shall be used when gates are extended 2 feet or more on either side of the paver.

2. An Asphalt Material Transfer Vehicle shall be used on arterial and collector roadways unless otherwise approved by the Engineer in writing.

2200.2.10 ***Automatic Screed Control:*** The use of automatic screed control devices will be required except for paving small irregular areas, shoulders, entrances, and side road connections. The screed of the mechanical spreading and finishing machine shall be regulated by an automatically controlled grade leveling, and slope control device approved by the Engineer. The device shall be of a standard commercial quality adapted to the type of paver used and shall provide control for producing a uniform surface to the established grade, and a cross slope conforming to the requirements of the typical section. The device shall also be equipped with the necessary controls to permit the operator to adjust or vary the slope throughout super-elevated curves.

2200.2.11 ***Grade Reference*****:** Except as modified above or by the contract, an established grade reference shall be used. The Engineer will establish the grade and will furnish variable thickness values at intervals along the centerline of the roadway for the use of the Contractor in setting a grade reference. The initial pass of the paver, when placing the first continuous layer, shall be made with the sensor following the established grade reference maintained true to grade. If the established grade reference is not required, the initial pass of the paver, when placing the first continuous layer, shall be made with the sensor following a traveling reference plane not less than 30 feet in length that is an integral part of the paver. Regardless of the method used for placing the first continuous layer, other layers shall be placed by use of a shoe-type sensor or indicator, the traveling reference plane, or by additional use of the established grade reference as follows:

1. If the current construction consists of only one bituminous or asphaltic layer, a shoe-type sensor or indicator resting on the adjacent surface shall be used for control of subsequent passes of the paver for that layer. When more than two adjacent passes of the paver are required to place the material the full width of the riding surface, additional use of the

established grade reference or use of the traveling reference may be required, if in the judgment of the Engineer, satisfactory grade control is not being obtained by the use of the shoe-type sensor.
2. If the current construction consists of two bituminous or asphaltic layers, subsequent passes of the paver for the first layer and the first pass of the paver for the second layer shall be made with the sensor following the traveling reference. The adjacent passes of the paver for the second layer shall be made with a shoe-type sensor or indicator resting on the previously placed second layer. When more than two adjacent passes of the paver are required to place the second layer the full width of the riding surface, additional use of the established grade reference or the traveling reference may be required, if in the judgment of the Engineer, satisfactory grade is not obtained by the use of the shoe-type sensor resting on the adjacent surface.
3. If the current construction consists of three or more bituminous or asphaltic layers, subsequent passes of the paver for the same layer and each pass of the paver for all additional layers except the top layer, shall be made with the sensor following the traveling reference. When more than two adjacent passes of the paver are required to place the surfacing material, except for the top layer, the full width of the riding surface, additional use of the established grade reference may be required, if in the judgment of the Engineer, satisfactory grade control is not obtained by the use of traveling reference. The automatic screed control device shall not be used when placing the top layer if the current construction consists of three or more full layers of a bituminous or asphaltic mixture.

2200.2.12 ***Failure of Automatic Equipment:*** The spreading operation shall be discontinued in the event of failure of the automatic control device except that placement will be permitted of mixtures already produced at the time of the failure. The use of the automatic control equipment does not preclude the need for manual control of the screed adjustment for wedging operations over small areas requiring more correction that the maximum thickness permitted for an individual layer of the type of material being placed.

2200.2.13 ***Paver Capabilities*****:** Pavers shall be capable of spreading mixes without segregation or tearing. They shall also be capable of placing courses in thicknesses of from 1/2 inch to at least three (3) inches, and from widths of eight (8) feet to at least 13 feet. Extensions and cut-off shoes shall permit changes in widths by increments of six (6) inches, or smaller.
An “averaging beam” shall be used on arterial and collector roadways unless otherwise approved by the Engineer in writing.

2200.2.14 ***Rollers:*** All rollers, vibrators, or other equipment used to compact the asphaltic mixture shall be in satisfactory working condition. All rollers shall be capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Pneumatic tire rollers shall be self propelled, of the oscillating-type, and equipped with smooth tires of equal size, diameter, and ply rating, all maintained at the same inflation

pressure. Rollers shall have a system for moistening each wheel or roll. The following types of rollers shall be provided:
1. Initial Rolling: Eight-ton or 12-ton three wheel roller or two wheel tandem-type roller, or pneumatic tire roller (adjusting ballast and tire inflation pressure as required).
2. Intermediate Rolling: Pneumatic tire oscillating-type roller developing at least 80 pounds per square inch contact pressure uniformly for all wheels. The contractor shall furnish evidence regarding tire size, pressure, and loading to confirm that 80 pounds per square inch contact pressure is being developed.
3. Final Rolling: Not less than 10-ton two or three wheel tandem-type roller.
4. Trench rollers, vibrators, and other special equipment used for compacting mixtures placed in areas inaccessible to the rollers specified shall be of a weight and design approved by the Engineer.

2200.2.15 ***Pressure Distributor*****:** The pressure distributor, when required, shall meet the requirements of the Section entitled "Pressure Distributor".

2200.2.16 ***Haul Tanks***: Vehicles used for the transportation of asphalt concrete from the plant to the site of work shall have tight metal bottoms, and shall be free from dust, screenings, petroleum oils, volatiles or other mineral spirits which may affect the load being hauled. Trucks shall be provided with covers of sufficient size and weight to protect the load and to prevent cooling of the upper surface. The Contractor shall provide haul trucks of such size, speed and condition to insure orderly and continuous operations.

2200.2.17 ***Truck Scales***: Plant-mix asphalt, paid for by the ton, shall be weighed on platform scales furnished by the Contractor, or on public scales at the Contractor's expense. The scales shall comply with all state laws governing the use of scales, and shall be tested and sealed by an authorized public official, at the expense of the Contractor, as often as the Engineer may deem it necessary to insure their accuracy.

2200.2.18 ***Field Testing Laboratory***: The Contractor shall provide a laboratory building or room at the plant site, if requested by the Engineer, for the exclusive use of the Engineer for performing tests, keeping records, and making reports. The Contractor shall also furnish necessary laboratory sieves and a powered shaker device for sieve analysis, scales, extractor and supplementary equipment to make aggregate sieve analysis, asphaltic concrete paving mixture analysis, and paving mixture density test.

2200.2.19 ***Hand Tools***: Only lutes or rakes with covered teeth shall be used during the spreading operation and when finished by hand.

2200.2.20 ***Tamping Irons:*** Tamping irons used to consolidate the edges of the pavement courses shall be of sufficient weight to compact the edges to the same degree as the body of the pavement. Irons shall be designed to form an edge as nearly vertical as possible. Irons which seal the material by heat

alone shall not be used. Tamping irons used to consolidate the material along curbs, gutters and other structures inaccessible to the roller shall weigh not less than 25 pounds, and shall have a bearing area not exceeding 48 square inches. Mechanical compaction equipment approved by the Engineer may be used instead of tamping irons. Straightedges, ten feet in length, shall be provided to test the finished surface.

2200.2.21 ***Inspection and Control of Asphalt Mixing Plant***:
1. General Provisions: For verifications of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mixes, the Engineer or his/her authorized representative will at all times, have access to all portions of the mixing plant, aggregate plant, storage yards, and other facilities for producing and processing the materials of construction. All sampling and testing of processed and unprocessed materials shall be under the control and direction of the Engineer, and shall be accomplished in accordance with the provisions set for in these specifications.
2. Job-Mix Formula: The Engineer will make frequent gradation analyses of the hot aggregates and of the completed mix to be certain that the materials being used and produced are within the tolerances of the job-mix formula, and the specifications of the mix number being used. If the mix is found to be outside of the job-mix formula tolerances, or outside of the specification limits as specified in Missouri Standards and Specifications for Highway Construction, correction shall be made in quantities measured from the hot bins and adjustments made at the cold bin feeders.
3. Sampling and Testing: Stockpiles and bins will be sampled for gradation analysis and examined for dust coating and for other purposes, in compliance with stated requirements.
Gradation analysis of each hot bin will be performed and a combined analysis computed at least twice a day--once in the forenoon, and once in the afternoon. A combined gradation analysis will be performed at least twice a day. If materials do not run uniform, more frequent tests will be made.
When requested by the Engineer, the Contractor shall provide representative samples by taking aggregate from the discharge of the aggregate through each of the hot bin gates, or by drawing aggregate from each bin through the mixture chamber (without asphalt) into a truck or other receptacle. At least one sample shall be taken from each 300 tons of the mix being produced. Samples will be used to determine compliance with general and special requirements set forth in Missouri Standards and Specifications for Highway Construction.

2200.2.22 ***Weather Limitations***: When the moisture of the aggregate in the stockpile or from the dryer interferes with the quality of mix production, or with normal plant operations, or when pools of water are observed on the surface to be paved, the mixing and placing of hot-mix asphalt will not be permitted without the special permission of the Engineer. Hot-mix asphalt paving shall not be mixed or placed when the ambient **air** temperature is below 40 degrees F., or when there is frost in the sub-grade or any other

time when weather conditions are unsuitable for the type of material being placed without expressed approval of the Engineer. When the ambient **air** temperature falls below 50 degrees F., precautions shall be taken to compact the mix before it cools too much to obtain the required density.

2200.3 CONSTRUCTION DETAILS:

2200.3.1 ***Preparation of the Area to be Paved***:
1. The area to be paved shall be true to line and grade, and have a dry and properly prepared surface prior to the start of paving operations. It shall be free from all loose screenings, and other loose or foreign material.
2. Where a base is rough or uneven, a leveling course shall be placed by use of a paver or, if so directed by the Engineer, a motor grader, and shall be properly compacted before the placing of subsequent courses.
3. When a leveling course is not required, all depressions and other irregularities shall be patched or corrected, and the work approved by the Engineer before the paving operation begins. All fatty and unsuitable patches, excess crack or joint filler, and all surplus bituminous material shall be removed from the area to be paved. Blotting of excessive deposits of asphalt with sand or stone will not be permitted.
4. Where the area to be paved is a prepared granular base or sub-base, it shall be primed in accordance with the provisions of Section 2100, Asphalt Tack and Priming.
5. A tack coat shall be applied when the surface to be paved is existing or new Portland cement concrete, brick, or asphalt pavement. When a tack coat is required, it shall consist of an application of the specified asphalt material at the rate of 0.02 to 0.08 gallons per square yard as specified by the Engineer. In order to apply limited quantities uniformly, the asphalt emulsion may be diluted 1:1 to 1:3 parts emulsion to water.
6. The surfaces of curbs, gutters, vertical faces of existing pavements, and all structures in actual contact with asphalt mixes shall be painted with a thin, complete coating of asphaltic material to provide a closely bonded, water-tight joint.
7. Asphalt release agents shall be in accordance with Missouri Standard Specifications for Highway Construction, Section 1071. Petroleum based release agents shall not be used within the Public Right of Way.

2200.3.2 ***Preparation of Paving Asphalt***: The asphalt shall be heated at the paving plant to a temperature at which it can be uniformly distributed throughout the mix. It shall be delivered into the Contractor's tank at a temperature not exceeding 350 degrees F., and shall not be heated above this temperature for any operation of the paving plant. Temperature of HMA shall be ± 15° of mix design target temperature @ time of placement.

2200.3.3 ***Preparation and Handling of Aggregate***:
1. Coarse and fine aggregates shall be stored at the plant in such a manner that the separate sizes will not become intermixed. Cold aggregates shall be carefully fed to the plant in such proportions that surpluses and shortages in the hot bins will not cause breaks in the continuous operation.

When loading aggregate into stockpiles, and into cars, barges, and trucks, the material shall be placed in such a manner as to prevent segregation of aggregate sizes. Stockpiles shall be built in uniform layers not exceeding five feet in depth.
2. Coarse and fine aggregate shall be sampled and tested upon arrival at the plant in accordance with the standard method specified in Missouri Standards and Specifications for Highway Construction, Latest Edition. Samples of coarse and fine aggregate shall be submitted to the Engineer for testing, prior to the start of work, and as often thereafter as requested by the Engineer. When coarse aggregate grading is such that the material will tend to segregate during stockpiling and handling, it shall be supplied in two or more sizes. Each size of coarse aggregate required to produce the combined gradation specified shall be placed in individual stockpiles at the plant site and separated by bulkheads or other means approved by the Engineer. Likewise, when it is necessary to blend fine aggregates from one or more sources to produce the combined gradation, each source or size of fine aggregate shall also be placed in individual stockpiles. Aggregate from the individual stockpiles shall be fed through separate bins to the cold elevator feeders. They shall not be blended into the stockpile.
3. Drying: The aggregate shall be thoroughly dried and heated to provide a paving mix temperature within a tolerance of + 15 degrees F., of that specified by the Engineer. The moisture content of the heated and dried aggregate shall not exceed *0.5* percent. The quantity of material fed through the dryer shall, in all cases, be held to an amount that can be thoroughly dried and heated in accordance with that specified in "Proportioning and Mixing".
4. Screening: Aggregates shall be screened into sizes such that they may be recombined into a gradation meeting the requirements of the job-mix formula.
5. Hot Aggregate Storage: Hot screened aggregate storage shall be accomplished in such a manner as to minimize segregation and loss of temperature of the aggregate.

2200.3.4 *Proportioning and Mixing*:
1. To aid in determining the proper temperature of the completed batch, current viscosity data shall be provided and shall be available at the plant at all times. With information relative to the viscosity of the particular asphalt being used, the temperature of the completed mix at the plant and at the paver shall be designated by the Engineer after discussing with the Contractor the hauling and placing conditions.
2. The asphalt shall be heated so that it can be distributed uniformly throughout the batch. For mixing applications, the specified temperature generally will be such that the asphalt viscosity is within the range of 150-300 centistokes *(75-150* seconds, Saybolt Furol). The material shall be sufficiently fluid to produce a complete coating on every particle of aggregate within the specified mixing time. The temperature of the aggregates and asphalt immediately prior to mixing shall be approximately that of the completed batch.

3. When the mix is produced in a batch-type plant, the aggregate shall be weighed accurately in the designated proportions to provide the specified batch weight. The temperature of the aggregate at the time of introduction into the mixer shall be as directed by the Engineer, with a tolerance of + 15 degrees F
4. Continuous mix plants shall, in general, be controlled in the same manner as batch-type plants. Details of control, differing because of the continuous mixing principle, shall be governed by instructions issued by the plant manufacturer, wherever these instructions are not contrary to these specifications.

2200.3.5 ***Control of Mixing Time***:
1. The dry mixing period is the interval of time between the opening of the weigh box gate and the application of the asphalt. The wet mixing period is the interval of time between the application of all asphalt and the opening of the mixer gate for discharge. When it is applied by a spray system, the wet mixing time shall begin with the start of the asphalt spray.
2. Batch-Type Plants: The Engineer will designate the length of time of both the dry and wet mixing periods to insure a uniformly and completely coated mix. Mixing period time shall not be altered unless so ordered by the Engineer. A dry mixing period of not less than five seconds shall precede the addition of the asphalt to the mix. Excess wet mixing shall be avoided. Wet mixing shall continue as long as is necessary to obtain a thoroughly blended mix, but shall not exceed 75 seconds nor be less than 30 seconds.
3. Continuous Type Plants: The determination of mixing time shall be by a weight method under the following formula, unless otherwise required:
Mixing Time, sec. = Pugmill Dead Capacity. lb. Pugmill Output, lb. per sec.
The weights shall be determined for the job from tests made by the Engineer.

2200.3.6 ***Transportation of Mix:*** The mix shall be transported to the job site in vehicles cleaned of all foreign material that may affect the mix. The inside of the truck beds shall be lubricated with a thin oil to prevent the mix from adhering to the bed, but an excess of lubricant will not be permitted. The dispatching of the vehicles shall be so scheduled that all material delivered may be placed in daylight unless the Engineer approves artificial light. Delivery of the material to the paver shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment. Trucks shall be tarped at all times in accordance with city ordinances.

2200.3.7 ***Spreading and Finishing***: The spreading and finishing of each course shall be to the thickness and width indicated in the contract. The thickness of individual layers shall not exceed the following for the respective listed type of mixture:

Asphalt Concrete Base	3” Maximum
Asphalt Concrete	2” Maximum

Surface	

2200.3.8 ***Spreading and Finishing with Mechanical Pavers***:
1. The base and surface courses shall be spread and struck-off with a mechanical paving machine meeting the requirements of Section *2200.2.9* entitled "Pavers and Lay-down Machines". The paving machine shall be operated so that the material does not accumulate and remain along the sides of the receiving hopper.
2. Equipment which leaves tracks or indented areas which cannot be corrected in normal operation, or which produces flushing or other permanent blemishes or fails to produce a satisfactory surface, shall not be used.
3. Longitudinal joints and edges shall be constructed to true line markings. Lines for the paver to follow in placing individual lanes will be established by the Engineer parallel to the centerline of the proposed roadway. The paver shall be positioned; and operated to follow closely the established line. When using pavers in echelon, the first paver shall follow the marks or lines, and the second paver shall follow the edge of the material placed by the first paver. In order to assure a hot joint and obtain proper compaction, the pavers shall work as close together as possible, and in no case, shall they be more than 100 feet apart. In backing trucks against the paver, care shall be taken not to jar it out of its proper alignment.
4. As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected.
5. Transverse joints in succeeding courses shall be offset at least two feet. Longitudinal joints shall be offset at least one foot.
6. Any irregularities in alignment left by the paver shall be corrected by trimming directly behind the machine. Immediately after trimming, the edges of the courses shall be thoroughly compacted by tamping. Distortion of the pavement during this operation shall be avoided.
7. Edges against which additional pavement is to be placed shall be straight and slightly beveled downward toward the unpaved area a maximum of 40 degrees from the vertical plane. A lute or covered rake shall be used immediately behind the paver, when required, to obtain a true line and vertical edge. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material forming high spots shall be removed by a shovel or lute. Indented areas shall be filled with hot mix and smoothed with the back of a shovel being pulled over the surface. Fanning of material over such areas shall not be permitted.

A material transfer vehicle shall be used on arterial and collector roadways unless otherwise approved by the Engineer in writing.

2200.3.9 ***Motor Grader***: When the Engineer permits the use of motor graders for

the spreading of the mix, the material shall be placed on the roadbed in a windrow by the windrow-leveler, measuring device, or by other methods approved by the Engineer so that the proper amount of material is available. The mix shall be spread to the required thickness, line and grade with a uniform surface texture while at a workable temperature. The Engineer will specify the length of the windrowed mix ahead of the spreading operations, based upon the workability of the mix, weather conditions, and the time required for the spreading operation.

2200.3.10 ***Hand Spreading***: In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand, if so directed by the Engineer. Wood or steel forms, approved by the Engineer, rigidly supported to assure correct grade and cross-sections may be used. In such instances, measuring blocks and intermediate strips shall be used to aid in obstructing the required cross-section. Placing by hand shall be performed carefully; the material shall be distributed uniformly to avoid segregation of the coarse and fine aggregate. Broadcasting of material shall not be permitted. During the spreading operation, all material shall be thoroughly loosened and uniformly distributed by lutes or covered rakes. Material that has formed into lumps and does not break down readily shall be rejected. Following placing and before rolling, the surface shall be checked with templates and straightedges and all irregularities corrected.

2200.3.11 ***Compaction:***

1. General: Rolling equipment for use in compacting mixes shall meet the requirements of Section 2200.2.14 entitled “Rollers”. Except for small jobs, such as driveways, at least two rollers shall be required at all times. As many additional rollers shall be used as necessary to provide specified pavement density.
2. During rolling, the roller wheels shall be kept moist with only sufficient water to avoid picking up the material.
3. After the longitudinal joints and edges have been compacted, rolling shall start longitudinally at the sides and gradually progress toward the center of the pavement. This holds true except on super-elevated curves, where the rolling shall begin on the low side and progress to the high side, overlapping on successive trips by at least one-half the width of tandem rollers and uniformly lapping each preceding track or covering the entire surface with the slow, but uniform speed with the drive roll or wheel nearest the paver. The speed shall not exceed three miles per hour for steel wheeled rollers or five miles per hour for pneumatic-tired rollers.
4. The line of rolling shall not be changed suddenly or the direction of rolling reversed suddenly. If rolling causes displacement of the material, the affected areas shall be loosened at once with lutes or shovels and restored to the original grade of the loose material before being rerolled. Heavy equipment or rollers shall not be permitted to stand on the finished surface before it has been compacted and has thoroughly cooled.
5. When paving in single width, the first lane placed shall be rolled in the following order:

1. Transverse joints
2. Outside edge
3. Initial or breakdown rolling, beginning on the low side and progressing toward the high side
4. Second rolling, same procedure as 3
5. Finish rolling
6. When paving in echelon, or abutting a previously placed lane, the longitudinal joint rolling shall follow the transverse joint rolling.
7. When paving in echelon, two or three inches of the edge which the second power is following shall be left unrolled, and rolled when the joint between the lanes is rolled. Edges shall not be exposed more than fifteen minutes without being rolled. Particular attention shall be given to the construction of transverse and longitudinal joints in all courses.
8. In laying a surface mix adjacent to any finished area, it shall be placed sufficiently high so that, when compacted, the finished surface will be true and uniform. When the wearing course is placed adjacent to curbs to form an asphalt gutter, it shall be sealed with asphalt for a distance of 12 inches from the curb. The seal shall be evenly applied to the surface by means of hot irons or squeegees so that the surface voids are completely filled and no excess asphalt remains on the surface. When necessary to do this in areas carrying traffic, the Engineer may direct that the surface be lightly dusted. Where the grade is slight, gutters shall be checked with a straightedge and tested with running water, to insure drainage to the desired outlet.

2200.3.12 *Transverse Joints*:
1. Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straightedges and string lined to assure smoothness and true alignment. If the joint is formed with a bulkhead, such as a board, to provide a straight line and vertical face, it shall be checked with a straightedge before fresh material is placed against it to complete the joint. If a bulkhead is not used to form the joint and the roller is permitted to roll over the end of the new material, the line of joint shall be located back of the rounded edge a sufficient distance to provide a true surface and cross-section. If the joint has been distorted by traffic or by other means, it shall be trimmed to line. In either case, the joint face shall be painted with a thin coating of asphalt before the fresh material is placed against it.
2. To obtain thorough compaction of these joints, the material placed against the joint shall be tightly crowded against the vertical face of the joint. To accomplish this, the paving machine shall be positioned so that the material shall overlap the edge of the joint one-inch to two inches. The depth of the overlapped material shall be kept uniform. The coarse aggregate in the overlapped material that has dislodged through raking or luting shall be removed from the pavement surface and discarded.
3. If a three-wheeled roller is used, it shall be placed on the previously compacted material transversely so that not more than six inches of the rear rolling wheel rides on the edge of the joint. The roller shall be operated to pinch and press the mix into place at the transverse joint. The

roller shall continue to roll along this line, shifting its position gradually across the joint, in six to eight-inch increments, until the joint has been rolled with the entire width of the neat joint is obtained. If only tandem rollers are available, they shall be similarly operated to complete the joint.
4. Transverse joints shall not be within 100' of another transverse joint measured longitudinally. When paving single width and maintaining traffic, one lane shall be taken no further than one half the total paving day. At the end of the paving day, all lanes shall be completed to approximately the same station. When paving in echelon, the lanes shall be as nearly even as practical.

2200.3.13 ***Longitudinal Joints***. Longitudinal joints shall be rolled directly behind the paving operation. The first lane placed shall be true to line and grade and have an approximately vertical face, the material being placed in the abutting lane shall then be tightly crowded against the face of the previously placed lane. The paver shall be positioned so that in spreading, the material overlaps the edge of the lane previously placed by one inch to two inches. The width and depth of the overlapped material shall be kept uniform along the joint for alignment purposes. Before rolling, the coarse aggregate in the material over-lapping the joint shall be carefully removed with a rake or lute and discarded. When rolling is accomplished with a three-wheeled roller, it shall be shifted over onto the previously placed lane, so that not more than six inches of the rear roller wheel rides on the edges of the newly laid lane. The rollers shall then be operated to pinch and press the fines gradually across the joint. Rolling shall be continued until a thoroughly compacted, neat joint is obtained. If only tandem rollers are available, they shall be similarly operated to complete the joint. When the abutting lane is not placed in the same day, or the joint is distorted during the day's work by traffic or by other means, the edge of the lane shall be carefully trimmed to line and painted with a very thin coating of asphalt before the abutting lane is placed.

2.Longitudinal Joints shall be offset a minimum of one foot from subsequent lifts.

3. Longitudinal Joints shall not be on a lane edge line, or within any the wheel path of any lane.

2200.3.14 ***Edges***: The edges of the pavement shall be rolled concurrently with or immediately after rolling the longitudinal joint. Care shall be exercised in consolidating the course along the entire length of the edges. Before it is compacted, the material along the unsupported edges shall be slightly elevated with a tamping tool or lute. This will permit the full weight of the roller wheel to bear on the material to the extreme edges of the mat. In rolling pavement edges, roller wheels shall extend two inches to four inches beyond the pavement edge.

2200.3.15 ***Breakdown Rolling***: Breakdown rolling shall immediately follow the rolling of the longitudinal joint and edges. Rollers shall be operated as

close to the paver as necessary to obtain adequate density without causing undue displacement. The breakdown roller shall be operated with the drive roll or wheel nearest the finishing machine. Exceptions may be made by the Engineer when working on steep slopes or super-elevated curves. When both three-wheeled rollers and tandem rollers are used, the threewheeled rollers shall work directly behind the paver followed by the tandem rollers.

2200.3.16 ***Second Rolling***: Pneumatic-tired rollers or tandem rollers, as specified in Section 2200.2.14 entitled "Rollers", shall be used for the second rolling. The second rolling shall follow the breakdown rolling as closely as possible and while the paving mix is still of a temperature that will result in maximum density from this operation. Pneumatic-tired rolling shall be continuous (at least three complete coverages) after the initial rolling until all of the mix placed has been thoroughly compacted. Turning of pneumatic-tired rollers on the hot paving mix which causes undue displacement shall not be permitted.

2200.3.17 ***Finish Rolling***: The finish rolling shall be accomplished with two-axle tandems or three-axle tandems while the material is still warm enough for the removal of roller marks. If necessary to obtain the desired surface finish, the Engineer shall specify the use of pneumatic-tired rollers.

2200.3.18 ***Non-Standard Compaction*****:** In places inaccessible for the operation of standard rollers as specified, compaction shall be performed by trench rollers or others meeting the requirements of Section 2200.2.14 entitled "Rollers". The trench roller shall be operated at the direction of the Engineer until the course is thoroughly compacted. Hand tamping, manual of mechanical, may be used in such areas, if it is proved to the Engineer that such Operations will give the desired density.

2200.3.19 ***Barricading***: The contractor shall safely barricade the completed area until the following morning except when authorized by the Engineer. The barricade may then be removed and that section opened to traffic. All traffic control shall correspond to MUCTD Standards.

2200.3.20 ***Density and Surface Requirements***:
1. The completed asphalt concrete paving shall have a density of 92-97 percent of laboratory maximum theoretical specific gravity (Gmm) in BP-1, BP-2 and Super Pave Asphalt Concrete or a laboratory specimen prepared as specified in Missouri Standards and Specifications for Highway Construction and made from plant mix conforming to the job-mix formula. Density testing will be performed based on random locations determined by the Engineer with no fewer than three tests performed in a production day. Acceptance will be based on the average of the day's density readings (minimum of 5 tests per day).
2. All unsatisfactory work shall be repaired, replaced or corrected. The surface of the final course shall be of a uniform texture and conform to line and grade shown on the plans.

3. Both density and thickness shall be carefully controlled during construction and shall be in full compliance with plans and specifications. During compaction, preliminary tests, as an aid for controlling thickness shall be made by means approved by the Engineer.
4. Representative samples of the compacted asphalt paving shall be obtained by the Contractor under the supervision of the Engineer and shall be tested by a suitable independent or municipal testing laboratory as necessary to verify compliance with respective density requirements.
5. Selection of the independent testing laboratory, the number, timing, location and testing procedures for the representative samples shall be approved by the Engineer. The testing laboratory shall submit to the Engineer four (4) copies of each report covering the details and results of the tests. All costs for the testing laboratory and all other costs of testing shall be covered by the City of Joplin for all City of Joplin funded projects. Testing for private work and for retesting of City of Joplin funded work shall be paid for by the contractor.

1. A rolling 10-foot straightedge shall be used for checking longitudinal elevation changes. A 4-foot straightedge shall be used for checking transverse elevation changes.

2. Length of pavement shall be defined in the following increments for the purpose of pavement smoothness acceptance.

a) Section- A section is a day's paving and shall begin and terminate at the construction joints. Interruptions designated by the Engineer which cause placement to cease and begin at a new location will be considered as a separate section for that day's operation if the separate section is greater than 250 feet.

b) Sections shall be divided into segments 0.1 miles in length with the exception of the last segment. If the last segment is greater than 250 feet and less than 0.1 miles, then the segment shall be measured for smoothness as an independent segment. If the last segment is 250 feet or less, the profile for that segment shall be included in the evaluation for the previous segment.

3. Profiling will not be required for the following areas

a) Bridge decks, bridge approach slabs and Portland Concrete approach pavements.

b) Pavement within a super-elevation transition,

c) 25 feet in direction of travel on each side of utility appurtenances such as manholes and pull boxes.

d) Fifty feet in direction of travel on each side of intersecting routes with special grade transitions.

e) Shoulders

f) Interruptions designated by the Engineer which provide independently placed sections shorter than 50 feet.

g) Any lane that abuts an existing lane not constructed under the same contract.

4. The straightedge path in the longitudinal direction for the driving lanes will be located 3 feet from the edge of pavement, or edge line of the lane of travel. Additional paths with suspect roughness may be selected at the Engineer's discretion. The Engineer also has discretion to use a manual straight edge for spot checking pavement.

5. The Engineer shall randomly check driving lanes, regardless of the smoothness measurement method used, for variations in the traverse direction with a four foot straight edge. Any variations in the transverse direction of more than ¼ inch shall be marked for correction in a manner approved by the Engineer.

6. No more than ¼ inch of change in elevation will be allowed between utility appurtenances, such as manholes and pull boxes, and the pavement immediately adjacent.

7. Method of Correction

a) Diamond grinding may be used for bumps, but shall not exceed ¼ inch.
b) Fog Sealing is required in areas where diamond grinding has taken place.
c) Use of impact devices shall not be permitted.
d) Heating and reworking of the asphalt pavement shall not be permitted.
e) The final surface texture of the corrected pavement shall be comparable to the adjacent sections that do not require correction.
f) All corrective work shall be completed prior to determination of the pavement thickness.
g) Areas greater than 3/8 inch in elevation change shall be marked for removal and replacement.
h) 5% of the tonnage placed may be deducted for each ¼ inch increment in excess of ¼ inch up to and including 3/8 inch.
i) Low areas shall be thoroughly tacked and material placed not less than 1.5 times the thickness of the nominal maximum particle size of the mix design.

6. At no time shall an open flame be placed on the asphalt surface. Only indirect heating sources shall be used to remediate deficiencies where allowed.

2200.4 MEASUREMENT AND PAYMENT: Asphalt yield shall be calculated periodically with a tolerance of three percent of design quantity. No change to lift thickness shall be made without Engineer's prior approval. Waste shall be noted on deliver tickets for any rejected or left over material. When listed in the proposal, the quantity of asphalt concrete will be paid for by the square yard or at the unit price per ton in place. These prices and payments shall constitute full compensation for cleaning and tacking of the underlying course, furnishing all materials, equipment, tools, labor and work incidental thereto. Payment will be made for each item listed in the proposal as follows:

Asphaltic Concrete Base	per ton
Asphaltic Concrete Base	per square yard
Asphaltic Concrete Surface	per ton
Asphaltic Concrete Surface	per square yard

END OF SECTION

DIVISION 2300
INCIDENTAL CONSTRUCTION
SECTION 2300 - INCIDENTAL CONSTRUCTION
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SECTION 2302 ASPHALT SIDEWALKS, DRIVEWAYS, AND BICYCLE/PEDESTRIAN PATHS

2302.1 Summary
This section governs the placement of asphalt sidewalks, driveways, and bicycle/pedestrian paths

2302.2 Asphalt Sidewalks
Asphalt shall not be used in the construction of any approved permanent sidewalk. Asphalt may be used as material f or temporary sidewalks if approved in advance by the Engineer.

2302.3 Asphalt Driveways
Asphalt driveways may be constructed with prior approval of the Engineer in accordance with the provisions of Section 2201 and Section 2205 "Asphalt Paving" and Section 2209 "Curbing" as applicable. The sidewalks, sidewalk ramps, driveways or bicycle/pedestrian paths shall be constructed or reconstructed to the configuration, and to the
lines and grades shown by the plans. Generally sidewalks, sidewalk ramps, driveways, and bicycle/pedestrian paths should be constructed after the curbing.

2302.4 Bicycle/Pedestrian Paths
Asphalt bicycle/pedestrian paths shall be constructed in accordance with the provisions of Section 2201 and Section
2205 “Asphalt Paving” and in accordance with the applicable provisions of Paragraph 2302.3 The sidewalks, sidewalk ramps, driveways or bicycle/pedestrian paths shall be constructed or reconstructed to the configuration, and to the lines and grades shown by the plans. Generally sidewalks, sidewalk ramps, driveways, and bicycle/pedestrian paths should be constructed after the curbing.

2302.5 Method of Measurement
A. Sidewalks: Sidewalks will be measured per square foot (square meter or tenth part thereof).
B. Temporary Sidewalks: Temporary sidewalks will be measured by one of the following:
1. Per ton (metric ton) or tenth part thereof.
2. Per square foot (square meter or tenth part thereof).
C. Driveways: Driveways will be measured by one of the following:
1. Per ton (metric ton) or tenth part thereof.
2. Per square foot (square meter or tenth part thereof).
D. Bicycle Pedestrian Paths: Bicycle/Pedestrian paths will be measured by one of the following:
1. Per ton (metric ton) or tenth part thereof.
2. Per square foot (square meter or tenth part thereof).
2302.6 Basis of Payment
All items in this section will be paid for at the contract unit bid price.

SECTION 2303 ROCK BLANKET

2303.1 Summary

This section governs the construction of a protecting blanket of rock or broken concrete on slopes, channel bank or stream banks.

2303.2 Materials

The material for rock blanket shall be durable stone or broken concrete containing a combined total of not more than 10 percent of earth, sand, shale, and non–durable rock. When broken concrete is accepted, reinforcing shall be neatly chipped from all faces and shall not protrude from an in-place exposed face. The material shall contain a large percentage of pieces as large as the thickness of the blanket will permit, with enough smaller pieces of various sizes to fill the larger voids. Acceptance of quality and size of material may be made by visual inspection
at the job site. Rock Blanket shall be specified by class as shown in the following tables:

Percent Heavier Than

Class	**1 Ton**	**½ Ton**	**¼ Ton**	**250 lbs**	**200 lbs**	**180 lbs**	**75 lbs**	**60 lbs**	**10 lbs**	**5 lbs**
1 ton	50+	95+								
½ ton	0	50+	95+							
¼ ton		0	50+				90+			
Facing					0		50+			90+
Light 24”			0		50+					90+
Light 18”				0		5-15		50-70	85-100	

Percent Heavier Than

Class	**1.75 MT**	**1 MT**	**½ MT**	**¼ MT**	**90 kg**	**80 kg**	**35 kg**	**25 kg**	**5 kg**	**2 kg**
1 ton	50+	95+								
½ ton	0	50+	95+							
¼ ton		0	50+				90+			
Facing					0		50+			90+
Light 24”			0		50+					90+
Light 18”				0		5-15		50-70	85-100	

2303.3 Construction Requirements

A trench at the toe of the slope shall be excavated to the elevation as shown on the plans or to a minimum of 2 feet (600 mm) when not shown. The slopes shall conform to the proper cross section and be compacted to a uniform density as required for adjacent material. The rock or broken concrete shall be placed on the slope, to the prescribed thickness, elevation and extent, and shall be manipulated so that the flat sides are in contact, thereby
eliminating large voids. The outside of the blanket shall present an appearance free from segregation and with a proportionate amount of the larger pieces showing.

2303.4 Method of Measurement
Rock blanket will be measured by one of the following:
A. Per square yard (square meter) or tenth part thereof.
B. Per ton (metric ton) or tenth part thereof.

2303.5 Basis of Payment
Rock blanket will be paid for by the contract unit bid price.

SECTION 2304 CONCRETE PAVER STONES (For Median Treatment)

2304.1 Referenced Standards
The following standards are referenced directly in this section. The latest version of these standards shall be used.
American Society of Test Methods (ASTM)
C33 – Standard Specification for Concrete Aggregates
C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
C140 – Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C150 – Standard Specification for Portland Cement
C207 – Standard Specification for Hydrated Lime for Masonry Purposes
C418 – Standard Test Method for Abrasion Resistance of Concrete by Sandblasting
C595 – Standard Specification for Blended Hydraulic Cements
C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in concrete.
C936 – Standard Specification for Solid Concrete Interlocking Paving Units
Midwest Concrete Industry Board (MCIB) Mix No. WA610–1–4

2304.2 Summary
This section governs the furnishing of all labor, equipment and tools and for the performance of all work necessary to construct concrete paver stone paving.

2304.3 Materials
A. Interlocking Concrete Paver Stones (ASTM Designation C936):
1. Paver stones shall be cobblestone style consisting of full stones, 4 5/8" by 7" by 2 3/8" (117 mm by178 mm by 60 mm); two thirds stones, 4 5/8" by 4 5/8" by 2 3/8" (117 mm by 117 mm by 60 mm); and one third stones, 4 5/8" by 2 5/16" by 2 3/8" (117 mm by 59 mm by 60 mm). The mix of stones sizes shall be approximately 28% full size, 57% two thirds size and 15% one third size.
2. Cementitious Materials: Materials shall conform to the following ASTM specifications as they apply
a. Portland Cements – Specification C150
b. Blended Cements – Specification C595
c. Hydrated Lime Type S – Specification C207
d. Pozzolans – Specification C618
3. Aggregates: Aggregates shall conform to ASTM Specifications C33 for Normal Weight Concrete Aggregate.
4. Other Constituents: Air–entraining agents, coloring pigments, integral water repellents, finely ground silica, etc. shall conform to ASTM standards where applicable, or shall be previously established as suitable for use in concrete.
5. Physical Requirements

a. Compressive Strength: At the time of delivery to the work site, the average compressive strength shall be not less than 8,000 psi (55.2 MPa) with no individual unit strength less than 7,200 psi (49.6 MPa), with testing procedures in accordance with ASTM Standard C140.
b. Absorption: The average absorption shall not be greater than 5% with no individual unit absorption greater than 7%.
c. Durability: The manufacturer shall certify either by proven field performance or the laboratory freeze–thaw test that the paving units have adequate durability.
d. Proven Field Performance: Satisfactory field performance is indicated when units similar in composition, and made with the same manufacturing processes those to be supplied to the purchaser, do not exhibit objectionable deterioration after at least three years. The units used as the basis for proven field performance shall have been exposed to the same environmental factors as is contemplated for the units supplied to the purchaser.
e. Freeze–Thaw Test: When tested in accordance with Section 8 of ASTM C67, Specimens shall have no breakage and not greater than 1.0% loss in dry weight of any individual unit when subjected to 50 freeze–thaw cycles. This test shall be conducted not more than 12 months prior to delivery of units.
f. Abrasion Resistance: When tested by sandblasting in accordance with ASTM C418, Specimens shall not have greater volume loss than 0.3 cubic inches per square inch (15 cubic cm per 50 square cm). The average thickness loss shall not exceed 1/8 inch (3 mm).
g. Permissible Variations in Dimensions: Length or width of units shall not differ by more than 1/16 inch (1.5 mm) from approved samples. Heights of units shall not differ by more than 1/8 inch (3 mm) from the specified standard.
h. Visual Inspection: All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or permanence of the construction. Minor cracks incidental to the usual methods of manufacturer, or minor chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.
6. Sampling and Testing: The purchaser or his authorized representative shall be accorded proper facilities to inspect and sample the units at the place of manufacture from the lot ready for delivery. Sampling and testing of units shall be in accordance with ASTM Methods C140 except as required.
7. Rejection: In case the shipment fails to conform to the specified requirements, the manufacturer may sort it, and new test units shall be selected at random by the purchaser from the retained lot and tested at the expense of the manufacturer. In case the second set of test units fails to conform to specified requirements, the entire lot shall be rejected.
8. Expense of Tests: The expense of inspection and testing shall be borne by the purchaser unless otherwise agreed.
B. Base Course Concrete: Base course concrete shall conform to the requirements of MCIB Mix No. WA610–1–4.
C. Sand for Laying Course: The sand for the laying course shall be a well graded, clean, washed, sharp sand with 100% passing a 3/8" (9.5 mm) sieve size and a maximum of 3% passing a No. 200 (75 um) sieve size. This is commonly known as manufactured concrete sand, limestone screening, or similar. Mason Sand will not be permitted.

2304.4 Construction Details
A. Product Handling: Paver stones shall be delivered and unloaded at jobsite on pallets and bound in such a manner that no damage occurs to the product during handling, hauling and unloading.
B. Edge Restraint: All edges of the installed paver stone shall be restrained by the concrete curb, concrete sidewalk, or another suitable method for preventing the movement of the edge stones.
C. Concrete Base Course: A concrete base course shall be constructed in accordance with the requirements of Section 2301. The base course shall be shaped to the grade and cross section as shown on the plans with an allowable tolerance of 1/4 inch (5 mm). The base course shall be 4 inches (100 mm) thick, and should be graded

to allow a 1 inch (25 mm) thick sand course between the base and the paving stones. Pavement for concrete base course shall be subsidiary to the bid items.
The finished base course must be approved by the Engineer before the placement of the sand laying course. The uncompacted sand laying course shall be spread evenly over the area to be paved and then screened to a level that will produce 1 inch (25 mm) thickness when the paver stones have been placed and vibrated. Once screened and leveled to the desired elevation, the sand laying course shall not be disturbed in any way.
D. Placing Paver Stones: The paver stones shall be installed in rows perpendicular to the major axis of the median being paved. Within each row the stone sizes shall be randomly mixed so that joints between stones are not normally aligned with joints between stones in adjacent rows. No joints shall be aligned for more than three consecutive rows. The paver stones shall be laid in such a manner that the desired pattern is maintained and the joints between the stones are as tight as possible. For maximum interlock the joints between stones should not exceed 1/8 inch (3 mm). String lines should be used to hold all pattern lines true.
The gaps at the edge of the paver surface shall be filled with standard edge stones or with stones cut to fit. Curing shall be accomplished to leave a clean edge to the traffic surface using a double–headed breaker or a masonry saw. However, when cutting precision designed areas, a masonry saw should be used. Whenever possible, no cuts should result with a paver less than 1/3 of original dimension. Paver stones shall be vibrated to their final level in the sand laying course by two or three passed of a vibrating compactor capable of 3,000 to 5,000 pounds (1360 kg to 2270 kg) compaction force with the surface clean and joints open. After vibration, clean concrete sand containing at least 30% of 1/8 inch (3mm) particles shall be spread over the paver stone surface, allowed to dry, and vibrated into the joints with additional passes of the plate vibrator so as to completely fill the joints. Surplus material shall then be swept from the surface. Upon completion of work covered in this Section, the
Contractor shall clean up all work areas by removing all debris, surplus material and equipment from the site. After final vibrating, the surface shall be true to grade and shall not vary by more than 1/4 inch (5 mm) when tested with a 10 feet (3.05 m) board at any location on the surface.

2304.5 Method of Measurement
Concrete Paver Stones will be measured by the square foot (square meter or tenth part thereof).

2304.6 Basis of Payment
Concrete Paver Stones will be paid for by the contract unit bid price.

SECTION 2305 MAINTENANCE OF TRAFFIC

2305.1 Referenced Standards
The following standards are referenced directly in this section. The latest version of these standards shall be used.
American Traffic Safety Services Association (ATSSA)
Quality Standards for Work Zone Traffic Control Devices
Manual of Uniform Traffic Control Devices, Part VI (MUTCD)

2305.2 Summary
This section governs the furnishing of all labor, equipment and tools and for the performance of all work necessary to provide Maintenance of Traffic as specified herein, on the plans or within the Special Provisions.

2305.3 General

The Contractor is required to maintain access to all properties served by the streets within the construction site limits.

2305.4 Traffic Maintenance and Warning Devices
The Contractor will be responsible for arranging for installation of the necessary traffic control devices (with the exception of the barricades and other channelizing devices) a minimum of 48 hours prior to beginning the project so that inspection can be conducted by the Engineer.
Traffic maintenance devices including barricades, flashing lights, flag persons and other traffic control devices shall be in conformance with "Part VI of the Manual on Uniform Traffic Control Devices" latest edition.

2305.5 Flashers and Other Traffic Control Devices
All traffic control devices shall be maintained in acceptable condition as defined by the latest ATSSA "Quality Standards for Work Zone Traffic Control Devices." Devices in unacceptable or marginal condition as determined above shall be removed from the job site and replaced with devices in acceptable condition.

2305.6 Method of Measurement
Maintenance of Traffic will be measured per each device per day listed in the proposal and as adjusted by the Engineer during construction. The device must be set for at least one–half of a calendar day for it to be measured for payment.

2305.7 Basis of Payment
Maintenance of Traffic will be paid for by one of the following:
A. Contract unit bid price
B. Contract lump sum bid price

SECTION 2306 PAVEMENT MARKINGS

2306.1 Referenced Standards
Reference MoDOT section 620:1048.
American Society of Test Methods (ASTM)
C321 – Standard Test Method for Bond Strength of Chemical–Resistant Mortars
C501 – Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
D36 – Standard Test Method for Softening Point of Bitumen (Ring and Ball Apparatus)
D92 – Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
D93 – Standard Test Methods for Flash Point by Pensky Martens Closed Tester
D256 – Standard Test Method Methods for Determining the Izod Pendulum Impact Resistance of Plastics
D476 – Standard Classification for Dry Pigmentary Titanium Dioxide Products
D562 – Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer Type Viscometer
D570 – Standard Test Method for Water Absorption of Plastics
D638 – Standard Test Method for Tensile Properties of Plastics
D711 – Standard Test Method for No–Pick–Up Time of Traffic Paint
D768 – Standard Specification for Yellow Iron Oxide Hydrated
D868 – Standard Test Method for Evaluating Degree of Bleeding of Traffic Paint

D969 – Standard Test Method for Laboratory Determination of Degree of Bleeding of Traffic Paint
D1152 – Standard Specification for Methanol (Methyl Alcohol)
D1155 – Standard Test Method for Roundness of Glass Spheres
D1199 – Standard Specification for Calcium Carbonate Pigments
D1210 – Standard Test Method for Fineness of Dispersion of Pigment–Vehicle Systems by Hegman–Type Gage
D 1214 – Standard Test Method for Sieve Analysis of Glass Spheres
D1475 – Standard test Method for Density of Liquid Coatings Inks and Related Products
D2240 – Standard Test Method for Rubber Property–Durometer Hardness
D2243 – Standard Test Method for Freeze–Thaw Resistance of Waterborne Coatings
D2369 – Standard Test Method for Volatile Content of Coatings
D 2805 – Standard Test Method for Hiding Power of Paints by Reflectometry
D3723 – Standard Test Method for Pigment Content of Water Emulsion by Low Temperature Ashing
D3960 – Standard Practice for Determining Volatile Organic Content (VOC) of Paints and Related Coatings
D 4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
D4061 – Standard Test Method for Retroreflectance of Horizontal Coatings
D4366 – Withdrawn,in 2003 and replaced by ANSI/ISO 1522
D4796 – Standard Test Method for Bond Strength of Thermoplastic Traffic Marking Materials
D5420 – Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
E70 – Standard Test Method for pH of Aqueous Solutions with the Glass Electrode
E303 – Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
E308 – Standard Practice for Computing the Colors of Objects by Using the CIE System
E660 – Standard Practice for Accelerated Polishing of Aggregates or Pavement Surfaces Using a Small–Wheel, Circular Track Polishing Machine
E1347- Standard Test Method for Color and Color–Difference Measurement by Tristimulus Colorimetry
E1349 – Standard Test Method for Reflectance Factor and Color by Spectophotometry Using Bidirectional (45:0or 0:45) Geometry American Association of State Highway and Transportation Officials (AASHTO)
M 247 -Standard Specification for Glass Beads Used in Traffic Paint
M 249 - Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form)
T 250 - Standard Method of Test for Thermoplastic Traffic Line Material
Manual of Uniform Traffic Control Devices, latest edition (MUTCD) American
Concrete Institute (ACI 301)
ACI 503 - Guide for the Selection and Use of Structural Adhesives with Concrete
Federal Test Methods
Federal Test Method Standard No. 141, Method 4252 – Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing
Federal Test Method Standard No. 141a, Method 6121 – Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing
Federal Standard 595, Colors used in Government Procurement
Federal Specification TT–P–115a – Paint, Traffic (Highway, White and Yellow)
Federal Specification TT–P–1952B – Paint, Traffic and Airfield Marking, Water Emulsion Base "Standard Color Chips for Highway Signs" (US Bureau of Public Roads, Washington D.C.)

2306.2 Summary

This section governs the furnishing of labor, equipment, and materials and for the performance of work necessary to furnish and install white and yellow permanent or temporary retro–reflectorized pavement marking materials.

2306.3 General

The permanent pavement markings shall be installed immediately after the roadway surface is complete unless prior approval is received by the Engineer. The installation of the yellow markings (as required) is the first priority. If the permanent markings cannot be installed and thus the roadway would be unmarked overnight, temporary removable

markings shall be installed and remain until the permanent markings can be installed. The contractor shall make every possible effort to remove the temporary pavement markings and install permanent pavement markings within 48 hours. Only under extreme circumstances and at the approval of the pavement marking inspector or the engineer, will the duration of the temporary pavement markings be extended. Under no circumstance should the temporary pavement markings be in place for more than 2 weeks. If permanent markings cannot be installed within the specified time then semi–permanent markings shall be installed following the guide lines as set forth in the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) Part VI, Sections F6 and G6. The temporary removable markings shall be removed prior to installation of the permanent markings. In situations where markings conflict with the traffic routing, such as a lane closure or a lane diversion, conflicting markings shall be removed prior to application of the next set of markings.

2306.4 Striping Applicability Chart

These charts provide guidance for the selection of striping materials.

Marking Material	Roadway Surface	Application	Durability
Thermoplastic	New asphalt	Permanent	High
Aggressive bond thermoplastic	Aged asphalt, concrete	Permanent	High
Performed thermoplastic	Asphalt, concrete	Permanent	High
Cold plastic	Asphalt, concrete	Permanent	Moderate
Paint	All surfaces	Permanent, temporary	Low
Epoxy	All surfaces	Permanent	High
Temporary Tape (Type 1)	All surfaces	Temporary	Low
Temporary Tape (Type 2)	All surfaces	Temporary	Low
Line masking tape	All surfaces	Temporary	Low

Roadway Surface	Permanent Marking	Temporary Marking
New asphalt	Thermoplastic	Temporary Tape (I or II)
Old Asphalt	Aggressive bond thermoplastic	Temporary Tape (I or II)
Slurry or mircrosurface	Thermoplastic	Temporary Tape (I or II)
Milled concrete or asphalt	Not applicable	Paint
Asphalt to be milled	Not applicable	Paint
Base asphalt	Not applicable	Paint Temporary Tape (Type II)
New or old concrete	Aggressive bond thermo, Epoxy	Paint
Concrete	Inlaid cold plastic	Paint

Diamond ground concrete	Epoxy	Paint

Note: Old asphalt is asphalt which is more than 6 months old, or which has been open to traffic.

2306.5 Symbol Applicability Charts
These charts provide guidance for the selection of text and non–text symbol materials.

Roadway Surface	**Non- Text Symbols**	**Temporary Non- Text Symbols**
New asphalt	Pre-formed thermoplastic, thermoplastic	Temporary Tape (I or II)
Old asphalt	Pre-formed thermoplastic, thermoplastic	Temporary Tape (I or II), paint
Slurry or Microsurface	Thermoplastic	Temporary Tape (I or II), paint
Milled concrete or asphalt	Not applicable	Paint
Asphalt to be milled	Not applicable	Paint
Base asphalt	Not applicable	Paint
New or old concrete	Aggressive bond thermo, inlaid	Temporary Tape (I or II), paint

	Cold plastic	
Concrete	Inlaid cold plastic	Temporary Tape (I or II), paint
Diamond ground concrete	Inlaid cold plastic	Temporary Tape (I or II), paint

Roadway Surface	**Non- Text Symbols**	**Temporary Non- Text Symbols**
New asphalt	Pre-formed thermoplastic, thermoplastic	Temporary Tape (I or II)
Old asphalt	Pre-formed thermoplastic, thermoplastic	Temporary Tape (I or II), paint

Slurry or Microsurface	Pre-formed thermoplastic, thermoplastic	Temporary Tape (I or II), paint
Milled concrete or asphalt	Not applicable	Paint
Asphalt to be milled	Not applicable	Paint
Base asphalt	Not applicable	Paint
New or old concrete	Inlaid cold plastic	Temporary Tape (I or II), paint
Concrete	Inlaid cold plastic	Temporary Tape (I or II), paint
Diamond ground concrete	Inlaid cold plastic	Temporary Tape (I or II), paint

2306.6 Prequalification:

A. Manufacturers interested in prequalifying material under this specification shall submit to the Engineer:

1. A sample of the material. Sample quantities are described in each section.
2. Certifications by qualified testing laboratories that the material meets all required tests.
3. A list of existing installations.

B. The Engineer may test submitted samples or materials as used for compliance with all requirements of this specification.

C. Products will remain on the prequalified list as long as the results of verification testing and field performance are satisfactory. Any changes in formulation should be reported to the Engineer for review and evaluation to determine if requalification is necessary

D. No material shall be used unless the material has been prequalified or approved by the Engineer.

E. A list of qualified materials by manufacturer may be maintained by the Owner.

2306.7 Materials

A. Pre–Mix Glass Spheres: Pre–mix glass spheres shall be uncoated and conform to AASHTO M247 Type 1. The glass spheres used in the formulation shall be lustrous, free from film, scratches, and pits. The glass spheres shall also meet the following requirements:

1. Roundness: The roundness of the spheres shall be a minimum of 70% when tested in accordance with ASTM D1155.
2. Gradation: The gradation when tested in accordance with the method provided in ASTM D1214 (by use of U.S. Standard Sieves) shall be:

Size of Sieve	**Mass % Passing**
No. 18 (1.00 mm)	80–100
No. 50 (300 μm)	20–50
No. 80 (180 μm)	0–10

3. Refractive Index: When tested by a liquid immersion method at 77 degrees F (25degrees C), the refractive index of the spheres shall be a minimum of 1.50.

B. Drop–On Glass Spheres: The spheres shall be manufactured from glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering. The particles shall be spherical in shape, containing not more than thirty percent (30%) of irregularly shaped particles. They shall be essentially free of sharp angular particles, and particles showing milkiness or surface scoring or scratching. They shall meet the requirements of AASHTO M247 Type 1.

1. Gradation: The gradation when tested in accordance with the method provided in ASTM D1214 (by use of U.S. Standard Sieves) shall be:

Size of Sieve	**% Passing (by weight)**
No. 20 (850 um)	100
No. 30 (600 um)	80-100
No. 50 (300 um)	18-35
No. 80 (180 um)	0-10
No.100 (150 um)	0-2

2. Refractive Index: When tested by a liquid immersion method at 77 degrees F (25 degrees C), the refractive index of the spheres shall be within the range of 1.50 to 1.60.
3. Moisture Proof Requirements: The spheres shall show no tendency to absorb moisture in storage and shall remain free of clusters and hard lumps. The spheres shall flow freely from dispensing equipment at any time when surface and atmospheric conditions are satisfactory for application
C. Thermoplastic Pavement Markings: This specification covers a white and yellow thermoplastic reflectorized pavement marking material of a type that is applied to asphalt road surfaces in a molten state by mechanical means to receive a surface application of glass spheres, and which upon cooling to normal pavement temperature, produces an adherent reflectorized stripe of specified thickness and width and is capable of resisting deformation.
1. Characteristics: The material shall not exude fumes that are toxic, obnoxious or injurious to person or property, when it is heated to the temperature range specified by the manufacturer for application. It shall remain stable when held for 4 hours at this temperature, or when subject to 3 reheatings after cooling to ambient temperature.
The temperature–viscosity characteristics of the plastic material shall remain constant throughout repeated reheatings, and shall show like characteristics from batch to batch. There shall be no obvious change in color of the material either as a result of repeated reheatings or from batch to batch.
The thermoplastic material shall easily extrude from the equipment to produce a cross–section of line 90 to 125 mil (1.5 mm to 4.8 mm) thick, which shall be continuous and uniform in shape, and have clear and sharp dimensions.
2. Serviceability: The compound shall resist deterioration by contact with sodium chloride, calcium chloride or other chemicals used to prevent roadway ice, or because of the oil content of pavement materials or from oil droppings or other effects of traffic. The markings shall remain intact under normal traffic conditions at temperatures below 140 degrees F (60 degrees C).
3. Specific Gravity: The material's specific gravity shall not be less than 1.8 nor exceed 2.3 referred to water at 77 degrees F (25 degrees C) when determined by a water displacement method at 77 degrees F (25 degrees C).

4. Set Time: When applied at the specified temperature and thickness, the material shall set to bear traffic in not more than 2 minutes when the air temperature is 50 degrees F (10 degrees C) and not more than 10 minutes when the air temperature is 90 degrees F (32 degrees C).
5. Composition: The thermoplastic pavement marking material shall be homogeneously composed of pigment,filler, resin binder and glass reflectorizing spheres. The solid resin shall be a "maleic–modified glycerol ester resin" (alkyd binder) comprising at least one–third of the binder compositions and be no less than eight (8) percent by weight of the entire material formulation. The alkyd binder shall consist of a mixture of synthetic
resins (at least one of which is solid at room temperature), and high boiling point plasticizers. The material shall not contain any petroleum derived ingredients. Yellow pigment shall be heat stabilized encapsulated lead chromate. The thermoplastic pavement marking material shall contain the following ingredients:

Ingredient (Percent by Weight)	**White**	**Yellow**
Binder(See note A below)	18.0 min	18.0 min
Titanium Dioxide	10.0 min	
Glass Spheres	20.0 – 50.0	20.0-50.0
Lead Chromate		2.0 – 4.5
Inert Fillers	42.0 max	50.0 max

The material shall be thoroughly mixed and furnished in a free flowing granular form. The material shall meet the requirements of this specification for a period of one year. The material shall readily melt in a uniform mixture.
The material shall be free from all skins, dirt, and foreign objects. It shall be of such composition that it will not bleed, stain or discolor when applied to bituminous pavement. The manufacturer shall replace material not meeting the above requirements.
6. Color: The color of the thermoplastic material after heating for 4 hours + 5 minutes at 425 + 3 degrees F (218 + 1.4 degrees C) shall conform to the following when tested by Federal Test Method Standard
141 Method 4252:

White:	Federal Color Chip No. 37875 (Fed. Std. No. 595)
Yellow:	Federal Color Chip No. 13538 (Fed. Std. No. 595)

7. Reflectance: The daylight luminous reflectance of the white material shall be not less than 75% when tested according to ASTM E1347. The yellow shall have a minimum brightness of 45% relative to magnesium oxide, and shall be within the green and red tolerance of the "Standard Color Chips for Highway Signs (January 1939)" obtainable from the United States Bureau of Public Roads, Washington, D.C. (TT–P–115a).
8. Softening Point: After heating the thermoplastic material for 4 hours + 5 minutes at 425 + 3 degrees C (218 + 1.4 degrees C) and testing in accordance with ASTM D36, the material shall have a softening point 215 + 15 degrees F (102 + 7.1 degrees C).
9. Flowability: After heating the thermoplastic material for 4 hours + 5 minutes at 425 + 3 degrees F (218 + 1.4 degrees C) and testing for flowability, the white thermoplastic shall have a maximum percent residue of 18 percent and the yellow thermoplastic shall have a maximum residue of 21 percent.
10. After heating the thermoplastic material for 8.5 hours + 5 minutes at 425 + 3 degrees F (218 + 1.4 degrees C) and testing for flowability, the thermoplastic shall have a maximum percent residue of 28 percent.

11. Indentation Resistance: Hardness shall be measured by a Shore Durometer, Type A2, as described in ASTM D2240, except that the Durometer and the panel shall be at 77 degrees F (25 degrees C), and a 4.4 lb (2 kg) load applied. After 15 seconds, the reading shall be not less than 55.
12. Abrasion Resistance: The material shall not show a maximum loss of 0.02 ounces (0.5 g) subjected to 200 revolutions on a Taber Abraser at 77 degrees F (25 degrees C), using H–22 calibrate wheels, weighted to 17.6 ounces (500 g). The wearing surface should be kept wet with distilled water throughout the test. The panel for this test shall be prepared by forming a representative lot of material at a thickness of 125 mil (3 mm) on a 4 inch
(100 mm) square panel (thickness 0.050 + 0.001 inch) [thickness 1.3 + 0.025 mm] on which a suitable primer has been previously applied.
13. Low Temperature Impact Resistance: The materials shall not fracture when subjected to an impact of 64 inch pounds at –4 degrees F (7.23 N–m at –20 degrees C) (), for at least 3 hours. The panel is then placed in an instrument also maintained at –4 degrees F (–20 degrees C), consisting of a 10.5 pound (4.7 kg) freely falling weight controlled to drop vertically for 6 inches (150 mm) onto the surface of the panel, which it strikes with a hemispherical indenter having a radius of .28 inches (7 mm).
14. Water Absorption: Materials shall have a maximum of 0.5 percent by weight of retained water when tested by ASTM D570, procedure (A).
15. Yellowness Index: The white thermoplastic material shall not exceed a yellowness index of 0.15.
16. Flash Point: The thermoplastic material shall have a flash point not less than 475 degrees F (246 degrees C) when tested in accordance with ASTM D92.
17. Cracking Resistance: After heating the thermoplastic material for 4 hours + 5 minutes at 425 + 3 degrees F (218 + 1.4 degrees C); applying to concrete blocks, and cooling 15 + 3 degrees F (7.1 + 1.4 degrees C), the material shall show no cracks. Properly applied, the material shall show less than six stress cracks per ten lineal feet (three lineal meters) of markings independent of pavement fracturing and faulting, for at least six months.
D. Aggressive Bond Thermoplastic Pavement Markings: This specification covers a white and yellow adhesive thermoplastic reflectorized pavement marking material that is applied to road surfaces, including Portland Cement Concrete (PCC) and aged asphalt without need of a primer/sealer. The material is applied to the road surface in a molten state by mechanical means with surface application of glass beads. Upon cooling to normal pavement temperature, it produces an adherent reflectorized stripe of specified thickness and width with limited thermal/seasonal deformation. In order to qualify as a non–sealer thermoplastic that can be applied to concrete surfaces without a sealer, the material must meet or exceed the requirements listed below.
1. Characteristics: The thermoplastic material shall be homogeneously composed of pigments, resins, polymers (adhesive constituent), glass reflectorizing spheres and other fillers
The thermoplastic material shall be available in a variety of surface delineation colors from the same manufacturer. The manufacturer shall have the option of formulating the material according to their own specifications. However, certain physical and chemical requirements specified must be satisfied in order to qualify as a non–primed striping application for PCC and aged asphalt surfaces. The material shall not exude fumes which are toxic, or injurious to persons or properties upon heating to application temperature.
2. Specific Gravity: The specific gravity of the white and yellow thermoplastic pavement marking material shall not exceed 2.15.
3. Composition: The pigment, intermix reflectorizing spheres, and fillers shall be uniformly dispersed in the resin and polymer upon heating to application temperature. The material shall be free of dirt and foreign matter and must meet or exceed the compositional requirements (percentage by weight) indicated below.
The total resin/binder content must be 22% min – 26% max (weight) of total product ingredients.

Test Component	**White**	**Yellow (lead Chromate)**	**Yellow (Heavy Metal Free)**
Glass Beads	30% min	30% min	30% min

Pigment- T-i02	10% min	NA	NA
Yellow (PbCr03)	NA	2% min	NA
Organic Yellow	NA	NA	Federal Color
Resin/Binder Content	22% min	22% min	22% min
Inert Fillers	42.0 max	50.0 max	At manufacturer's discretion

4. Color: The thermoplastic material after heating for four hours ± 5 min. at 425 ± 3 degrees F (218 ± 2 degrees C) and cooled to 77 ± 3 degrees F (25 ± 2 degrees C) shall meet the following:

White:	Daylight reflectance at 45 degrees – 0 degrees – 80% min.
Yellow:	Daylight reflectance at 45 degrees – 0 degrees – 45% min.

Yellow color shall match Federal Test Standard Number 5958 – Color 13538 and lie within the following ranges:

X	0.485 – 0.510
Y	0.445 – 0.470

The chromaticities and luminance factors of ordinary colors of retroreflecting material shall be determined under an angle of illumination of 45 degrees; direction of view perpendicular to surface; and illumination CIE standard illuminant D65.

5. Bond Strength: After heating the thermoplastic material for four hours ± 5 minutes at 425 ± 3 degrees F (218 ± 2 degrees C), the bond strength to Portland Cement Concrete (PCC) shall equal or exceed 275 psi (1.9 MPa) (ASTM Standard Test Method for Bond Strength of Thermoplastic Traffic Marking Materials – D4796 or ASTM C321). Failures of type described in Section 6.1 of ASTM D4796 bond test, must be repeated to obtain a quantifiable number. Failure of types 6.2, 6.3, and 6.4 of ASTM D4796 bond test, must exceed the specified thermoplastic – cement brick separation.

6. Low Temperatures Cracking (Stress) Resistance for Extended Period: The material shall be tested according to AASHTO T 250 Section 7 with Section 7.2.3. modified for an extended cold temperature of 15 ± 3 degrees F (–9.4 ± 2 degrees C) exposure period of 72 hours. Any cracking shall constitute failure of the material to qualify as a non–sealer aggressive bonding material for PCC road surfaces.

7. Impact Resistance (Gardner Falling Weight): The test specimens should be formed according to the following procedure:

Heat approximately 14.1 ounces (400 grams) of material in an open pint can for 4 hours at 425 ± 3 degrees F (218 ± 2 degrees C). Preheat specimen draw down blade, 2 inches x 4 inches (5 mm x 100 mm) with a 1/8 inch (3mm) die opening for approximately one hour at 425 ± 3 degrees F (218 ± 2 degrees C). The blade is usually placed in the oven containing the sample material during the last hour of sample heating.

After heating the sample for four hours, remove the sample and the draw down blade from the oven. Place the 125–mil blade onto a PCC block. Quickly pour the sample 425 ± 3 degrees F (218 ± 2 degrees C) into the opening of the draw down screed and draw down the sample for the entire length of the concrete block. Allow the drawn down test sample to condition in the open in the standard laboratory atmosphere, 73.4 ± 3 degrees F (23 ± 2 degrees C) and 50 ± 5% relative humidity. Perform the testing procedure according to ASTM D5420 Section 11. Record and report the type of failure as (a) crack or cracks on the surface, (b) cracks that penetrate the entire thickness, (c) brittle shatter (the test specimen in several pieces after impact), or (d) ductile failure (the

specimen is penetrated by a blunt tear). Both the yellow and white non–sealer materials shall have minimum impact resistance of 80 inch pounds (9.0 N–m) with no visible surface cracks.
8. Impact Resistance (Notched Izod): After heating the material for four hours ± 5 minutes at 425 ± 3 degrees F (218 ± 2 degrees C) and forming test specimens according to AASHTO T 250 Section 8, both the yellow and white samples shall be a minimum notched impact resistance of 11.0 ± 0.3 inch pounds (1.24 + 0.03 N–m). The specimens shall be tested both at room temperature 73.4 ± 3 degrees F (23 ± 2 degrees C) and low temperature of 15 ± 3 degrees F (9.4 ± 2 degrees C) in accordance with ASTM D256 test method A.
9. Oil and Grease Resistance: The thermoplastic material shall show no signs of deterioration or solubility after motor oil is rubbed vigorously into a sample for 2 minutes and allowed to penetrate for 5 minutes.
10. Set Time: When applied at a temperature range of 412.5 ± 12.5 degrees F (211 ± 7 degrees C) and thickness of 90 to 125 mil (2.3 mm to 3 mm) the material shall set to bear traffic in not more than 2 minutes when the air temperature is 50 ± 3 degrees F (10 ± 2 degrees C) and not more than ten minutes when the air temperature is 90 ± 3 degrees F (32 ± 2 degrees C).
11. Flash Point: The thermoplastic material shall have a flash point of not less than 500 degrees F (260 degrees C) when tested in accordance with ASTM D92.
12. Storage Life: The material shall maintain the requirements of this specification for a minimum period of one year. The thermoplastic material must melt uniformly with no evidence of skins or unmelted particles for this one year time period. Any material failing to do so shall be replaced by the manufacturer at their expense.
13. Packaging and Marking: The thermoplastic material shall be packaged in suitable containers to which it will not adhere during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. (23kg). Each container shall designate user information, manufacturer's name and address, batch number and date of manufacture. Each batch manufactured shall have its own separate number. The label shall carry appropriate user warnings and instructions.
14. NTPEP Test Program: The material must have been applied, without surface primer, on two NTPEP Decks (PCC) and evaluated for a period of at least one year. A minimum of 90% of the original pavement striping must be intact on the PCC decks after a one–year review period. The percent retention is calculated based on the measured test area square footage (square meter) (neglecting mil thickness wear down) minus the road surface areas that are exposed due to cracking and chipping away of thermoplastic from the concrete surface caused by product bond failure to the substrate.
E. Preformed Thermoplastic Pavement Markings: This specification is for the furnishing of retroreflective preformed thermoplastic pavement marking materials that can be adhered to asphalt, concrete and Portland cement concrete pavements by means of heat fusion. The applied markings shall be very durable, oil and grease impervious and provide immediate and continuing retroreflectivity.
1. Characteristics: The preformed marking material shall consist of a resilient white and yellow polymer thermoplastic with uniformly distributed glass beads throughout its entire cross section.
Preformed words and symbols shall conform to the applicable shapes and sizes as prescribed in the latest revision of the Manual on Uniform Traffic Control Devices.
The preformed markings shall be fusible to asphalt concrete and Portland cement concrete pavements by means of the normal heat of a propane type of torch. Adhesives, primers or sealers shall not be used prior to the preformed marking application on asphalt concrete and Portland cement concrete pavements. The preformed markings shall conform to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics and be capable of fusing to itself and previously applied worn hydrocarbon and/or alkyd thermoplastic pavement markings. The preformed markings shall be capable of application on new, dense and open graded asphalt concrete wearing courses during the paving operation in accordance with the manufacturer's instructions. After application, the markings shall be immediately ready for traffic. The preformed markings shall be suitable for use for one year after the date of receipt when stored in accordance with the manufacturer's recommendations.

The preformed thermoplastic markings shall not be brittle and must be sufficiently cohesive and flexible at temperatures exceeding 50 degrees F (10 degrees C) for one person to carry without the danger of fracturing the material prior to application.
2. Composition: The retroreflective pliant polymer thermoplastic pavement markings shall consist of a homogeneous mixture of high quality polymeric thermoplastic binders, pigments, fillers and glass beads. The thermoplastic material must conform to AASHTO designation M 249 with the exception of the relevant differences due to the material being supplied in a preformed state.
3. Glass Beads: The markings shall contain 30% glass spheres which shall conform to AASHTO M 247 Type 1, except that glass spheres shall have a minimum of 70% true spheres on each sieve and 80% true spheres overall. The glass beads must be homogeneously blended throughout the material with a securely bonded protruding exposed layer of beads that provide immediate and continuous retroreflectivity; no additional glass beads shall be dropped on the material during application. Curved arrows must be available without protruding glass beads if reversibility is needed.
4. Retroreflectivity: The preformed marking shall upon application exhibit uniform adequate nighttime retroreflectivity. At 86 degree 30 feet (9.1 m) incidence angle and 1 degree 30 feet (9.1 m) divergence angle, the markings shall have average minimum intensities of 350 millicandelas for white and 175 millicandelas for yellow as measured with a Mirolux retroreflectometer.
Using a Taber Abraser with an H–18 wheel and a 4.4 ounce (125 g) load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure. No more that 15% of the beads shall be lost due to pop-out and the predominant mode of failure shall be “wear down” of the beads.
5. Color Characteristics: The thermoplastic material without glass beads shall meet the following:

White:	Daylight reflectance at 45–degree/ 0 degree of 80% minimum
Yellow:	Daylight reflectance at 45–degree/ 0 degree of 45% minimum.

Yellow: Daylight reflectance at 45–degree/ 0 degree of 45% minimum.
The daylight reflectance shall not change significantly when the preformed thermoplastic is properly applied to the roadway surface For highway use, the white markings shall contain a minimum of 8% by weight of Titanium Dioxide pigment to ensure
a color similar to Federal Highway White, Color No. 17886 Standard 595. Yellow color shall reasonably match color chip Number 13538 of Federal Standard number 595 and be lead free.
6. Skid Resistance: The surface of the preformed thermoplastic markings shall provide a minimum skid resistance value of 45 BPN when tested according to ASTM E303.
7. Thickness: The width of the supplied material shall have a minimum average thickness of 90 mils (2.3mm) .
8. Flexibility: The preformed thermoplastic marking material shall have flexibility at 50 degrees F (10 degrees C) such that no cracking occurs in the test sample when a 1 inch by 6 inches (25 mm by 150 mm) sample is bent through an arc of 90 degrees at a uniform rate in 10 seconds (9 seconds per degree) over a one inch (25 mm) mandrel. The sample must be conditioned prior to testing at 50 + 2 degrees F (10 + 0.9 degrees C) for a minimum of four hours. At least two specimens tested must meet the flexibility requirements at 50 degrees F (10 degrees C) for a passing result.

9. Environmental Resistance: The applied markings shall be resistant to deterioration due to exposure to sunlight, water, oil, diesel fuels, gasoline, pavement oil content, salt and adverse weather conditions.
10. Effective Performance Life: When properly applied, in accordance with the manufacturer's instructions, the pavement markings shall be neat and durable. The markings shall remain retroreflective and show no fading, lifting, shrinkage, tearing, roll back or other signs of poor adhesion.
F. Cold Plastic Pavement Markings: This specification covers a white and yellow pre–formed cold plastic reflectorized pavement marking material of a type that is applied to a road surface by an inlaid, pre–coated pressure sensitive adhesive that produces an adherent reflectorized stripe of specified thickness and width and is capable of resisting deformation.
1. Characteristics: The material shall be manufactured without the use of lead–chromate pigments or other, similar, lead–containing chemicals.
Glass beads shall be incorporated to provide immediate and continuing retroreflection. Ceramic skid particles shall be bonded to the top layer to provide a skid–resistant surface.
Preformed word and symbol markings shall conform to the applicable shapes and sizes as outlined in the Manual on Uniform Traffic Control Devices.
The preformed markings shall be capable of being adhered to pavements by an inlaid, pre–coated pressure sensitive adhesive. A surface preparation adhesive may be used to precondition the inlay pavement surface.
The preformed marking film shall mold itself to pavement contours by the action of traffic. Following proper inlay application and tamping, the markings shall be immediately ready for traffic.
2. Composition: The retroreflective pavement marking film shall consist of a mixture of high–quality polymeric materials, pigments and glass beads distributed throughout its base cross–sectional area. A reflective layer of glass beads and a layer of skid–resistant ceramic particles shall be bonded to the top urethane wearing surface. The urethane wear surface shall have a nominal thickness of 0.005 inches
(13 mm). The film shall have a pre–coated, shear–resistant, pressure sensitive adhesive.
3. Color: The daytime color of the white film shall provide a minimum initial luminance factor, Y, of 80 and shall conform to the following chromaticity requirements:

White		Yellow	
X Values	Y Values	X Values	Y Values
0.290	0.315	0.474	0.455
.0310	0.295	0.491	0.435

White		Yellow	
0.330	0.360	0.512	0.486
0.350	0.340	0.536	0.463

The daytime color of the yellow film shall provide an initial luminance factor, Y, in a range of 36 to 59 and shall conform to the above chromaticity requirements:
Measurements shall be made in accordance with ASTM E1349, using illuminant "C" and 0/45 (45/0) geometry. Calculations shall be in accordance with ASTM E308 for the 2–degree observer.
4. Reflectance: The white and yellow films shall have the following initial minimum reflectance values as measured in accordance with the testing procedures of ASTM D4061. The photometric quantity to be measured shall be coefficient of retroreflected luminance (R_L) and shall be expressed as millicandelas per square foot per foot–candle (mcd–ft^{-2}–fc^{-1}) (millicandelas per square meter per lux (mcd–m^{-2}–lux^{-1})).

	White			Yellow		
Entrance Angle	86.0º	86.0º	86.5º	86.0º	86.0º	86.5º

Observation Angle	0.2º	0.5º	1.0º	0.2º	0.5º	1.0º
Retroreflected Luminance R_L (mcd–ft–2–fc–1)	700	500	400	410	250	175

5. Skid Resistance: The surface of the retroreflective films shall provide an initial minimum skid resistance value of 55 BPN as measured by the British Portable Skid Tester in accordance with ASTM E303.
The surface of the retroreflective film shall retain an average skid resistance value of 45 BPN, when tested in accordance with ASTM E303, for a period of one year when installed in non–snow removal areas. The 45 BPN minimum value shall be an average of several readings taken in both the wheel track and non–wheel track areas.
6. Tensile Strength and Elongation: The film shall have a minimum tensile strength of 150 lbs. per square inch (7.18 kilopascals) of cross–section when measured in the direction of the length of the roll and tested in accordance to ASTM D638, except that a sample 6 inch x 1 inch (150 mm x 25 mm) shall be tested at a temperature between 70 degrees F and 80 degrees F (21.1 degrees and 26.7 degrees C) using a jaw speed of 10 to 12 inches per minute. The sample shall have a maximum elongation of 50% at break when tested by this method.
7. Reflectivity Retention: The glass beads must be strongly bonded and not be easily removed by traffic wear. Using a Taber Abraser with an H–18 wheel and a 4.4 ounce (125 g) load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure. No more that 15% of the beads shall be lost due to pop-out and the predominant mode of failure shall be "wear down" of the beads.
8. Glass Beads: The size, quality and refractive index of the glass beads shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched.
The film shall have glass bead retention qualities such that when a 2 inches by 6 inches (50 mm by 150 mm) sample is bent over a 1/2 inch (12.7 mm) diameter mandrel, with the 2 inch (50 mm) dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.
9. Thickness: The film, without adhesive, shall have a minimum thickness of 60 mil (1.55 mm).
G. Lead–Free, Water–Borne Emulsion Based White and Yellow Traffic Paint: The pavement marking paint shall be a rapid dry. The traffic paint shall provide optimum adhesion for glass spheres when both binder and glass spheres are applied in the recommended quantities.
1. Drying Time: When applied at a wet film thickness of 15 mils (38mm) with a top dressing of 6–10 pounds (0.70 – 1.20 kg) of glass spheres per gallon (per liter) of paint and when the pavement temperature is between 50 degrees F and 120 degrees F (4.4 degrees C and 48.9 degrees C) and the relative humidity doesn't exceed 80%, the binder shall dry to a no–tracking condition in a minimum of 20 seconds and a maximum of 60 seconds.
These dry times shall not be exceeded when the paint is applied with specialized equipment so as to have the pigmented binder at a temperature of 150 degrees F to 170 degrees F (65.5 degrees C to 76.7 degrees C) at the spray gun.
The no–tracking condition shall be determined by passing over the applied line in a simulated passing maneuver with a passenger car traveling 35 MPH (56 KPH). There shall be no visual deposition of the paint to the pavement surface when viewed from a distance of 50 feet (15.2 meters). Furthermore, the pigmented binder, without glass spheres, shall dry to no–tracking condition in 180 seconds or less when tested in accordance with ASTM D711.
2. Directional Reflectance: The daylight directional reflectance of white pigmented binder (without glass spheres) shall be not less than 85% relative to magnesium oxide when tested in accordance with Federal Test Method Standard No. 141a, Method 6121. If yellow, after drying shall suitably match color 33538 of Federal Standard 595.

The paint for the pavement markings shall contain no lead and/or chromium and shall have volatile organic content conforming to the latest Environmental Protection Agency regulations.
In addition, the paint and/or components shall conform to the American Society for Testing Materials(ASTM) as follows:
D93 – Standard Test Methods for Flash Point by Pensky Martens Closed Tester
D476– Standard Specification for Titanium Dioxide Pigments, Type II Rutile
D562 – Standard Test Method for Consistency of Paints Using Stormer Viscosimeter
D711– Standard Test Method for No–Pick–Up Time of Traffic Paint
D768 – Standard Specification for Yellow Iron Oxide
D868 – Standard Test Method for Evaluating Degree of Bleeding of Traffic Paint
D969 – Standard Test Method for Laboratory Test for Degree of Bleeding of Traffic Paint D1152 – Standard Specification for Methanol (Methyl Alcohol)
D1199 – Standard Specification for Calcium Carbonate Pigments
D1210 – Standard Test Method for Fineness of Dispersion of Pigment–Vehicle Systems by Hegman–Type Gage
D1475 – Standard test Method for Density of Paint, Varnish, Lacquer, and Related Products
D2243 – Standard Test Method for Freeze–Thaw Resistance of Waterborne Coatings
D2369 –Standard Test Method for Volatile Content of Coatings
D2805 – Standard Test Method for Hiding Power of Paints by Reflectometry
D3723 – Standard Test Method for Pigment Content of Water Emulsion by Low Temperature Ashing
D3960 – Standard Practice for Determining Volatile Organic Content (VOC) of Paints and Related Coatings
D4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by Taber Abraser D4366– Standard Test Methods for Hardness of Organic Coatings by Pendulum Damping Tests E70 –Standard Test Method for pH of Aqueous Solutions with the Glass Electrode
E1347 – Standard Test Method for Color and Color–Difference Measurement by Tristimulus (Filter) Colorimetry The paint shall show no cracking, flaking, blistering, appreciable loss of adhesion, softening, coagulation, discoloration, and have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT–P–1952B.
The paint shall be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.
The minimum contrast ratio shall be 0.96 when drawing down with a 0.005 bird film applicator on a 2A Leneta Chart or equal and ai r–dried for 24 hours. Contrast Ratio = Black/White.
H. Temporary Tape: This specification covers pavement marking tape of two colors, white and yellow, and of two types, Type I and Type II.
Type I–Regular (This type is not required to be easily removable intact.)
Type II–Removable (This type is to be readily removable intact, either manually or with a roll–up device after having been in place through the construction season.)
1. General: This material shall be a pavement striping tape designed to provide reflective delineation under both dry and moderate rainfall conditions. The tape shall consist of glass spheres tightly embedded to a binder; on a conformable backing precoated with a pressure sensitive adhesive. The striping material shall be thin, flexible, formable and following application shall remain conformed to the texture of the pavement surface. The tape shall be furnished in the color and type designated on the Plans or in the contract. The markings shall be precoated with a pressure sensitive adhesive and shall be capable of being adhered to asphalt concrete or Portland cement concrete in accordance with manufacturer's instructions without the use of heat, solvents or other additional adhesive means, and shall be immediately ready for traffic after application. The adhesive shall not require a liner or release paper. The striping material shall have a uniform appearance, free from cracks and the edges shall be true, straight and unbroken. The material shall be weather

resistant and show no appreciable fading, lifting or shrinkage when applied in accordance with the manufacturer's recommendations.
2. Color and Daylight Reflectance: The daylight reflectance (ASTM E1347) of white shall be not less than 70%. The color of yellow shall be within the red and green tolerance limits of the Highway Yellow Color Tolerance Chart issued by the U.S. Department of Transportation.
3. Dimensions: The width and length shall be as shown on the Plans or in the contract. The material shall be available in rolls and there shall be no more than three splices per 50 yards (45.7 m) of length.
4. Packaging: The material shall be packaged in accordance with accepted commercial standards and when stored under normal conditions, shall be suitable for use for a period of at least one year after purchase.
5. Adhesion: The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperatures above 50 degrees F (10 degrees C) and shall be immediately ready for traffic following application.
6. Removability: Type II tape shall be removable from asphalt and Portland cement concrete intact or in large pieces, either manually or with a roll–up device, at temperatures above 40 degrees F (4.5 degrees C) without use of heat, solvents, grinding or blasting.
7. Reflection: The white and yellow material shall be retroreflective, reflecting white or yellow respectively and shall be readily visible at night when viewed with automobile headlamps using high beams from a distance of at least 300 feet (91.4 m).
8. Durability: Type Il material shall maintain adhesion, show no alligatoring, show no signs of pulling apart, and shall suffer no more than a 25% loss of beads, sand and grit when subjected to 30, 000 revolutions on a small–wheel circular track as described in ASTM E660, with the following variations or exceptions:
a. Two opposite wheels mounted with Goodyear 3.40–5 NHS Industrial Rib tires shall be used with a total load of 51.5 pounds (23.4 kg) on each tire. Tire air pressure shall be maintained at 25 pounds (11.3 kg). The wheels shall be mounted perpendicular to the specimens and toed out 2° to produce a slight abrading action.
b. Specimens shall be applied to 6 inch (150 mm) diameter dense graded bituminous concrete surface which has been compacted at 3000 psi (20.7 MPa) for two minutes. After application, the specimens shall be allowed to cure at least 16 hours before beginning the test.
9. Prequalification: Manufacturers interested in prequalifying material under this specification shall submit 20 linear feet (6 linear meters) of each color to the Engineer, and shall comply with the provisions of Paragraph 2307.4.
I. Epoxy: This specification is for the application of epoxy resin and glass beads as reflective pavement markings on Portland cement concrete or bituminous pavements. The epoxy resin material shall be toxic heavy metal free, two–component, 100% solids, and shall be formulated and tested to perform as a pavement marking material with glass spheres applied to the surface. The two components are an epoxy resin and an amine curing agent. The contractor shall provide complete manufacturer’s specifications and material safety data sheets to the Engineer for all material furnished.
1. Characteristics: The material shall not exude toxic fumes when heated to application temperature. The material which, when mixed in the proper ratio and applied at 0.14 mil (500 μm) wet film thickness at 74.8 degrees F (23.8 degrees C) with the proper saturation of glass beads, has a no–tracking time of less than 40 minutes for slow curing material and less than 10 minutes for rapid curing material. The material shall be capable of fully curing under a constant surface temperature of 32 degrees F (0 degrees C) or above.
2. Properties of Cured Material
a. Color: Provide white which complies with Federal Standard 595 17875. Provide yellow which matches the standard shade within the red and green tolerance limits when compared with the Highway Yellow Color Tolerance chart available from the U.S. Department of Transportation, Washington, D.C. (Federal Standard 595 13538).
b. Abrasion Resistance: 0.0028 ounces (80 mg) maximum loss when tested at 30 + 1.5 mils (750 + 38 μm) and a 72 hour cure and with a CS–17 wheel under a load of 2.2 lbs. (1000 grams) for 1000 cycles
c. Hardness: Shore D hardness of 75 minimum.

d. Adhesion to Concrete: When catalyzed, has such a high degree of adhesion to the specified concrete surface that there is a 100% concrete failure. Apply the material at a film thickness of 15 + 1.5 mils (375µm + 38µm) to concrete with a minimum compressive strength of 4061 psi (28 MPa). Allow the material to cure for 72 hours at 77 degrees F (25 degrees C) before the test is performed.
e. Yellowness Index: White only. Value after 72 hours in QUV – 30 maximum when tested at 15 ± 1.0 mils (375µm + 25µm) and a 72 hour cure.
f. Field Evaluation: Field test materials at AASHTO NTPEP regional test facilities, which include both hot and cold weather conditions and are a minimum of six months in duration.
3. Glass Beads for Drop–On Application (double drop system)
a. For the first drop, furnish large beads, which are compatible with the epoxy system, and comply with AASHTO M 247 except with the following gradation (FP–96, Type 4):

Sieve Size	**Percent Passing**
No. 10 (2.00 mm)	100
No. 12 (1.70 mm)	95 – 100
No. 14 (1.40 mm)	80 – 95
No. 16 (1.18 mm)	10 – 40
No. 18 (1.00 mm)	0 – 5
No. 20 (850 µm)	0 – 2

b. For the second drop, furnish regular beads which are specifically manufactured to be compatible with the epoxy system, and which comply with the requirements of AASHTO M247, Type 1.
c. Both types of beads are to be coated with a moisture resistant coating and an adhesion promoting coating which is compatible with the epoxy system.
4. Test Methods
a. Adhesion to Concrete ACI 503, Appendix A.1
b. Hardness ASTM D2240
c. Abrasion Resistance ASTM C501
5. Prequalification
a. Manufacturers interested in prequalifying material under this specification must comply with the provisions of Paragraph 2307.4 and shall provide a one liter sample of each color plus one liter of hardener to the Engineer for laboratory testing. Also include a copy of the quality control test report for each lot of material, an infrared spectroscopy analysis for each component if available, material safety data sheets and a complete set of installation recommendations and instructions. Forward an official copy of the AASHTO NTPEP test report along with evidence that the product in reference is identical to that submitted for prequalification.
b. The material will be evaluated for compliance with all requirements of this specification, and the manufacturer will be notified of the results. Both component A and component B will be analyzed and "fingerprinted" using infrared spectroscopy for use in screening future verification samples to ensure that materials submitted for use are of an identical formulation as originally approved.
c. Verification testing: The Engineer will take a one liter verification sample of Part A and Part B of the epoxy from one lot of each color per project. Send the samples to the engineer for testing and evaluation. Lots previously tested will be exempted from testing and may be exempted from sampling if coordinated with the engineer. Samples may be tested using infrared spectroscopy and testing as necessary. Deviations as determined by comparison with the prequalification sample will be cause for removal from the prequalified list. The

Engineer may also take a 0.5 gallon (2 liter) sample of each type of glass bead used on the project. Forward all samples to the engineer for verification testing.

2306.8 Method of Installation

The proposed permanent markings shall be laid out by the contractor in advance of the marking installation. Markings shall not be applied until the layout and conditions of the surface have been approved by the Engineer. If a paint line is used for layout purposes (in lieu of a chalk line or string line) the paint line shall not be wider than 1/2 inch (16.5 mm) in width. If wider, the paint shall be removed following the application of the final permanent marking. New
markings shall match existing markings as applicable in areas abutting existing road surfaces. The surface shall be dry and all dust, debris, oil, grease, dirt, temporary markings and other foreign matter shall be removed from the road surface prior to the application of the permanent marking material.

The Contractor shall be responsible for keeping traffic off freshly applied markings until they have set sufficiently to bear traffic. Traffic control is the responsibility of the Contractor and shall conform to the MUTCD. Failure to comply with traffic control guidelines will result in the Pavement Marking Contractor being directed to stop operations and l eave the site until proper and approved traffic control has arrived and put in place on site.

Temporary pavement markings shall be installed the same day that the existing pavement markings are damaged, removed or covered up prior to lane opening.

Temporary pavement markings shall be installed using the same cycle length as the permanent markings and be at least 2 feet (600 mm) long. Double yellow markings shall be used for temporary centerline and single white markings shall be used for temporary lane lines on four lane roadways. Single yellow markings shall be used for temporary centerline on two lane roadways as directed by the engineer.

Half–cycle lengths with a minimum of 2 foot (600 mm) stripe and 10 foot (3.05 m) gap should be used on roadways with severe curvature.

A. Glass Spheres: The drop on glass beads shall be applied at a rate of eight to ten pounds per 100 square feet (3.6 to 4.5 kg per 9.3 square meters).

B. Thermoplastic Pavement Markings: Thermoplastic material shall readily apply to the pavement at temperatures of 400 – 425 degrees F (204 – 218 degrees C) from approved equipment to produce an extruded line that shall be continuous and uniform in shape having clear and sharp dimensions. Application temperatures shall not exceed 450 degrees F (232 degrees C).

Thermoplastic may be used for cross walks and stop bars as specified under the conditions described herein. The thermoplastic markings shall be applied to the pavement surface in a molten state by mechanical means with surface application of glass spheres, and upon cooling to normal pavement temperature, produce an adherent retro–reflectorized stripe of specified thickness and width and capable of resisting deformation.

1. Equipment: The equipment used to install the thermoplastic shall be as follows:

a. A self–propelled machine is required in order to fulfill the timing needs of the marking installation for longitudinal lines.

b. If thermoplastic is used for transverse lines, i.e., crosswalks and stop lines, a push cart shall be used according to the following requirements: Only one pass with the thermoplastic pavement marking equipment shall be allowed in order to provide the required line width according to the plans. Multiple passes of narrower lines with overlaps to provide the required width shall not be allowed unless otherwise approved by the inspector after review of a test strip installation. If approved, the contractor shall be required to heat the seam with a torch and feather the overlapped material with a putty knife. Liquid thermoplastic shall not be used for word or symbol markings.

c. Constructed to provide mixing and agitation of the materials. Conveying parts between the main material reservoir and the shaping die shall be constructed as to prevent accumulation and clogging.

d. Constructed so that mixing and conveying parts up to and including the shaping die will maintain the materials at a temperature not less than 400 – 450 degrees F (204 – 232 degrees C). To assure that the material does not fall below the minimum temperature, the shaping die shall be heated by means of a gas–fired infrared heater or a heated, oil–jacketed system.
e. Constructed as to insure 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 to be able to provide for varying die widths and to produce varying widths of traffic markings. The use of pans, aprons, or similar appliances with die overruns will not be permitted.
f. All conditions apply as stated above for material temperatures, line definition and workmanship when a hand pushcart is used for cross walks. The Inspector will verify measurement.
g. Equipped with a special kettle for melting and heating the material shall be provided. The kettle shall be equipped with a thermostat so that heating can be done by controlled heat transfer liquid rather than by direct flame so as to provide positive temperature control and prevent overheating of the material.
h. Constructed for a nominal application of 90 – 125 mil (2.3 – 3.2 mm) thickness.
i. The heater and applicator shall be so equipped and arranged as to meet the requirements of the National Board of Fire Underwriters of the National Fire Protection Association, of the state, and of the local authorities.
j. Equipped with an automatic glass bead dispenser attached to the striping machine in such a manner that the beads are dispensed almost instantaneously upon the installed line. The glass bead dispenser shall be equipped with an automatic cut–off control synchronized with the cut–off of the thermoplastic material.
k. The equipment shall be arranged as to permit preheating of the pavement immediately prior to application of the thermoplastic material, if preheating is recommended by the thermoplastic manufacturer.
l. The applicator shall be capable of containing a minimum of 1000 pounds (453.6 kg) of molten material (not applicable for hand–liner use).
m. The applicator shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.
n. The Contractor's striper shall be equipped with electrical foot (meter) counters. The counters shall individually tabulate the length of line applied by each gun whether solid or dashed. The Contractor shall determine the accuracy of the foot (meter) counters and establish an adjustment factor as required to determine the pay item quantities. The foot (meter) counters shall be periodically checked to assure accurate measurements. No thermoplastic shall be applied without the accurate operation of the foot (meter) counters. The Contractor shall provide the Engineer with a certified document on these calibrations.
2. Application over Existing Markings
a. Existing thermoplastic markings on asphalt road surfaces may be over laid with thermoplastic material providing that the existing markings (thermoplastic) are less than 30 mils (760 μm) thick, and are securely bonded to the substrate. If the thermoplastic is greater than 30 mils (760 μm), or not securely bonded to the substrate, then it shall be ground to 30 mils (760 μm), or removed completely if not securely bonded to the road.
b. Existing solvent based paint on asphalt road surfaces may be over laid with thermoplastic provided that more than 75% of the road surface is exposed, and there is no more than a single coat of paint on the remaining unexposed area. If more than one layer of paint exists, the paint is not securely anchored to the substrate, or there is less than 75% of the road surface exposed, then the paint must be thoroughly removed.
c. All existing polyester, epoxy, or other type pavement marking paints on asphalt or concrete road surfaces must be completely removed from all road surfaces prior to the installation of thermoplastic material.
3. Application Temperatures: To insure optimum adhesion, the pavement and ambient air temperature shall be 50 degrees F (10 degrees C) and rising. The thermoplastic material shall be applied in a melted state at a temperature of 400 – 425 degrees F (204 – 218 degrees C). The temperature of the material within the shaping dies shall be maintained at the manufacturer's recommendations for application temperatures, but in no case shall the temperature fall below 400 degrees F (204 degrees C) or exceed 450 degrees F (232 degrees C). Where manufacturer's application temperatures differ from those as specified, the manufacturer's temperatures shall apply upon approval of the Engineer.

4. Line Quality: The finished lines shall have well defined edges and be free of waviness. Pavement marking lines shall be straight or of uniform curvature and shall conform with the tangents, curves, and transitions as specified in the pavement marking standards and/or as directed by the Inspector.
5. Line Thickness: The minimum thickness of the lines as viewed from a lateral cross section shall be not less than 90 mil (2.4 mm) near the edges, or less than 125 mil (3.2 mm) at the center. Drop–on glass beads shall not be included in the measurement, or if so, then appropriate allowances shall be made for the added mil thickness. A device for gauging the installed material thickness shall be furnished to the City Inspector as requested for use on the project. The gauge shall be easy to read and shall readily indicate excessive variations.
6. Clean Up: The Contractor shall be responsible for removing all pavement markings material spilled upon the roadway surface or adjoining area. The Contractor shall use methods acceptable to the Engineer/Inspector for removing the spilled material.
7. Line Repair: Any pavement marking which is crossed by a vehicle and tracked shall be replaced and any subsequent marking made by the vehicle shall be removed by methods acceptable to the Inspector at NO additional cost to the City.
C. Preformed Thermoplastic Pavement Markings: The markings shall be applied in accordance with the manufacturer's recommendations on clean and dry surfaces.
1. Asphalt: The materials shall be applied using the propane torch method recommended by the manufacturer. The material must be able to be applied at ambient and road temperatures down to 32 degrees F (0 degrees C) without any preheating of the pavement to a specific temperature. The pavement shall be clean, dry and free of debris and oil or grease residue.
a. At temperatures below 50 degrees F (10 degrees C), the preformed thermoplastic pavement markings shall be kept as warm as possible to maintain flexibility.
b. Remove pavement surface moisture by holding a propane torch approximately 6 inches (150 mm) above the section of asphalt using a continuous circular motion.
c. Heat the pavement with the torch upon placing the material to a temperature of 200 degrees F (93 degrees C) for 90 mil (2.3 mm), and up to 300 degrees F (149 degrees C) for 125 mil (3.2 mm) materials.
d. Immediately after the road surface has been properly preheated, position the material with exposed bead side up and heat.
e. Position the torch approximately 12 inches (305 mm) over the marking so the flame is extended and heat is evenly applied moving the torch in a circular motion across the marking. When the correct temperature of the marking has been reached, it will turn slightly darker or pale yellow if the material is white. Over heated or burned material shall be removed.
f. After the entire material section has been heated and bonded to the pavement, re–heat the perimeter of the marking and the road surface to bond the edges.
g. If installing reversible arrows, which do not contain a top coating of glass beads, the glass spheres shall be hand applied on the molten material.
h. Feather the leading edge of the pavement marking with a putty knife or bevel with the torch. Leading edges are any edge that would be susceptible to snow plow blades approaching from the direction of normal travel.
i. After cooling, use a putty knife to attempt to remove a portion of the material. The material shall not pry off without asphalt embedded to the underside.
2. Concrete: New concrete surfaces must be sandblasted to entirely remove curing compound. The same application procedure shall be used as described for asphalt pavements. However, a compatible primer sealer may be applied before application to assure proper adhesion.
3. Chip Seal Surfaces: The same application procedure shall be used as described for asphalt pavements. However, exposed aggregate should be removed where the preformed thermoplastic pavement marking is to be applied.
D. Cold Plastic Pavement Markings: The Contractor shall furnish and install white and yellow permanent retro–reflectorized cold preformed plastic pavement marking material at the location shown on the plans, in conformance with the details and material specifications included herein.

The cold plastic markings shall consist of a homogeneous, extruded, prefabricated material of specified thickness and width which shall contain reflective glass spheres uniformly distributed through–out the cross–section, and shall be applied only to concrete pavement surfaces by means of an approved inlaid grinding process with pre–coated adhesive and pressure.

1. Contractor's personnel: It is important that the contractor's personnel be completely knowledgeable of all application requirements and procedures prior to product application. It is the responsibility of the contractor to contact the supplier of the cold plastic material if questions regarding application procedures or conditions arise.
2. Prequalification: Manufacturers may be required to supply a 3 sq. ft. (0.28 sq. m.) sample of each color for laboratory testing and must comply with Paragraph 2307.4.
3. Procedure: This procedure explains how to apply tape to concrete surfaces only. Apply the tape according to manufacturer's instruction in conjunction with an approved inlaid grinding method.
4. Road conditions: It is recommended that the tape be installed as soon as practical following tape manufacturer instructions.

a. Cold plastic pavement markings shall be inlaid by an approved grooving process into concrete pavement surfaces. Cold plastic will not be allowed on asphalt pavement surfaces whether inlaid into hot asphalt or existing asphalt surfaces. Grooving the pavement surface allows preformed pavement marking tape to better adhere by creating a fresh surface. Grooving also produces a lower profile marking by embedding the tape into the pavement surface, which helps protect the tape from snowplow damage.

b. The cutting head shall consist of diamond tipped cutting blades "gang stacked" 0.25 inches to 0.50 inches (6 mm to 13 mm) wide. The spacers between each blade must be such that there is less than a 10 mil (.254mm) raise in the finished groove between the blades. Water–cooling the blades may be necessary for long line grooving.

c. The groove width shall be equal to the tape width plus 1 inch + 1/8 inch (25 mm + 3.2 mm). The depth of the groove shall be 75% of the tape thickness + 15%. For series 420, 60 mil (1.5 mm) tapes, the groove shall be 45 mils + 10 mils or 0.05 inch + 0.01 inch (1.25 mm + 0.25 mm). The bottom of the groove should have a smooth, flat surface. If a coarse tooth pattern is present, increase the number of blades and decrease the thickness of the spacers between the blades on the cutting head. If water–cooling is used, flush the groove immediately after grooving to clean the surface.

d. Clean the surface of the road and the groove using a broom and/or high–pressure air blower. If either of these methods fails to clean the road surface, then high–pressure water wash shall be used. Road surface, including the surface of the groove must be dry and all dust, dirt, debris, oil, grease and foreign material removed before applying tape. If using water–cooling to groove, the groove must be completely dry prior to tape application.

5. Tape Application: If there is a crack in the pavement, or if the tape is to be applied over a bridge expansion joint, manhole or utility box, lay the tape over the crack joint or fitting, then cut the tape 1 inch (2.54 cm) away from the crack or joint on each side. Apply the required surface preparation adhesive and allow to dry completely (5–10 minutes at 70 degrees F (21 degrees C), but not over 30 minutes.
6. Tamping: Tamp the tape thoroughly with a tamping cart with a minimum 200 pound (90 kg) load, three times back and forth (six passes) over each part of the tape. Start in the center of the marking and work out to the edges removing any trapped air.
7. Do not twist or turn the tamper cart on the tape
8. Make six passes (three passes back and forth) over each part of the tape (tamping is very important)
9. Make sure all edges are firmly adhered
10. Application Conditions

a. Air temperature 60 degrees F (15.5 degrees C) and rising
b. Surface temperature 70 degrees F (21.1 degrees C) and rising
c. Overnight air temperature 40 degrees F (4.4 degrees C) the night before tape application
d. Pavement surface must be clean and dry. No rainfall should occur within 24 hours prior to application

e. Butt splices must be used; do not overlap tape ends
f. Traffic must be kept off of pavement surfaces coated with a surface preparation adhesive prior to tape application (follow manufacturer's instruction regarding the use of surface preparation adhesive)
11. Surface moisture: Cold preformed plastic tapes will not adhere if moisture is present. Therefore, road surfaces must be dry and above the minimum required temperature for application of all tapes. If rainfall occurs within 24 hours prior to application, a surface moisture test (plastic wrap or roofing paper method as approved by the inspector) must be performed and approval obtained from the inspector. The groove must be visibly dry for a minimum of two hours prior to application. A moisture test shall be completed after the two–hour drying time to ensure no presence of moisture.
E. Pavement Marking Paint: The Contractor shall furnish and install white and yellow retro–reflectorized pavement marking paint material at the location shown on the plans, in conformance with the details and material specifications included herein.
1. The wet thickness and dry thickness of the pavement marking paint shall not be less than 15 mils (0.4 mm) and 12 mils (0.3 mm), respectively without glass beads.
2. Glass beads shall be applied uniformly over the entire length of line at the rate of 6 to 10 lbs. per gallon (0.70 – 1.20 kg per liter) of paint.
3. The gun tip shall be oriented perpendicular to the centerline to ensure that the beginning and ends of all lines are perpendicular to the centerline and not skewed.
4. The equipment shall be maintained such that the needle can be fully closed when shut as to ensure square cut lines at the beginning and ends.
F. Epoxy Pavement Marking: The Contractor shall furnish and install white and yellow epoxy markings at the location shown on the plans, in conformance with the details and material specifications included herein.
1. Equipment
a. Use equipment that is capable of spraying both yellow and white epoxy in the manufacturer's recommended proportions. Provide equipment that call place stripes on the left and right sides, and place two lines simultaneously with either line in a solid or intermittent pattern in yellow or white. All guns must be in full view of operators at all times. If words, symbols, crosswalks, cross–hatching and stop bars are to be of epoxy resin material, equip the truck with a hand spray wand for such application. Mount the equipment on a truck of sufficient size and stability, and with an adequate power source, to produce lines of uniform dimension and prevent application failure. Provide equipment with metering devices to register the accumulated volume dispensed for each material, each day. Additionally, provide individual pressure gauges, clearly visible to the operator, for each pump used.
b. Provide equipment with two glass bead dispensers (double drop system) that uniformly distributes the glass beads to the surface of the epoxy pavement marking at a rate of at least 25 pounds per gallon (3kilograms per liter). Glass beads may be applied by a pressure gun or controlled free fall.
2. Contractor's Personnel: Assure that at least one employee on the project when pavement markings are being applied holds an American Traffic Safety Services Association (ATSSA) pavement marking certification.
3. Surface Preparation
a. On existing pavements, remove the existing pavement markings in accordance with Section 822 of the Standard Specifications. Remove the existing markings and prepare the surface according to the manufacturer's recommendations (for the type of markings being installed).
b. On new Portland cement concrete pavement (PCCP), use shot blasting to remove curing compounds and laitance from the surfaces to which the pavement marking will be applied. Prepare the surfaces of new concrete bridge decks the same as new PCCP.
c. On all pavements, THOROUGHLY remove all dirt, grit, grease, grime, vegetable matter, residue of prior pavement marking application (including such adhesives or primers that may have been used in their application), and any other foreign matter from the roadway surface prior to the application of epoxy pavement markings.

4. Alignment: All layout required in the construction of the pavement marking is the responsibility of the Contractor. Lay out the pavement marking as detailed on the Plans. When the Plans do not provide details, submit a layout plan (conforming to the requirements of the Manual on Uniform Traffic Control Devices (MUTCD)) for the pavement markings to the Engineer for approval. Normally locate longitudinal pavement marking stripes 2 inches (50 mm) from existing longitudinal joints. Provide adequate guide marks (approximately 2 inches (50 mm) by 6 inches (150 mm) at approximately 30 to 50 ft. (10 to 15 m) intervals) for the application of the pavement markings.
5. Pavement Marking Application
a. When no traffic is present, and for edge lines under any condition of traffic, a slower curing epoxy material (40 minutes) may be used. When the application is taking place under traffic, use a fast setting (10 minutes) epoxy material for center lines and skip lines.
b. Apply the epoxy material closely behind the cleaning procedure.
c. Provide the Project Engineer with a copy of the manufacturer's application instructions. Apply the epoxy pavement markings in accordance with the manufacturer's recommendations. In the absence of manufacturer's recommendations, apply the markings when the ambient and pavement surface temperatures are 50 degrees F (10 degrees C) and rising. Cease pavement marking operations when the ambient or the pavement surface temperature drops to 50 degrees F (10 degrees C).
d. Before mixing the components of the pavement marking material, heat the individual components to the temperature ranges recommended by the manufacturer of the material. Avoid exceeding the maximum recommended temperature at any time.
e. Apply the epoxy pavement marking material at a thickness of 20 mils ± 0.2 mils (500 μm ± 50 μm) on asphalt and PCCP. Immediately apply the glass beads to the epoxy pavement marking at the rate of 25 pounds per gallon (3 kilograms per liter) of epoxy, equally divided between the large and regular bead gradations. Apply the large beads on the first drop and the regular beads on the second.

2306.9 Method of Removal
Temporary pavement markings on milled surfaces scheduled to be overlaid do not have to be removed prior to performing the overlay. Permanent pavement markings installed on new asphalt surfaces shall be removed without structurally damaging the pavement or scarring the surface. The method of pavement marking tape removal shall be by a high pressure water blast method, a low pressure water and sand blast method, a steel shot blast method, or burning method. Grinding or black paint covering shall not be allowed on new pavement surfaces.

2306.10 Performance Measures
A. Thermoplastic and Aggressive Bond Thermoplastic Performance Measures
1. Lack of specified thickness: The full unit price bid per foot (meter) shall be withheld if lack of thickness is found more than three (3) times per 1 mile (1.6 km), or project if less than 1 mile (1.6 km) in length. Each line shall be checked a minimum of six (6) times per 1 mile (1.6 km), or project if less than 1 mile (1.6 km) in length.
2. Lack of specified width: Payment shall be made with penalty being equal to 25% of the unit price bid per foot (meter) for each 1/4 inch (6.4 mm) of width lacking not to exceed 100% of the unit price bid per foot (meter) for the length of the line less than specified width. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.
3. Lack of specified length/cycle: Payment shall be made with penalty being equal to 25% of the unit price bid per foot (meter) for each 1 inch (50 mm) of length lacking or exceeding the specified length for broken lane line and/or broken center line not to exceed 100% of the unit price bid per foot (meter) for the length of the line less than specified length. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.
4. Lack/Excess of Surface Beads or Improper Application: The full unit price bid per foot (meter) shall be withheld for each lineal foot (meter) of material with inappropriate application rate of the surface glass beads.

The same penalty shall apply if the beads are not evenly disbursed across and along a line or if the beads imbed improperly. This penalty shall be imposed for each instance that the Contractor fails to take corrective action after one warning by the Engineer.
5. Bell ends: The full unit price bid per foot (meter) shall be withheld for wide "bell" ends greater in length than 2 inches (50 mm). This penalty shall be for the full 6 feet (1.8 m) of a lane line or broken centerline or for no more than 6 feet (1.8 m) of a long line.
6. Lack of Adhesion: The full unit price bid per foot (meter) shall be withheld for 3 feet (1 meter) for each occurrence if found more than three (3) times per 1 mile (1.6 km), or project if less than 1 mile (1.6 km) in length.
OR
7. Line Deviation: A line that in the judgment of the Engineer deviates from the specified layout by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation.
8. Pitted Line: The full unit price bid per foot (meter) shall be withheld for each pit greater than 10 feet m (3.05 m) in length.
9. Gaps in Line or Crumbly Edges: The full unit price bid per foot (meter) shall be withheld for the entire length of the portion of any line receiving less than the required amount of thermoplastic material. This penalty shall be
imposed when the Contractor fails to correct line quality after the second warning within 1 mile(1.6 km), or project if less than 1 mile (1.6 km) in length.
10. Rough Line Surface: The full unit price bid per foot (meter) shall be withheld for the entire length of the portion of any line with a rough or "burlap" surface. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.
11. Excessive Dripping between Lines: The full unit price bid per foot (meter) shall be penalized for the length of any dribbled open space between broken lines that is not removed to the satisfaction of the Engineer before leaving the project site that work day. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.
12. Swollen Line of Excessive Width: The full unit price bid per foot (meter) shall be penalized for swollen lines in excess of the specified width.
13. Smeared Line Edges: Fifty (50) percent of the unit price bid per foot (meter) shall be penalized for each occurrence of a length greater than 15 feet (4.6 m).
14. Wavy Line: The full unit price bid per foot (meter) shall be withheld for the entire length of waviness in a line caused by poor operation by the driver/operator of the application equipment. Penalty shall be imposed from the first occurrence.
15. Work Outside the Scope/Limits of Project: Payment for all pavement marking work performed shall be withheld in full until the Contractor (a) removes all pavement marking material placed outside the scope/limits of the project, and (b) repairs the pavement surface as directed by and to the satisfaction of the Engineer.
B. Preformed Thermoplastic Installation Performance Measures
1. Lack/Excess of Surface Beads or Improper Application: The full unit price bid per foot (meter) shall be withheld for each lineal foot (meter) of material or per each for symbol markings with inappropriate application rate of the surface glass beads. The same penalty shall apply if the beads are not evenly disbursed across and along a line or if the beads imbed improperly. This penalty shall be imposed for each
instance that the Contractor fails to take corrective action after one warning by the Engineer.
2. Lack of Adhesion: The full unit price bid per foot (meter) or per each for symbol markings shall be withheld for 3 feet (1 meter) for each occurrence if found more than three (3) times per 1 mile (1.6 km), or project if less than 1 mile (1.6 km) in length.

3. Line Deviation: A line that deviates from the specified layout by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation. 5 mm (3/16")
4. Wavy Line: The full unit price bid per foot (meter) shall be withheld for the entire length of waviness in a line caused by poor workmanship and/or application procedures. Penalty shall be imposed from the first occurrence.
5. Gaps between Successive Lines: Successively placed lines that contain gaps as specified by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation.5 mm (3/16")
6. Burned or Discolored Markings: Fifty (50) percent of the full unit price bid per foot (meter) shall be withheld for each lineal foot (meter) of material or per each for symbol markings which shows signs of burning or discoloration due to prolonged application of the torch. This penalty shall be imposed for each instance that the Contractor fails to take corrective action after one warning by the Engineer.
7. Work outside the Scope/Limits of Project: Payment for all pavement marking work performed shall be withheld in full until the Contractor (a) removes all pavement marking material placed outside the scope/limits of the project, and (b) repairs the pavement surface as directed by and to the satisfaction of the Engineer.
C. Cold Plastic Installation Performance Measures
1. Lack of adhesion: The full unit price bid per foot (meter) shall be withheld for 3 foot (1 meter) for each occurrence if found more than three (3) times per 1 mile (1.6 km), or project if less than 1 mile (1.6 km) in length.
2. Line Deviation: A line that in the judgment of the Engineer deviates from the specified layout by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation.5 mm (3/16")
3. Gaps between Successive Lines: Successively placed lines that contain gaps as specified by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation. 5 mm (3/16")
4. Inlaid Groove Quality: The full unit price bid per foot (meter) shall be withheld for the entire length of line that does not meet the requirements for depth of the inlaid material or for a groove that displays a coarse tooth pattern bottom that is not conducive to complete adhesion of the marking material. Penalty shall be imposed from the first occurrence.
5. Wavy or Misaligned Line: The full unit price bid per foot (meter) shall be withheld for the entire length of waviness caused by poor operation by the driver/operator of the grooving/installation equipment or for any misalignment in the material installed within the inlaid groove. Penalty shall be imposed from the first occurrence.
6. Work Outside the Scope/Limits of Project: Payment for all pavement marking work performed shall be withheld in full until the Contractor (a) removes all pavement marking material placed outside the scope/limits of the project, and (b) repairs the pavement surface as directed by and to the satisfaction of the Engineer and the local entity, if different from the Engineer.
D. Pavement marking paint and epoxy installation performance measures
1. Lack of Specified Thickness: The full unit price bid per foot (meter) shall be withheld if lack of thickness is found more than three (3) times per 1 mile (1.6 km), or project if less than 1 mile (1.6 km) in length. Each line shall be checked a minimum of six (6) times per 1 mile (1.6 km), or project if less than 1mile (1.6 km) in length.
2. Lack of Specified Width: Payment shall be made with penalty being equal to 25% of the unit price bid per foot for each 1/4 inch (6.4 mm) of width lacking not to exceed 100% of the unit price bid per foot (meter) for the length of the line less than specified width. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.

3. Lack of Specified Length/Cycle: Payment shall be made with penalty being equal to 25% of the unit price bid per foot (meter) for each 1 inch (50 mm) of length lacking or exceeding the specified length for broken lane line and/or broken center line not to exceed 100% of the unit price bid per foot (meter) for the length of the line less than specified length. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.
4. Lack/Excess of Surface Beads or Improper Application: The full unit price bid per foot (meter) shall be withheld for each lineal foot (meter) of material with inappropriate application rate of the surface glass beads. The same penalty shall apply if the beads are not evenly disbursed across and along a line or if the beads imbed improperly. This penalty shall be imposed for each instance that the Contractor fails to take corrective action after one warning by the Engineer.
5. Pointed Ends: The full unit price bid per foot (meter) shall be withheld for pointed ends. This penalty shall be for the full 6 feet (1.8 m) of a lane line or broken centerline or for no more than 6 feet (1.8 m) of a long line.
6. Skewed Ends: The full unit price bid per foot (meter) shall be withheld for skewed ends. This penalty shall be for the full 6 feet (1.8 m) of a lane line or broken centerline or for no more than 6 feet (1.8 m) of a long line.
7. Line Deviation: A line that in the judgment of the Engineer deviates from the specified layout by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation.
8. Excessive Dripping between Lines: The full unit price bid per foot (meter) shall be penalized for the length of any dribbled open space between broken lines that is not removed to the satisfaction of the Engineer before leaving the project site that work day. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.
9. Wavy Line: The full unit price bid per foot (meter) shall be withheld for the entire length of waviness in a line caused by poor operation by the driver/operator of the application equipment. Penalty shall be imposed from the first occurrence.
10. Non–Uniform Thickness: The line shall be uniform thickness across the entire cross section of the line with well–defined edges. Heavy inner thickness and thin edges or vice–versa will not be accepted. The full unit price bid per foot (meter) shall be withheld for lines that are not of uniform thickness. Penalty shall be imposed from the first occurrence.
OR
11. Work outside the Scope/Limits of Project: Payment for all pavement marking work performed shall be withheld in full until the Contractor (a) removes all pavement marking material placed outside the scope/limits of
the project, and (b) repairs the pavement surface as directed by and to the satisfaction of the Engineer.

2306.11 Method of Measurement
Pavement Markings will be measured by one of the following:
A. Per linear foot (linear meter) of line. Skip lines are paid based upon length of marked section; 1 foot of adual line is paid for at two unit feet bid.
B. Per each symbol.

2306.12 Basis of Payment:
Pavement Markings will be paid for by one of the following:
A. Contract unit bid price
B. Contract lump sum bid price

SECTION 2307 FENCING

2307.1 Summary
This section governs the installation, and removal of fence.

2307.2 Referenced Standards
The following standards are referenced directly in this section. The latest version of these standards shall be used.
Missouri Standard Specifications for Highway Construction
Section 1043 Fence Materials
Section 607 Chain – Link Fence
Kansas Standard Specifications for State Road and Bridge Construction
Section 828 – Fencing
Section 1620 – Material for Fencing
Midwest Concrete Industry Board (MCIB)
Section 4.1 (Use Latest Revision Adopted)

2307.3 Materials:
A. All materials used for the installation of a permanent chain link fence shall be new material conforming to: Missouri Projects: Section 1043 of the Missouri Standard Specification for highway construction except concrete for posts shall be MCIB Mix No. A543-1-4-0.479 or approved equal. Kansas Projects: Section 1620 of the Kansas Standard Specifications for State Road and Bridge Construction except concrete for posts shall be MCIB Mix No. A543-1-4-0.479 or approved equal.
B. All material used for the installation of permanent decorative fence shall be new material as specified or as shown on the plans or match the existing fence.

2307.4 Construction Details:
A. Removal: Existing fence shall be removed as specified or as shown on the plans or as directed by the Engineer. Removed fencing may be used for temporary fencing only with the Engineer's approval.
B. Chain-Link Fence. Chain-Link Fence shall be installed at the locations shown or as directed by the Engineer in accordance with Section 607 of the Missouri Standard Specifications For Highway Construction,or Section 828 of the Kansas Standard Specifications for State Road and Bridge Construction as applicable, except that the bottom of the fabric shall be not more than 1 ½ inches (38 mm) above the finished ground line. All residential fence shall have a top rail and all edges of fence fabric shall be knuckled.
C. Decorative Fence: Decorative shall be installed at the locations shown or as directed by the engineer in accordance with the manufactures instructions and recognized industry standards or as directed by the Engineer.
2307.5 Measurement and Payment
A. Fence: Fence shall be measured along the slope of the fence to the nearest linear foot (.05m). Vehicle gates shall not be included in this measurement. .
B. Gates: Gates shall be measured per each for the size and type specified.
C. Temporary Fence: Temporary fence will be measured by one of the following.
_ No measurement made.
_ Per foot measured along the slope to the nearest linear foot
D. Fence Removal: Fence removal will be measured by one of the following.
_ No measurement made.
_ Per linear foot to nearest foot.
E. Payment. Fence of the respective type and size will be paid for as listed on the Bid Form – Unit Prices. There will be no separate payment for pedestrian gates; they are subsidiary to the fence pay item.

SECTION 2308 STEEL BEAM GUARDRAIL

2308.1 Scope

This section governs furnishing materials for and installation of steel beam guardrail.

A. Steel Posts: All posts, terminal post connectors, and steel blocks for guardrail shall be formed from a structural steel meeting the requirements of ASTM A-36, and shall be galvanized in accordance with ASTM A-123.

B. Guardrail and Hardware: All guardrail and hardware shall conform to the requirements of AASHTO M-180 Class A, Type 1. Hardware shall be galvanized in accordance with ASTM A-153. Guardrail shall be galvanized with a minimum of 1.80 ounces of Zinc per sq. ft. All Zinc shall be "Prime Western" grade or better 2308.2 Erection:

A. Setting Posts: Posts shall be set to the depth and spaced at the intervals shown on the construction plans or standard drawings. They shall be set vertical and true to line and grade. Steel posts may be driven by a power hammer or may be set in dug or bored holes of a size sufficient to permit thorough compacting of the backfill around the post. The backfill material shall be dry sand, placed in layers not exceeding 12 inches (30.5 cm) in thickness to height 12 inches (30.5 cm) below the finished grade. After erecting and adjusting the rail to true line and grade, the sand backfill shall be compacted by flooding. The final 12 inches (30.5 cm) of backfill consisting of suitable earth material shall then be compacted in six inch (15.24 cm) lifts. Any "mushrooming" of the top of a post shall be removed and damaged spelter coating on posts shall be repaired by the zinc alloy stick method while the surface is heated to approximately 600° F (315°C). Other methods of repairing the spelter coating shall receive prior approval of the Engineer. B. Erecting Guardrail: Bolt holes shall be shop punched. Field punching, reaming and drilling will not be permitted. Guardrail beams shall be spliced, only at posts by lapping in the direction of traffic, using the required number of splice bolts. Beams for twisted turned down terminal sections may be either field or shop twisted. Sufficient twist shall be introduced such that the beam shall retain the required shape in a relaxed condition. Beams to be erected on a radius of 150 feet (45.7 m) or less shall be shop-curved as shown on the plans. Each end of every installation of guardrail shall have an end, bridge anchor, or terminal section of the design and type shown on the construction plans or standard drawings. They shall be of the same material and shall be galvanized in accordance with the requirements for the guardrail beam. Galvanized rail shall be handled in a manner to avoid damage to the galvanized coating. Any sections of rail, end sections or terminal sections on which the spelter coating has been bruised or broken shall be rejected, or may, with the prior approval of the Engineer, be repaired by the method prescribed for repairing damaged speltercoating of steel posts.

2308.3 Measurement and Payment

Steel beam guardrail will be measured from center of terminal post to center of terminal post per linear foot and quarter part thereof. Payment will be made at the contract unit or lump sum bid price. There will be no separate payment for terminal end sections except when specified in the project manual.

SECTION 2309 MEASUREMENTS AND PAYMENT

2309.1 Summary

This section governs the method of measurement and the basis of payment for furnishing all labor, equipment, tools, and materials and for the performance of all related work necessary to complete any construction covered in Section 2300.

2309.2 General
Unless specifically altered by the Special Provisions, the methods of measurement and payment shall be as specified in each section herein, and as listed in the Proposal.

2309.3 Measurement
The Engineer or his representative will measure the work for payment. The method of measurement and computations used in determination of quantities of work performed will be those methods generally recognized as conforming to good engineering practice.
Items not listed in the Proposal: There shall be no measurement or separate payment for any item of work not specifically identified and listed in the Proposal and all costs pertaining thereto shall be included in the contract unit prices for other items which are listed in the Proposal.

2309.4 Measurement and Payment Summary Table

Item Description	Ref. Section	Method of Measurement	Basis of payment
Sidewalks	2301	1 sq ft (0.1 sq.m.)*	Unit Bid Bid
Sidewalk Ramps	2301	1 sq ft (0.1 sq.m.)* each	Unit Bid Price Lump Sum
Concrete Driveways	2301	1 sq ft (0.1 sq.m.)*	Unit Bid Price
Bicycle/Pedestrian Paths(PCC)	2301	1 sq ft (0.1 sq.m.)*	Unit Bid Price
Temporary Asphalt Sidewalks	2302	0.1 ton (0.1 metric ton) 1 sq ft (0.1 sq.m.)*	Unit Bid Price
Asphalt Driveways	2302	0.1 ton (0.1 metric ton) 1 sq ft (0.1 sq.m.)*	Unit Bid Price
Bicycle/Pedestrian Paths (Asphalt)	2302	0.1 ton (0.1 metric ton) 1 sq ft (0.1 sq.m.)*	Unit Bid Price
Rock Blanket	2303	1 sq. yd. (0.1 sq. m.)* 1 ton (1 metric ton)	Unit Bid Price
Concrete Paver Stones	2304	1 sq ft (0.1 sq.m.)**	Unit Bid Price
Maintenance of Traffic	2305	Each device listed per day.	Unit Bid Price Lump Sum
Pavement Markings	2306	1 lin. Ft. (1 lin.m.) each	Unit Bid Price Lump Sum
Fencing	2307	1 lin. Ft. (1 lin.m.) each	Unit Bid Price Lump Sum
Steel Beam Guardrail	2308	1 lin. Ft. (1 lin.m.) each	Unit Bid Price Lump Sum

*Items measured by area shall be listed with the specified depth of material indicated. ** Concrete Paver Stones includes PCC base course

DIVISION 3000
CONCRETE

SECTION 3100 - PORTLAND CEMENT CONCRETE

3100.1 SCOPE: Furnish all labor, materials, equipment, and appliances and perform all operations in connection with the installation of concrete work, complete, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

3100.2 DESCRIPTION This work shall be composed of Portland cement concrete, with or without reinforcement as specified, constructed on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. All work shall be done under the supervision of a qualified superintendent experienced in concrete construction.

3100.3 MATERIALS, DEFINITIONS AND EQUIPMENT

3100.3.1 ***Portland Cement***: Portland Cement shall conform to the standard specifications for Portland Cement, ASTM Designation C-l50, Type I.

3100.3.2 ***Coarse Aggregate:*** All coarse aggregate for concrete shall consist of sound, durable rock particles, free from objectionable coatings and frozen and cemented lumps. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances, exclusive of Items *5* and 6, shall not exceed six (6) percent. The below requirements apply to each size or fraction of aggregate produced.

	Item	**Percent By Weight**
1.	Deleterious Rock	6.0
2.	Shale	1.0
3.	Chert in Limestone	4.0
4.	Other foreign material	0.5
5.	Material passing No. 200 sieve	
5a	Coarse Fraction, Limestone, Gradation A	1.5
5b	Fine Fraction, Limestone, Gradation A	2.5
5c	Limestone, Gradations B, D, and E	2.0
5d	Other aggregates	1.0
6	Thin or Elongated Pieces	5.0

3100.3.3 ***Crushed Stone:*** Crushed stone shall be obtained from rock of uniform

quality and when tested in accordance with AASHTO 1 96-721 (Los Angeles Abrasion), the percentage of wear shall not exceed 50.

3100.3.4 ***Gravel:*** Gravel shall be washed and when tested in accordance with T 96-721 (Los Angeles Abrasion), the percentage of wear shall not exceed 45.

3100.3.5 ***Coarse Aggregate Classifications***: Coarse aggregate for concrete pavement or base course shall be divided into three classifications as follows:
Aggregate No.2. Any gravel of essentially glacial origin similar in character to that found in deposits in Missouri at LaGrange and Sampsel.
Aggregate No.3 . Crushed limestone or any other accepted aggregate not falling under the designations for Aggregate No. 1 or Aggregate No. 2.
NOTE: Aggregate No. 3 shall be used unless otherwise specified.

3100.3.6 ***Coarse Aggregate Gradation:*** Coarse aggregate, except as hereinafter provided, shall be furnished, handled, and batched in two separate sizes or fractions. One fraction shall consist of material retained on the 3/4-inch sieve, and the other fraction shall consist of material passing the 3/4-inch sieve. A tolerance not to exceed 15 percent may be permitted on the 3/4-inch sieve for each fraction. The two fractions will be combined in a ratio as near as possible to the proportions in which the two fractions are furnished by the contractor to make a uniformly well-graded coarse aggregate graded within the following limits:

Gradation A	Percent
Passing 2-inch sieve	100
Passing 1-1/2 inch sieve	95-100
Passing 3/4-inch sieve	35-70
Passing 3/8-inch sieve	10-30
Passing No. 4 sieve	0-5

Coarse aggregate may be divided into more than two fractions if approved by the Engineer.

3100.3.7 ***Proper Balance***: The contractor shall be responsible for maintaining the proper balance in the quantities for each fraction and for securing the final quantities of each fraction in such proportions as to minimize wastage.

3100.3.8 ***Separation of the Aggregate***: The separation of the aggregate into two sizes or fractions will not be required if: (1) the contractor is permitted by special provisions to use concrete paving mixers having a rated capacity of less than either a 27E single drum mixer or a 1 6E dual drum mixer; or (2) if hand finishing methods of the pavement are permitted; or (3) if the design pavement thickness is six (6) inches or less.
If the aggregate is not separated into two sizes or fractions, it shall be graded to meet the following requirements:

Gradation B	**Percent**
Passing 1-1/2 inch	100
Passing 1-inch sieve	95-100
Passing 1/2-inch sieve	25-60
Passing No. 4 sieve	0-8
Passing No. 10 sieve	0-3

3100.3.9 ***Coarse aggregate for Class A concrete***: Coarse aggregate for Class A concrete may be gravel or crushed stone and shall meet the following gradation requirements:

Gradation E	**Percent**
Passing 3/4-inch sieve	100
Passing 1/2-inch sieve	80-100
Passing 3/8-inch sieve	40-70
Passing No. 4 sieve	0-10
Passing No. 10 sieve	0-3

3100.3.10 ***Fine Aggregate***: Fine aggregate for Portland cement concrete shall be a fine granular material naturally produced by the disintegration of rock of a siliceous nature, except that by specific approval of the Engineer, chat sand produced from flint chat in the Joplin area or fines manufactured from igneous rock or chert gravel may be used. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating of injurious material. The quantity of deleterious substances shall not exceed the following limits:

Item	**Percent by Weight**
Clay lumps	.25

Lightweight aggregate particles, including coal and lignites	.25
Material passing No. sieve	
(a) Natural sand	2.0
(b) Manufactured sand	4.0
Other deleterious substances	0.10

3100.3.11 ***Mortar Strength:*** Fine aggregate subjected to the mortar strength test shall produce a mortar having a tensile strength at the age of seven (7) days at least 90 percent of that developed at the same age by mortar of the same proportions and consistency made of the same cement and Standard Ottawa sand. Tests shall be made in accordance with procedures set out in ASTM C-190. Cement used in the tests shall be Type I meeting the requirements of AASHTO M85-721.

3100.3.12 ***Colorimetric Test:*** Fine aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the standard will be rejected unless it passes the mortar strength test specified above.

3100.3.13 ***Fine Aggregate Gradation***: All fine aggregate, except angular chert sand and manufactured sand, shall meet the following gradation requirements:

	Percent Passing
Passing 3/8 inch sieve	100
Passing No 4 sieve	95-100
Passing No 20 sieve	40-75
Passing No 50 sieve	5-30
Passing No 100 sieve	0-10

3100.3.14 ***Manufactured Sand:*** Manufactured sand shall be the product of grinding flint chat, igneous rock or gravel and shall meet the following gradation requirements:

	Percent Passing
Passing 4 sieve	100
Passing No 10 sieve	80-100
Passing No 20 sieve	50-75

Passing No 50 sieve	5-30
Passing No 100 sieve	2-10

3100.3.15 ***Mixing Water:*** Water for mixing and curing concrete shall be clean, and free from injurious amounts of sewage, oil, acid, alkali, salt or organic matter. (Only potable water will be acceptable without testing.)

3100.3.16 ***Air-Entraining Agent:*** Air Entraining Agents when specified and used to produce specified amounts of air entrainment shall be neutralized Vinsel Resin, Darex AEA, Protex AEA or an approved equal conforming to the applicable requirements of ASTM Designation C-260.

3100.3.17 ***Admixtures:*** Admixtures shall not be used unless specifically approved by the Engineer.

3100.3.18 ***Reinforcing***: 1. Reinforcing steel, if specified, shall conform to the latest ASTM Specification as follows:

Type	**ASTM Designation**
Bars and rods	A-15 or A-16
Steel wire fabric	A-185

NOTE: The bars which are to bent after one end is encased in concrete shall be structural grade.

2. **Fiber Mesh Reinforcement**: Fiber reinforcement, if specified, shall comply with the material specifications and performance requirements set forth in ASTM C1116, for Type III Synthetic-Fiber Reinforced Concrete, and as follows. Synthetic reinforcing fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials. Fibers shall have a specific gravity of 0.9, a minimum tensile strength of 70 ksi, graded per manufacturer, and be specifically manufactured to an optimum gradation for use as concrete reinforcement. Provide a minimum of 1.5 pounds fiber reinforcement per cubic yard of concrete. Fibers shall be added at the batch plant.

3100.3.19 ***Expansion Joints***: Expansion joints shall be non-extruding preformed joint fillers of one of the following types: bituminous material or other approved material, and shall conform to MODOT Standards.

3100.3.20 ***Joint Sealing Compound***: Material for sealing expansion joints and for filling dummy contraction joints and longitudinal center joints shall be any material meeting either the AASHTO Standard Specifications for Mixed Asphalt and Mineral Filler or Asphalt Filler (Designations N89 or Ml 8, respectively) or the ASTM Specifications for Joint Sealing Compounds,

D-l850, and D-l 190.

3100.3.21 ***Premolded Joint Material***: Premolded parting strips when called for on the plans, shall be 3/16-inch thick or more and of the width shown on the plans. They shall consist of strips which have been formed from layers of felt or shredded felt, cane, wood, or other suitable fibers securely bound together and uniformly impregnated with a suitable binder. They shall be of such character that they will not be permanently deformed by ordinary handling during hot weather or become hard and brittle in cold weather.

3100.3.22 ***Metal Supports***: Metal chairs used to support tie-bars or reinforcing bars shall be channel shaped pressed out of sheet steel of not less than twelve (12) gauge (U.S. Standard) metal, and conforming to details shown on the plans.

3100.3.23 ***Expansion Tubes***: Metal dowel caps or tubes shall be manufactured from thirty-two (32) gauge sheet metal, shall be indented to provide a limiting stop for the dowel bar, and shall provide unobstructed expansion space of not less than one (1) inch to permit movement of the dowel bar. They shall be of proper size to fit the specified bars tightly and the closed end shall be watertight.

3100.3.24 ***Storage of Materials***:
1.Cement in packages shall be stored in a weathertight, dry, well ventilated building with the floor raised a minimum of one (1) foot from the ground. Each shipment shall be identified and arranged for easy access and inspection and used in sequence of receipt. Cement which has hardened in packages shall not be used. Bulk cement shall be used direct from cars to bins.
2. Aggregates obtained from different sources and those having different gradations shall be stored separately and batched by weight. Mixing in the stockpile or alternating layers in one stockpile will not be permitted. Stockpiles shall be placed on sites properly prepared to prevent inclusion of foreign materials. Stockpiles shall be constructed in horizontal layers or lifts to prevent segregation of sizes and shall be free-draining. During severe weather, they shall be protected from freezing and inclusion of frost.

3100.3.25 ***Mix Design***:
1. The proportions of cement, fine aggregate, and coarse aggregate for Portland cement concrete shall be as specified by the Engineer within the applicable limits of the specifications for the class of concrete designated in the contract. The Engineer assumes no responsibility for the volume of concrete produced or furnished for the week.
2. The proportions for any mixture of materials obtained from established and approved commercial sources may be obtained by the contractor from the Engineer upon request. If the contractor desires to ascertain the mix for a certain combination of aggregates obtained from commercial sources before construction work starts, he/she shall advise the Engineer in writing

of the specific course of materials which he/she desires to use, and the Engineer will supply him with the mix for each combination of coarse and fine aggregates for which a specific request is made.
3. If mix design information is desired for bidding, requests for such information may be made to the Department of Public Works, Division of Engineering, at Joplin, Missouri. The contractor shall make the request as far in advance of the letting as possible to allow the Engineer sufficient time to furnish a reply. The mix set by the Engineer will be based upon the material designated by the contractor as intended for use in the work and, if sources of supply are changed, the mix may be revised if necessary.
4. For simplicity of design, the various fine aggregates are grouped into four classes, and a minimum and maximum cement factor has been established for each class. The cement factor for the individual job may vary within the maximum and minimum limits, depending upon the gradation of the coarse aggregate, the quantity of mixing water used, the quantity of entrained air when air-entrained concrete is specified, and upon changes in proportions which may be necessary to produce satisfactory workability, strength, or entrained air content. The engineer will make such changes in proportions, within the limits of these specifications, as necessary to produce concrete of satisfactory workability and strength.
Class A sand shall include all sand weighing 109 pounds or more per cubic foot.
Class B sand shall include all river, and Crowley Ridge sand weighing from 106 pounds to 108 pounds inclusive per cubic foot, or glacial sand weighing less than108 pounds per cubic foot.
Class C sand shall include all, river, and Crowley Ridge sand weighing from 101 pounds to 105 pounds inclusive per cubic foot.
Class D sand shall include all sand weighing 100 pounds or less per cubic foot and any sand which is produced by the process of grinding and pulverizing large particles of aggregate, or which contains more than 50 percent of material produced by the reduction of coarser particles.
5. The cement factor or the quantity of cement used in any cubic yard of concrete shall be the cement content in sacks per cubic yard of concrete as determined from a summation of the absolute volumes of all the ingredients and, when air-entrained concrete is specified, the volume of air. The cement requirements in sacks per cubic yard of concrete for the various classes of sand are as follows:

Class of Sand	Class A-1 Concrete	Class B Concrete	Class B-1 Concrete	Pavement Concrete
Max	3.5 inches	4 inches	4 inches	2.5 inches

Slump								
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	6.40	8.00	5.75	6.00	6.50	7.00	6.00	6.40
B	6.80	8.00	6.00	6.40	6.80	7.20	6.20	6.60
C			6.20	6.60	7.00	7.40	6.40	6.80
D			6.60	7.00	7.40	7.80	6.80	7.20

NOTE: The weight per cubic foot means the dry rodded weight per cubic foot of the aggregate.

3100.3.26 ***Consistency***: The slump of concrete shall be from 1 inch, unless approved by the Engineer. The consistency shall be measured as described in the current ASTM Standard Method of Slump Test for Consistency of Portland Cement Concrete (Designation C-143), or the method of test for bail penetration for Portland Cement Concrete ASTM Designation C-360.

3100.3.27 ***Workability***: Concrete shall at all times be of such consistency that it can be worked into corners and angles of the forms and around joints, dowels, and tie-bars by the construction methods used without excessive spading, segregation or undue accumulation of water of latency on the surface. At no time shall water be added to a load after placement has begun. Likewise, additional aggregate shall not be added for the purpose of reducing slump, or to "dry up" a load of concrete.

3100.3.28 ***Ready-Mixed Concrete***: Ready-Mixed Concrete shall be mixed and transported in accordance with the current ASTM specifications for Ready-Mixed Concrete (Designation C-94). Any concrete which is not plastic and workable when it reaches the sub-grade shall be rejected. When construction conditions are such that it is absolutely necessary for trucks hauling concrete to operate on the grade between forms they shall not back over previously deposited concrete. Concrete shall be completely discharged from ready-mix trucks no later than 45 minutes after batching.

3100.3.29 ***Measuring Air Content***: The air content of freshly mixed air-entrained concrete shall be **5.5%, ±1.5% and shall be** checked at least twice daily. Concrete with air contents above or below the amount specified shall be corrected by adjustments in the mix design or quantities of air entraining admixture being used. The air content shall be measured in accordance with ASTM Tentative Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method (Designation*C-175).* **Air entrainment may be added one time per production day at delivery. If more than one load fails to meet requirements operations shall cease until corrective measures are taken at mixing plant.**

3100.3.30 ***Compressive Strength:*** Concrete shall reach 3000 psi before being opened to traffic. Standard 28 day tests shall reach a minimum of 4000 psi for both structural and non-structural concrete.

3100.3.31 ***MoDOT Mix Designs.*** In lieu of the previously defined mix designs. Similar mix

designs from the Missouri Standards Specifications for Highway Construction may be utilized with approval of the engineer.

3100.3.32 *Concrete Suppliers*: Suppliers of concrete for all work on the public right-of-way in the City of Joplin shall provide a copy of their MODOT plant certification obtained within the previous six months. Each truck shall have a mixer rating plate on each drum that defines how much that truck is rate to. Any trucks with worn out fins shall be rejected.

3100.3.33 *Delivery Tickets*. Batch weights shall be furnished on the delivery tickets with each load of concrete accepted for the project. Concrete without this shall be rejected.

3100.4 CONSTRUCTION DETAILS

3100.4.1 *Forms*:
1. Forms shall be made of metal and shall have a depth equal to or greater than the prescribed edge thickness of the pavement slab unless otherwise approved by the Engineer in writing. Forms shall have a base width of not less than four (4) inches for all forms eight (8) inches or more in height. All side forms less than eight (8) inches in height shall have a base width of not less than four (4) inches. The minimum length of each section of form used shall be ten (10) feet. Each section or form shall be straight and free from bends or warps.
2. The maximum deviation of the top surface of any section shall not exceed one-eighth (1/8) inch, or the inside face not more than one-fourth (1/4) inch from a straight line. The method of connection between sections shall be such that the joint thus formed shall be free from movement in any directions.
3. Forms shall be of such cross-section and straight and so secured as to resist the pressure of the concrete when planed, and the impact when planed, and the impact and vibration of any equipment which they support, without springing or settlement.
4. Each ten (10) foot length of form shall have at least three (3) form braces and pin sockets which shall be spaced at intervals of not more than five *(5)* feet, having the end brace and socket not more than six (6) inches from the end of the form. Approved flexible forms shall be used for construction where the radius is 150 feet or less.

3100.4.2 *Setting Forms*: The sub-grade under the forms shall be compacted and cut to grade so that the form when set will be uniformly supported for its entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are free from play or movement in any direction. The supply of forms shall be sufficient to permit their remaining in place for at least 12 hours after the concrete has been placed. All forms shall be cleaned and oiled each time they are used.

3100.4.3 *Grade and Alignment*: The alignment and grade elevations of the forms shall be checked by the contractor and the necessary corrections made by

the contractor immediately before placing the concrete. When any form has been disturbed or any sub-grade there under has become unstable, the form shall be reset and rechecked.

3100.4.4 ***Placing Concrete***: The concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub-grade to the required depth and width of die construction lane in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented.
The concrete shall be vibrated and tamped against the forms and along all joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab. No concrete shall be placed around manholes or other structures until they have been brought to the required grade and alignment.

Redi-mix trucks shall be fully discharged within one hour of batching.

Water shall not be added to the load at any time after placement has begun.

3100.4.5 ***Consolidating and Finishing*** .General: The pavement shall be struck off and consolidated with a mechanical finishing machine or by hand finishing methods. When a mechanical finishing machine is used, the concrete shall be struck off at such a height that after consolidation and final finishing it shall be at the exact elevations as shown on the plans. A depth of at least two (2) inches of concrete shall be carried in front of the strike-off screed for the full width of the slab, whenever the screed is being used to strike off the pavement. The finishing machine shall be provided with a screed which will consolidate the concrete by pressure. The concrete shall, through the use of this machine, be brought to a true and even surface, free from rock pockets, with the fewest possible number of passages of the machine. The edge of the screeds
along the curb line may be notched out to allow for sufficient concrete to form the integral curb. Hand-finishing tools shall be kept available for use in case the finishing machine breaks down.
When hand finishing is used, the pavement shall be struck off and consolidated by a vibrating screed to the exact elevation as shown on the plans. When the forward motion of the vibrating screed is stopped, the vibrator shall be shut off it shall not be allowed to idle on the concrete. Internal mechanical vibration shall be used along side all formed surfaces. Additional water shall not be used unless approved by the Engineer or his/her representative.

3100.4.6 ***Longitudinal Floating***: After the concrete has been struck off and consolidated, it may be further smoothed by means of a mechanical longitudinal float or float finishers using a longitudinal hand float. If a longitudinal hand float is used, it shall be operated from foot bridges

spanning the pavement and shall be worked with a wiping motion parallel to the centerline, and passing from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than one-half (1/2) of the length of the float. The float shall not be less than twelve (12) feet in length and six (6) inches in width, and shall be properly stiffened and provided with handles of each end. This operation may be eliminated if specified tolerances can be attained by some other approved method.

3100.4.7 ***Scraping***: In cases where the longitudinal floating operation has been eliminated, the pavement shall be scraped with a straightedge ten (10) feet long, equipped with a handle to permit it to be operated from the edge of the pavement. The straightedge shall be operated so that any excess water and latency are removed from the surface of the pavement. After the scraping operation, the surface of the pavement shall be within the specified tolerances.

3100.4.8 ***Straightedging:*** While the concrete is still plastic, the slab surface shall be tested for smoothness with a 10-foot straightedge swung from handles three (3) feet longer than one-half the width of the slab. The straightedge shall be placed on the surface parallel to the centerline of the pavement and at not more than 5-foot intervals transversely. After each test the straightedge shall be moved forward one-half its length and the operation repeated. When irregularities are discovered, they shall be corrected by adding or removing concrete. The pavement surface shall have no depression in which water will stand.

3100.4.9 ***Edging:*** Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be carefully finished with an edger of the radius shown on the plans.

3100.4.10 ***Final Surface Finish***: A burlap drag or a broom finish shall be used as the final finishing method. When a drag is used it shall be at least three (3) feet in width and long enough to cover the entire pavement width. It shall be kept clean and saturated while in use. It shall be laid on the surface of the pavement and dragged in the direction in which the pavement is being laid. When broom finishing, a hard bristle broom shall be used. The broom shall be kept clean and used in such a manner as to provide a uniform textured surface. The curb shall have the same final finish as the pavement. The final surface of the concrete pavement and curb shall have a uniform gritty texture free from excessive harshness and true to the grades and cross section shown on the plans. The engineer may require changes in the final finishing procedure as required to produce the desired final surface texture.

3100.4.11 ***Integral Curb***:

1. Integral curbs shall be required along the edges of all street pavements as indicated on the plans, except at such locations as the Engineer may direct. Depressed curbs shall be in compliance with ADA specifications

shall be provided at all driveway entrances if shown on the plans.
2. The integral curb shall be constructed immediately following the finishing operation unless otherwise shown on the plans. Special care shall be taken so that the curb construction does not lag the pavement construction and form a "Cold Joint".
3. Steel curb forms shall be required to form the backs of all curbs except where street returns of small radius or other special sections make the use of steel forms impractical.
4. In placing curb concrete, sufficient spading shall be done to secure adequate bond with the paving slab and eliminate all voids in the curb.
5. The finished surface of the curb and gutter shall be checked by the use of the 10-foot straightedge and corrected if necessary. Where grades are flat and while the concrete is still plastic, the drainage of the gutter should be checked by pouring water at the gutter summit and observing its flow to the inlet. In order to prevent damage to the concrete surface, water should be poured onto a piece of burlap or curing paper.

3100.4.12 ***Curing.*** Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods. The concrete shall not be left exposed for more than one-half (1/2) hour between stages of curing or during the curing period.

3100.4.13 ***White Pigmented Membrane:*** After the free water has left the pavement surface, the entire surface shall be sealed by hand or machine spraying with a uniform application of white-pigmented membrane curing material. The contractor shall provide satisfactory equipment to insure uniform coverage of curing material, without loss, on the pavement at the rate of one gallon for each 150 square feet. If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the contractor will be required to apply additional curing material to the affected portions. All areas cut by finishing tools subsequent to the application of the curing material shall immediately be given new applications at the rate specified above. If hair checking develops before the membrane can be applied, the concrete shall be initially cured with wet burlap as specified in Section 3100.4.6 before the membrane is placed.

3100.4.14 ***Waterproofed Paper, Polyethylene Sheeting, and Polyethylene-Burlap Sheeting***: As soon as the concrete has set sufficiently to prevent marring, the top surface of the pavement shall be covered with units of waterproofed paper, white polyethylene sheeting, or white polyethylene burlap sheeting, which shall be lapped not less than 18 inches. If polyethylene-burlap sheeting is used, the burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All coverings shall be so placed and weighted that they remain in contact with the pavement surface and edges for not less than 72 hours after the concrete has been placed. If hair checking develops before the covering

can be applied, the concrete shall be initially cured with wet burlap as specified in Section 3100.4.6 before the covering is placed.
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3100.4.15 ***Mats of Jute or Cotton***: New mats of jute or cotton, and any such mats that have been used for purposes other than the curing of concrete, shall be thoroughly washed before being used. The use of mats contaminated with earth or other deleterious substances will not be permitted. The top surface of the pavement shall be completely covered with mats as soon as the concrete has set sufficiently to prevent marring of the surface. Prior to being placed, the mats shall be damp throughout and shall be placed with the wettest side down. The mats shall be handled in such manner that contact with earth or other deleterious substances is avoided, and they shall be so placed that they remain in contact with the pavement surface and edges. The covering shall be kept wet and maintained in position for not less than 72 hours after the concrete has been placed. If hair checking develops before the mats can be applied, the concrete shall be initially cured with wet burlap as specified in Section 3100.4.6 before the mat covering is placed.

3100.4.16 ***Burlap:*** The top surface of the pavement shall be temporarily covered with thoroughly damp burlap after the concrete has set sufficiently to prevent marring of the surface. Burlap shall be handled in such manner that contact with earth or other deleterious substances will be prevented. All new or contaminated burlap and all burlap that has been used for purposes other than the curing of concrete shall be thoroughly washed before being used. The burlap shall be kept thoroughly wet until removed for application of the final curing material. Neither the top nor the edge of the pavement shall be left unprotected for more than one-half (1/2) hour. When the burlap is removed, curing shall be continued by one of the approved methods.

3100.4.17 ***Straw***: The pavement shall be initially cured with wet burlap. As soon as the burlap is removed, the surface shall be covered with not less than six (6) inches of straw, the thickness being measured after wetting. The straw shall be kept saturated for not less than 72 hours after the concrete has been placed. When removed, the straw shall be disposed of so as to leave the road in a sightly condition, but shall not be burned on the pavement or in close proximity to the edges.

3100.4.18 ***Joints***:
1. Longitudinal and transverse joints shall be constructed as shown on the plans.
2. Longitudinal joints are those joints parallel to the lane of construction. They may be either intermediate center joints or the construction joints between construction lanes.
3. Transverse joints shall be contraction joints or construction joints. Construction joints are put in transversely whenever construction operations require them.

4. Expansion joints may be either longitudinal or transverse. They are used only where specifically shown on the plans.
5. The edges of the pavement and those joints where such edging is shown on the plans shall be rounded with an edger having a radius of not larger than one-eighth (1/8) inch. Transverse joints, except keyed and tied construction joints, shall be continuous across the entire paved area including the curb.

3100.4.19 ***Transverse Joints***: Transverse joints shall be contraction, expansion or construction joints. Contraction and expansion joints shall be placed as indicated on the plans and construction joints wherever construction may require them. They shall make a right angle with the centerline of the pavement and with the surface of the sub-grade.

3100.4.20 ***Transverse Expansion Joints***: Expansion joints, where shown on the plans, shall conform to the specification in Section 3100.3.2 entitled "Expansion Joints". They shall extend the entire width of the pavement and from the sub-grade to one (1) inch below the surface of the pavement. They shall be of the dimensions and spacing as shown on the plans. The filler shall be held accurately in place during the placing and finishing of the concrete by a bulkhead, a metal channel cap or other approved method. Under no circumstances shall any concrete be left above the expansion material or across the joint at any point. Any concrete spanning the ends of the joint next to the forms shall be carefully cut away after the forms are removed. Before the pavement is opened to traffic, the groove above the filler shall be cleaned and sealed with specified joint sealing material covered under Section 3100.3.22 entitled "Joint Sealing Compound".

3100.4.21 ***Transverse Contraction Joints***: Transverse contraction joints shall be of the sawed one quarter the thickness of concrete unless otherwise shown on the plans.

3100.4.22 ***Transverse Sawed Contraction Joints***: When transverse contraction joints are to be formed by sawing, care must be taken to saw the grooves soon after placing to prevent the formation of cracks due to contraction of the slab. All transverse joints shall be sawed at least one-fourth *(1/4)* of the slab depth. Any procedure for sawing joints that results in premature and uncontrolled cracking shall be revised immediately by adjusting the time interval between the placing of the concrete and the cuffing of the joints.

3100.4.23 ***Transverse Formed Dummy Groove Joints***: Transverse dummy groove joints shall not be used.

3100.4.25 ***Transverse Construction Joints***: Transverse construction joints of the type shown on the plans shall be placed wherever the placing of the concrete is suspended for more than 30 minutes. A butt type joint with dowels shall be used if the joint occurs at the location of a construction joint. Keyed joints with tiebars are used if the joint occurs at any other location.

3100.4.26 *Dowels*: If joints are to be equipped with dowels, they shall be of the dimension and at the spacing and location indicated on the plans. They shall be firmly supported in place, accurately aligned parallel to the pavement grade and the centerline of the pavement by means of a dowel support that will remain in the pavement and will insure that the dowels are not displaced during construction. One-half of each dowel shall be painted and greased and in an expansion joint, one end shall be equipped with a tight-fitting sleeve of the dimensions shown on the plans conforming to Section 3100.3.25 entitled "Expansion Tubes".

Dowels shall meet section 1036 requirements in the Missouri Standard Specifications for Highway Construction.

3100.4.27 *Longitudinal Joints*: Longitudinal joints shall be placed as shown on the plans. They shall be of the sawed, dummy groove, pre-molded strip, or the keyed construction type, unless otherwise shown on the plans. Joints between construction lanes shall be the keyed construction type, unless otherwise shown on the plans.

3100.4.28 *Longitudinal Center Joint*: Longitudinal center joints shall be of the sawed or premolded strip type, unless otherwise shown on the plans.

3100.4.29 *Sawed Longitudinal Center Joints*: Sawed longitudinal center joints shall be sawed grooves made with a concrete saw after the concrete has hardened. The saw cut shall be at least one-fourth (1/4) of the slab depth. The joint may be sawed at any time prior to the time the pavement is open to traffic. These joints are otherwise formed in the same manner as the transverse sawed joints in Section 3100.4.21 entitled "Transverse Contraction Joints".

3100.4.30 *Longitudinal pre-molded strip joints*: Longitudinal pre-molded strip joints are formed in the same manner described for transverse pre-molded strip joints in Section 3100.4.24 entitled "Transverse Pre-Molded Strip Joints".

3100.4.31 *Longitudinal Construction Joints*: Longitudinal construction joints (i.e., joints between construction lanes) shall be of the dimensions shown on the plans. The key shall be constructed by placing an approved key against the form when the first slab adjacent to the joint is placed. When placing the second slab, care must be taken that no concrete is left to overhang the lip formed in the first slab by the edging tool.

3100.4.32 *Tiebars:* Tiebars or tiebolts when shown on the plans shall be of deformed steel and of the dimensions and of the spacing specified. Tiebars shall be firmly supported by sub-grade chairs or so installed as not to be displaced during construction operation.

3100.4.33 *Joint Sealer*: After the curing period, all sawed joints

in the pavement shall be cleaned and sealed with material meeting the requirements in Section 3100.3.22 entitled "Joint Sealing Compounds". All foreign materials, joint sawing residue, dirt and curing membrane shall be removed. Joints shall be lightly underfilled (about 1/4 inch) to prevent extrusion of sealer. Any excess material should be removed from the pavement surface as soon after sealing as possible.

3100.4.34 ***Integral Curb Joints***: In the construction of transverse joints of concrete integral curb pavement, special care must be taken to see that all transverse joints extend continuously through the pavement and curb.

3100.4.35 ***Structures***: All manholes, catch basins, or structures of a permanent nature encountered in the area to be paved shall be raised or lowered as the case may be, to the surface of the new pavement, and the necessary expansion material as specified in Section 3100.3.21 entitled "Expansion Joints" placed around each structure for the full depth of the slab and of the thickness shown on the plans.

3100.4.36 ***Weather Limitations and Protection***:

1. Unless otherwise authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending ambient air temperature away from artificial heat reaches 40 degrees F. and not resumed until an ascending ambient air temperature away from artificial heat reaches 35 degrees F.
2. If approval has been granted for the contractor to place the concrete while the ambient air temperature is at or lower than 40 degrees F., the contractor shall take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates, or applying heat directly to the contents of the mixer. Aggregates shall not be heated higher than 150 degrees F., and the temperature of the aggregates and mixing water combined shall not be higher than 90 degrees F., when the cement is added. Unless otherwise authorized, the temperature of the mixed concrete when heating is employed shall not be less than 50 degrees f. and not more than 80 degrees F. at the time of placement. Cement or fine aggregate containing lumps or crusts of hardened material or frost shall not be used. Concrete shall not be placed upon a frozen sub-grade except with written approval of the Engineer.
3. All concrete shall be effectively protected from freezing for a period of at least five (5) days after it has been placed and until a minimum compressive strength of 3500 psi has been attained. Protection will be required for not more than ten (10) days. Regardless of precautions taken, the contractor shall assume all risks, and all frozen concrete shall be replaced at his/her expense.

3100.4.37 ***Protection and Opening to Traffic***: The contractor shall protect the pavement against all damage prior to final acceptance of the work by the Engineer. Traffic shall be excluded from the pavement by erecting and

maintaining barricades and signs until the street is opened for traffic as authorized by the Engineer.

3100.4.38 ***Slip-form Paver***: In lieu of the construction methods described in the preceding section of the specifications, the contractor may use a slip-form paver. When the slip-form paver is used, all reference in the preceding sections of this specification referring to forms shall be deleted. Slip-form pavers shall be equipped with vibratory and tamping bar assemblies that are effective over the full width of the pavement. The paver shall also have a metal float with a bull nosed front end for the full width of the pavement, excluding curbs, which will extrude the concrete under pressure.
Behind the float shall be a rubber belt, mechanically operated and with a lateral movement of four (4) to eight (8) inches. The curb shall be formed by extrusion plates or mules mounted at the rear of the machine. The requirement for longitudinal floating in Section 208.26 entitled "Longitudinal Floating" shall be deleted.

3100.4.39 ***Slip-form Paver Subgrade Preparation***: The sub-grade shall be brought to the proper grade and cross section by means of a properly designed and operated machine. The sub-grade shall comply with applicable sections of this specification.
If any traffic is allowed to use the prepared sub-grade, some device, satisfactory to the Engineer, shall be provided for checking and correcting the sub-grade immediately ahead of placing the concrete.
The sub-grade work, especially the path on which the tracks of the paver ride must be done carefully and accurately as its degree of precision greatly affects the resulting smoothness of the pavement surface.

3100.4.40 ***Slip-form Paver Concrete Placing***: Concrete shall be of uniform slump and adequately supplied in front of the paver. The rate of progress shall be controlled so that the forward movement of the paver will be as nearly continuous as practicable. If it is necessary to stop the forward movement of the paver, the vibrator and tamping elements shall also be stopped immediately. Care must be taken to see that a sufficient supply of concrete passes around the float and the belt along the form line to form the integral curb where shown on the plans.

3100.4.41 ***Final Finishing***: Final finishing operations shall conform to the applicable sections of this specification.

3100.4.42 ***Surface Tolerances***: Pavements shall have the following surface tolerances when checked longitudinally with a 10-foot straightedge:
Residential Streets 1/4 inch in 15 feet
Collector (minor) 1/4 inch in 15 feet
Collector (major) 1/8 inch in 15 feet
Arterial 1/8 inch in 10 feet

3100.4 MEASUREMENT AND PAYMENT: Portland Cement Concrete pavement shall be measured in square yards of the design thickness shown on the plans. The width for measurement shall be the width from outside edge of completed pavement or, when integral curbs are included, from back to back of completed curb. The length shall be the

actual length measured along the centerlines.

Concrete Pavement S.Y.
END OF SECTION

SECTION 3200 - CONCRETE CURB AND GUTTER

3200.1 SCOPE: This section governs the furnishing of all labor, equipment, tools, and materials, and the performance of all work necessary to construct curb, or curb and gutter, complete, including all necessary incidental work done in accordance with the applicable requirements of Sections entitled "Grading", and "Sub-Grade Preparation", at the locations shown on the plans, as provided for in the Special Provisions, and by authorized Change Orders.

3200.1.1 Curb and gutter shall be required of all public improvement street projects.

3200.2 MATERIALS, EQUIPMENT, AND DEFINITIONS:

3200.2.1 General: All items of material included in this section shall conform to the requirements in Section 3100 unless otherwise specified in special provisions or shown on the plans.

3200.2.2 Mix Design: All concrete used in curb and gutter shall be a Class B1 with a minimum 28 day compressive strength of 4000 psi or Pavement Mix as specified in Section 3100. Similar MoDOT approved mixes may be substituted with approval of the Engineer.

3200.2.3 Air Entrainment: Air entrainment for curb shall be in accordance with Section 3100.3.29. Air entraining admixture shall conform to the requirements of ASTM C260.

3200.2.4 Fiber Mesh Reinforcement: Fiber reinforcement, if specified, shall comply with the material specifications and performance requirements set forth in ASTM C1116, for Type III Synthetic-Fiber Reinforced Concrete, and as follows. Synthetic reinforcing fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials. Fibers shall have a specific gravity of 0.9, a minimum tensile strength of 70 ksi, graded per manufacturer, and be specifically manufactured to an optimum gradation for use as concrete reinforcement. Provide a minimum of 1.5 pounds fiber reinforcement per cubic yard of concrete. Fibers shall be added at the batch plant.

3200.3 CONSTRUCTION DETAILS:

3200.3.1 General: 1. The incidental work of clearing, grubbing, demolition, grading, and sub-grading preparation shall be carried well in advance of the construction herein specified. The curb, or curb and gutter shall be constructed to the configuration and to the lines and grades shown on the plans. The curb, or curb and gutter section shall be placed prior to placement of pavement or sidewalk sections, except when curb and gutter is integral with pavement, and as ordered by the Engineer.

2. Construction Staking: Curb and gutter shall be staked on 50' stations maximum spacing. Additional staking may be required by the engineer.

3. All staking shall be done using hub and tack unless deemed impractical by the Engineer.

4. Prior to starting construction, surveyor will check existing pavement elevations against the plan finished grade elevations on 50' stations for the length of the project.

3200.3.2 Grading and Sub-Grade Preparation: All excavation required in he/she grading and sub-grade preparation shall be considered as "Unclassified Excavation" as defined in the Section entitled "Grading" and "Sub-grade Preparation".

3200.3.3 Forms: All forms shall be in good condition, with not more than one fourth (1/4) inch variation in horizontal and vertical alignment for each ten (10) feet in length**. A face form shall be required for all upright curbs**. The forms shall be set true to line and grade and shall be adequately supported to stay in position while depositing and consolidating the concrete. They shall be designed and constructed so as to permit their removal without damages to the concrete.

3200.3.4 Joints: The joints shall be formed at right angles to the alignment of the curb, or curb and gutter and to the depths as specified and as shown on the plans.

3200.3.5 Expansion Joints: Expansion joints are required at 200 foot intervals. Expansion joints shall be formed by aone-half (1/2) inch thick bituminous pre-formed joint filler, cut to the configuration of the full size of the curb, or curb and gutter section, being secured at the location shown on the plans, so that they are not moved by depositing and compacting the concrete of these joints. The edges of these joints shall be rounded with an edging tool of one-eighth (1/8) inch radius. The joints do not require a joint sealer when constructed as shown on the plans. Expansion joint shall be used when installing concrete next to existing surfaces and as directed by the engineer.

3200.3.6 Contraction Joints: Contraction Joints shall be formed by a one-quarter (1/4) inch thick template, cut to the configuration of the curb section to the extent shown on the plans. The maximum length between contraction joints shall be 12.5 feet unless approved by the Engineer. These templates shall be secured at the locations shown on the plans, so that they are not

moved by depositing and compacting the concrete. Unless otherwise shown on the plans, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool of one-eighth (1/8) inch radius.

3200.3.7 Forms: These items shall be placed on a prepared sub-grade of uniform density. Forms shall be metal, sound, straight, free from warp, of sufficient strength to resist springing during construction, and of a height equal to the full depth of the item to be constructed. Wood forms shall have a minimum nominal thickness of two (2) inches except where flexible forms are used. Flexible forms will be required for all curved form lines, except that straight steel form sections ten (10) feet or less in length may be used for form lines having a radius greater than 200 feet. Straight steel form sections five (5) feet in length will be acceptable for form lines having a radius of not less than 100 feet. The forms shall be thoroughly cleaned, well oiled, securely staked, braced, and held to the required line and grade.

3200.3.8 Slip-forming: In lieu of the forming requirements specified in Section 3100, slip form methods may be used for placement of concrete curb, concrete gutter, sidewalk, curb and gutter, and paved ditch providing proper lines, grades and typical sections are maintained.

3200.3.9 Reinforcement: Required reinforcement and tie bars shall be held in the designated position during the placing of concrete by bar chairs or other approved devices. Joint shall be constructed at intervals and locations shown on the plans or as directed by the Engineer.

3200.3.10 Placement: Concrete shall be placed on the prepared and sprinkled subgrade, compacted and struck off to the required thickness. Concrete shall be vibrated sufficiently to eliminate all voids and to bring mortar to the top, after which the surface shall be finished smooth and even. All edges shall be rounded with an edging tool having a 1/4-inch radius. Faces of curb shall be rounded at the top and bottom, by means of an approved tool, to the radius shown. After finishing, concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane shall be used in lieu of pigmented membrane. After the concrete has set sufficiently, the forms shall be removed, and where necessary, the contractor shall backfill adjacent to the concrete with suitable material, compacted and finished in a satisfactory manner.

3200.3.11 Finishing: The curb shall be tooled to the required radii as soon as possible after the concrete takes its initial set. After the forms and templates are removed, the joints shall be tooled and the curb surface finished with a wood or cork float to remove all imperfections without additional mortar or dryer. In all cases the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The finished curb shall have a true surface, free from sage, twists, or warps,

and shall have a uniform appearance, and shall be true to the specified lines, grades, and configurations shown on the plans.

3200.3.12. Curing: Shall conform to the requirements of Section 3100.

3200.3.13 Protection: The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the City. Concrete which is not acceptable to the Engineer because of damage of defacement, shall be removed and replaced, or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

3200.3.14 Weather Limitations and Protection:

1. Weather Limitations. Unless otherwise authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending ambient air temperature away from artificial heat reaches 40 degrees F. and not resumed until an ascending ambient temperature away from artificial heat reaches 35 degrees F. If approval has been granted for the contractor to place the concrete while the ambient air temperature is at or lower than 40 degrees F., the contractor shall take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates, or applying heat directly to the contents of the mixer. Aggregates shall not be heated higher than 150 degrees F., and the temperature of the aggregates and mixing water combined shall not be higher than 100 degrees F., when the cement is added. Unless otherwise authorized, the temperature of the mixed concrete when heating is employed shall not be less than 50 degrees F. and not more than 80 degrees F. at the time of placement. Cement or fine aggregates containing lumps or crusts of hardened material or frost shall not be used. Concrete shall not be placed upon a frozen sub-grade except with written approval of the Engineer.
2. Protection. All concrete shall be effectively protected from freezing in accordance with Section 3100.4.36

3200.4 MEASUREMENT: Measurement will be made to determine the number of linear feet of each type of Portland cement concrete curb, or curb and gutter that are constructed in accordance with the specified Standard Drawings and the plans.

3200.5 PAYMENT: The cost of furnishing all labor, equipment, tools and materials, and the performance of all work necessary to construct curb, or curb and gutter, complete including all necessary incidental work done in grading and sub-grade preparation as specified herein shall be included in the lump sum bid price, or in the unit bid price per foot for items listed in the Proposal:

Curb	per linear foot

Curb and Gutter	per linear foot
Curb & Gutter, Fiber Reinforced	per linear foot

END OF SECTION

SECTION 3300 CONCRETE SIDEWALK

3300.1 SCOPE: This section governs the furnishing of all labor, equipment, tools, and material, and the performance of all work necessary to construct sidewalks and ADA ramps, complete, including all necessary incidental work done in accordance with the applicable requirements of the Sections entitled "Grading", and "Sub-Grade Preparation" respectively, at the locations shown on the plans, as provided for in the Special Provisions, and by authorized Change Orders.

3300.1.1 General: This section governs the design and the furnishing of all labor, equipment, tools, and material, and the performance of all work necessary to construct sidewalks and ADA ramps complete, including all necessary incidental work done in accordance with the applicable requirements of the Sections entitled "Grading", and "Sub-Grade Preparation" respectively, at the locations shown on the plans, as provided for in the Special Provisions, and by authorized Change Orders.

3300.1.2 Design. Sidewalks are required on at least one side of residential streets and both sides of collector and arterial streets (see Subdivision Regulations). The sidewalks shall be constructed on a minimum of two (2) inches of base rock. The thickness of the sidewalks shall be a minimum of four inches in residential areas and six inches in commercial areas. Sidewalks across residential drives shall be constructed with a six inch (6) thickness and an eight inch thickness across commercial drives. The additional thickness at driveways shall extend a minimum of 18 inches beyond the drive and curb tapers. All new sidewalks shall meet the requirements of the most current ADA Standards for Accessible Design and Public Right of Way Accessibility Guidelines and city standards. Variance from the requirements in this section shall require a written design exception.

3300.1.3 Location. The outside edge of sidewalk shall be placed a minimum of one foot inside the street right of way line.

3300.1.4 Width. Sidewalks shall be a minimum width of five feet when offset from the back of curb by a minimum of one foot and six feet when immediately adjacent to the back of curb.

3300.1.5 Sidewalk Cross-Section Grade. The minimum cross slope for sidewalks shall meet the requirements of the ADA standards. Driveway grade shall be adjusted to meet this maximum. Written design exceptions for a lesser width will be considered in some situations. Joint lines shall delineate the portion of the sidewalk that crosses the driveway, so it is clear where the sidewalk crosses the entrance.

3300.1.6 Longitudinal Grade. The longitudinal grade of the sidewalk shall not exceed the grade of the adjacent roadway within the right of way. For sidewalks and trails not built adjacent to a street the maximum grade is 5%.

3300.1.7 Drainage. Drainage from properties adjacent to the sidewalk shall not drain across the surface of the sidewalk nor shall the grade of the sidewalk be constructed that water would pond on the surface of the sidewalk.

3300.1.8 Obstructions. All obstructions shall be removed or relocated off of the sidewalk.

3300.1.9 Grade Breaks. Grade breaks shall not be permitted across curb ramps, landings or gutter areas within the pedestrian access route.

3300.2 MATERIALS, EQUIPMENT, AND DEFINITIONS: All items of material included in this section shall conform to the requirements of Section 3100 unless otherwise specified in the special provisions or shown on the plans.

3300.2.1 Aggregates: Coarse aggregate for use in wet bonded topping work shall consist of basalt, granite, trap rock, or other approved materials well graded within the limits for a nominal 3/8-inch size.

3300.2.2 Concrete Mix: Concrete for use in the construction of sidewalks shall conform to the requirements of Section 3100, "Mix Design". Mix design shall be a Class B1 Portland Cement Concrete with a compressive strength of 4000 psi or Pavement Mix. Comparable MoDOT mixes may be substituted with the permission of the Engineer.

3300.2.3 Fiber Mesh: Concrete for use in the construction of sidewalks if specified shall conform to the requirements of Section 3200.2.4, "Fiber Mesh Reinforcement".

3300.3 CONSTRUCTION DETAILS: The incidental work of clearing, grubbing, demolition, grading, and sub-grade preparation shall be carried on well in advance of the sidewalk construction as herein specified. The sidewalks have been constructed after the curb and gutter, if any, have been done or completed.

3300.3.1 Grading and Sub-Grade Preparation: All excavation required in the grading and sub-grade preparation shall be considered as "Unclassified Excavation" as defined in Sections entitled "Grading". All grading shall be done in conformance with Sections entitled "Grading" and "Sub-Grade Preparation" respectively.

3300.3.2 Forms: Forms shall be steel or wood, in good condition, and acceptable to the Engineer. All forms shall not have more than one-fourth (1/4) inch variation in

horizontal and vertical alignment for each ten (10) feet in length. The forms shall be set true to line and grade shall be adequately supported to stay in position while depositing and compacting the concrete. They shall be designed and constructed so as to permit their removal without damage to the concrete.

3300.3.3 ***Expansion Joints***: Expansion joints constructed at 50 feet intervals or as shown on the plans, shall be formed one-half (1/2) inches wide and shall extend the full depth of the slab between the sidewalk and all structures within the limits of the sidewalk or shown on the plans, shall be constructed by installing ½ thick bituminous material for the full depth of the concrete slab to within one quarter of an inch of the surface of the sidewalk slab. Edges of the slab shall be edged with an edging tool that has a ¼ inch radius. Expansion joints shall be placed between the sidewalk and all structures such as light standards, traffic light standards, traffic poles, and columns on each side of driveways and any other locations when against a substantial structure. All of the joint except the top one quarter inch below the surface shall be filled with the expansion material. The Contractor when applying sealer shall follow the manufacturer's instructions for applying the joint sealer. He/she shall use the equipment that is suitable for the purpose. The compounded sealer material shall be poured into the joint to the level of the adjacent concrete surfaces. Joints must be clean and dry before the sealer is poured.

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3300.3.4 C*ontraction Joints*: The sidewalk surface shall be marked off into square stones by contraction joints as shown on the plans. The joints shall be one-eighth (1/8) inches wide by depth of one quarter the thickness of the concrete, one (1) inch deep, and may be formed by use of a concrete saw. The maximum distance between contraction joints shall be six feet and a minimum of four feet unless otherwise approved by the Engineer.

3300.3.5 Curb Ramps. Curb ramps shall be installed at all intersections with streets, alleys, and mid-block pedestrian crossings in accordance with ADA Standards for Accessible Design and Public Right of Way Accessibility Guidelines. The running slope shall be 12:1 maximum except that the length of the curb ramp shall not exceed fifteen feet. The cross slope shall be two percent maximum. A minimum landing of five feet by five feet shall be provided at the top and bottom of the curb. Brick red truncated domes shall be placed at the end of all ramps to public streets and alleys.

3300.3.6 Truncated Domes. Truncated domes shall be placed prior to a public street or alley and shall have a diameter of 0.9 inches at the bottom, a diameter of 0.4 inches at the top, a height of 0.2 inches and a center to center spacing of 2.35 inches measured along diagonal of a square arrangement. There shall be a 70% contrast in light reflectance between the detectable warning and the adjoining surface. The color shall be brick red, homogenous and made of an integral part of the detectable warning surface.

3300.3.7 Concrete Work: Concrete shall be placed in accordance with the requirements of Section 3100.

3300.3.8 Joints: Joints shall be constructed at the locations shown on the plans. The premolded joint filler shall be supported so as to prevent its displacement while depositing concrete at the expansion joints. Pre-molded joint filler shall be

positioned in true alignment at right angles to the Line of the sidewalk and be normal to the surface of the concrete.

3300.3.9 ***Finishing***: After the concrete has been thoroughly consolidated and leveled, and the initial set has taken place, the surface shall be finished with a soft wood or cork float and either burlap or a broom finished with no other mortar than that contained in the concrete. The resulting surface shall be uniform in color with all imperfections removed. The edges shall be rounded with an edging tool having a radius as shown on the plans. Special care shall be taken to insure a straight, neat appearance along the edges of the sidewalk and at the joints. In general, finishing shall conform to the requirements of MCIF Bulletin No. "10" Finishing.

3300.3.10 ***Curing***: See Section 3100.

3300.3.11 ***Protection:*** The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the City. Concrete which is not acceptable to the Engineer because of damage or defacement, shall be removed and replaced, or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

3300.3.12 ***Weather Limitations and Protection***: See Section *3100.*

3300.13 MEASUREMENT: Measurement will be made to determine the number of square feet yards of Portland cement concrete sidewalk placed and accepted, for the purpose of making payments.

3300.14 PAYMENT: The cost of furnishing all labor, equipment, tools, and materials, and the performance of all work necessary to construct sidewalk, complete, including all incidental work necessary in grading and sub-grade preparation at the locations specified herein, shall be included in the lump sum bid price, or in the unit bid price per square foot yard, listed in the Proposal as:

Sidewalk Construction	Per Square yard

END OF SECTION

SECTION 3400 DRIVEWAYS

3400.1 General: Driveway approaches are located to serve the operation of automobiles and other vehicles from the street pavement to the garage, parking area, building entrance, structure, or other approved use located on the property.

3400.2 Residential Design: Residential driveway approaches shall be constructed using Class B1 Portland Cement Concrete with a minimum 28-day compressive strength of 4000-psi in accordance with Section 3100. All driveway pavement

shall be constructed on a minimum of 4" inches of base rock. When a driveway approach intersects an existing 4-inch thick sidewalk, the area of the sidewalk within the driveway are including both sides of the sidewalk transition sections to Sidewalk Construction Per Square Yard meet the drive elevation or 18 inches, whichever is greater, shall be removed and reconstructed with 6 inch thick concrete. The cross slope of the sidewalk area shall not to exceed 1:50 (2%). The grade of the driveway approach from the gutter line shall rise on a constant grade to the front edge (side street0 of the sidewalk area. The algebraic difference of longitudinal grade changes of the driveway approach shall not exceed 13% . The maximum grade for a driveway shall be 15%. The width of residential driveway approaches shall not exceed 36 feet without permission from the City Traffic Engineer and shall not be less than 11 feet for new construction. The Width of a driveway is measured at the Right-of-Way line.

3400.3 Commercial Design: Commercial/non-residential driveway approaches shall be constructed 8 inches thick using Class B1 Portland Cement Concrete with a minimum 28 day compressive strength of 4,000-psi in accordance with Section 3100. All driveway pavement shall be constructed on a minimum of four inches of base rock. When a driveway approach intersects an existing 4 inch sidewalk, the area of the sidewalk within the driveway area, including both sides of the sidewalk transition sections to meet the drive elevation or a minimum of 18 inches shall be removed and reconstructed with 8-inch concrete. The cross slope of the sidewalk section is not to exceed 1:50 (2%). The grade of the driveway approach from the gutter line shall rise on a constant grade to the front edge (side street) of the sidewalk area. The algebraic difference of longitudinal grade changes of the driveway approach shall not exceed 13%. The maximum grade of the drive shall be 15%. The width of commercial driveway approaches shall not exceed 35 feet. Provided, however driveway widths shall be between 30 feet and 55 feet for those driveways exiting and entering upon arterial and collector streets. The specific width shall be established by the City Engineer based upon traffic volume and the proposed sign design. One-Way driveways shall be a minimum of 12 feet and a maximum of 22 feet wide. The width of driveways is measured along the Right-of-Way line

3400.4 Approach Location: Driveway spacing is restricted by the city Subdivision Regulations and the City Code. Zoning cases, planned developments and subdivisions are subject to the access restrictions as set forth in the city Subdivision Regulations and city Code.

3400.4.1 No driveway approach shall be permitted which will interfere with any existing parking meters, signs, traffic control devices, planting, cables, poles, guys, water mains, gas mains, or other public utilities.

3400.4.2 No part of any driveway approach shall be located within 4 feet of a drop inlet or other drainage structure of pedestrian ramp.

3400.4.3 Shared Driveways. Shared driveway approaches shall be permitted only if there is a perpetual mutual access agreement approved by the City Attorney and filed of record in the Jasper County Recorder's Office.

3400.4.5 Edges of the driveway approach may be skewed so that the angle between the street right-of-way line and the edge of the driveway approach is not less than 60 degrees.

3400.4.6 Radius of the driveway approach shall not, in any case, extend beyond the projection of the adjacent property line, extended perpendicularly to the right-of way line.

3400.4.7 Radius. The radius of a driveway return shall not extend beyond the right-of way line or 15 feet, whichever is smaller.

3400.5 Expansion Joints. The plans shall show bituminous ½ inch thick performed expansion joints to be placed at the right-of-way and sidewalk connections and connections at the curb and gutter radius.

3400.6 Existing Curb and Gutter. The plans shall show the existing curb and gutter section in front of a driveway (radius point to radius point) shall be saw cut full depth and removed before the driveway is constructed. The entire curb and gutter section would then be reconstructed the same concrete and depth as the driveway approach.

3400.7 Concrete shall be placed in accordance with the provisions of Section 3100.

3400.8 MEASUREMENT: Measurement will be made to determine the number of square yards of Portland cement concrete driveway placed and accepted, for the purpose of making payments.

3400.9 PAYMENT: The cost of furnishing all labor, equipment, tools, and materials, and the performance of all work necessary to construct driveway, complete, including all incidental work necessary in grading and sub-grade preparation at the locations specified herein, shall be included in the lump sum bid price, or in the unit bid price per square yard, listed in the Proposal as:

Driveway Construction	Per Square Yard

END OF SECTION

DIVISION 4000

SEWER

SECTION 4100 - SANITARY SEWER MAIN

4100.1 SCOPE: This section covers the requirements for all labor, equipment and materials for the installation of sanitary sewers. Trenching guidelines are provided in a separate section.

4100.2 MATERIALS, DEFINITIONS AND EQUIPMENT

4100.2.1 ***Pipe Material & Size:*** All pipe materials utilized in sanitary sewers shall be corrosion-resistant, such as PVC, Polypropylene or lined Ductile Iron. Other materials may be approved on a case-by-case basis by the Director of Public Works. The minimum diameter of pipe that will be used in sanitary sewer main lines is 8 inches. Lined RCP pipe may be allowed for diameters greater than 36 inches.

4100.2.2 ***Polyvinyl Chloride Pipe*** **(*PVC Pipe*)**:

1. Lateral Pipes and Appurtenances –

PVC pipes in laterals shall conform to ASTM D2665, Schedule 40, and shall be four (4) inches in diameter for all residential and six (6) inches for all commercial, unless otherwise specified by the Engineer. Saddles for lateral tap connections shall be made of PVC and conform to ASTM D3034. They shall have skirts that extend down to half the diameter of the mainline pipe onto which they will be connected. Saddles shall be tightened onto the main using two stainless steel straps that extend around the entire circumference of the pipe. No lateral connections shall be made with the Inserta Tee product because it obstructs maintenance equipment. Prefabricated tees or wyes shall be made of PVC and conform to these specifications.

2. Mainline Pipes –

PVC pipes in laterals shall conform to ASTM D2665, Schedule 40. No lateral connections shall be made with the Inserta Tee product because it obstructs maintenance equipment. PVC pipes and fittings from 8-inch to 15-inch in diameter shall conform to ASTM D3034. PVC pipes larger than 15-inch diameter shall conform to ASTM F-679. Wall thickness for 8-inch and 10-inch diameter pipe shall conform to SDR 35 for invert flow line depths of less than 10 feet. Wall thickness for 8-inch and 10-inch pipes shall conform to SDR 35 if the depth to the invert flow line along the entire run between manholes is less than 10 feet. For greater depths, wall thickness shall conform to SDR 26. Wall thicknesses shall not vary from manhole to manhole regardless of depth. Wall thickness for pipe larger than 15 inches shall be specified by an engineer and approved by the Public Works Director on a case-by-case basis. Joints shall conform to ASTM 3212, and bell end shall be grooved to receive gasket.

4100.2.3 ***Ductile Iron Pipe (DIP):*** DIP pipe and fittings for gravity systems shall conform to ASTM A746. The minimum thickness for all sizes of DIP gravity sewer pipe shall be pressure class 350. Push-on joints shall be provided, conforming to AWWA C111 for all buried pipe unless otherwise specified or indicated. Fittings shall conform to AWWA C110 and be ductile iron. Pipe shall be furnished with factory applied 40 mil thickness polyethylene lining, or approved equal. Lining material shall be virgin polyethylene complying with ASTM D1248, compounded with sufficient carbon black to resist ultraviolet rays during above ground storage of the pipe. Where indicated on the drawings or Special Conditions, DIP pipe shall be encased in 8-mil polyethylene tubes or sheets.

4100.2.4 ***Polyvinyl Chloride Pressure Pipe (PVC) for Pressure Sewer*** : PVC pipe and fittings for force mains shall conform to AWWA C900 or AWWA C905 and shall be designed to have internal pressure plus allowance for surge pressure equal to 250 percent of the operating pressure listed in the Special Provisions, but not less than 200 psi. Gaskets shall conform to ASTM F477 and be synthetic rubber. PVC pressure pipe shall have Cast-Iron Pipe Equivalent (CI) outside diameters. Pipe joints shall be integral bell type pipe ends designed for joint assembly using elastomeric gaskets. Fittings shall be ductile iron and conform to AWWA C110 or AWWA C153 and be either mechanical joint or push-on type joint.

4100.2.5 ***Ductile-Iron Pressure Pipe (DIP) for Pressure Sewer*** : DIP pipe and fittings for force main shall conform to ANSI A21.50 and ANSI A21.10. Joints may be mechanical or push-on type. Pipe shall have cement lining conforming to ANSI A21.4 or polyethylene lining as specified in 2.01.C. Where indicated on the drawings or Special Provisions, DIP pipe shall be encased in 8-mil polyethylene tube or sheet. DIP pipe and fittings within one (1) laying length of force main air release or air and vacuum relief valves shall be polyethylene lined.

4100.2.6 ***Polypropylene Pipe (PP):*** PP pipe and fittings from 12-inch through 30-inch shall be of a dual wall configuration and shall meet ASTM F2764. Pipe and fittings from 30-inch through 60-inch shall be of a triple wall configuration and shall meet ASTM F2764. Pipe shall be joined using a bell and spigot joint meeting the requirements of ASTM F2764. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. 12-inch through 60-inch diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.

4100.2.7 ***Bedding Material:*** Material for bedding shall be compacted limestone base meeting the gradation requirements of ASTM C-33, latest revision, gradation 67, as follows:

Sieve Size	Percent Passing
1”	100
3/4”	85-100
3/8”	15-55
#4	0-10

4100.2.8 ***Pipe Locating Materials:*** Materials used for locating pipes are placed either above- or below-ground, depending on the application.

a. Below-ground materials shall conform to the requirements found in the City’s standard tracer wire and protective enclosure details.

b. Above-ground witness posts shall be manufactured for 360-degree readability, UV stable, weather and impact resistant. The witness posts shall be at least 72” in length, with the at least 24” imbedded in the ground, anchored per manufacturer’s instructions. Acceptable products include the Rhino Tri-view (triangular shaped), or approved equal. Posts shall be marked “CAUTION SEWER PIPELINE” and colored green.

4100.3 CONSTRUCTION DETAILS:

4100.3.1 ***Bypass Pumping*:** Except for reaches specifically listed in the Special Conditions as not requiring bypass pumping, contractor shall provide bypass pumping for sewage flows as follows:

1. The line segments scheduled for cured-in-place sectional or spot repairs, replacement by pipe bursting or pipe reaming, or containing manholes to be lined, shall have all flows bypassed around them. The pumping system shall be sized for normal to peak flow conditions. Contractor shall maintain an operational backup pump on site where required in the Special Conditions. Direct discharge of flow to surrounding area drainage is unacceptable. Do not attempt flow diversion on combined sewers or storm sewers if rainfall is anticipated before completion of the installation can be completed.

2. The upstream manhole shall be monitored at all times, and an emergency deflate system shall be incorporated so that plugs may be removed at any time without requiring confined space entry. A plug shall be used to stop the sewage from reaching the line segment or manhole being lined or replaced. Remove plug at end of each working day and place relined, replaced and existing sections and temporary or permanent service tie-ins back in service.

4100.3.2 ***Pipe Bedding:*** The sub-grade shall be excavated so as to provide space for at least four (4) inches of bedding material between the sub-grade and the pipe if the sub-grade material is earth, and six (6) inches of bedding material between the sub-grade and the pipe if the sub-grade material is rock. Bedding material shall be placed in the trench and carefully graded and tamped to the proper elevation so that the pipe, when placed, shall conform to the specified line and grade.

4100.3.3 ***Grade and Alignment:*** The Engineer will provide the Contractor with line and grade information. It shall be the Contractor's responsibility to furnish all required labor and equipment needed to install the sewer according to the plans. Any apparent inaccuracy in grade stakes shall be called to the Engineer's attention immediately upon discovery. The Contractor will be held responsible for the correct flow of sewers.

1. Initial Construction Staking: The Contractor shall furnish and set all stakes for the lines and grades as shown on the drawings. All staking shall be done using hub and tack unless deemed impractical by the Engineer. All structures shall be staked with a minimum of two offsets. All pipe shall be staked on 25 feet stations for the first 100 feet in the upstream direction, and on 100 feet stations thereafter.

2. Installing Pipe to Grade: The Contractor shall furnish and set up for underground construction all equipment required to ensure that each pipe segment is installed to grade and alignment. Three (3) batter boards, a top line and grade pole or pipe laser beam shall be used for this purpose unless some other method of checking the inner lower grade and line is approved by the Engineer in writing. The Contractor must check the grade of the top line and sewer. The Contractor shall provide and maintain on site at all times a laser beam or a gauge rod of sufficient length to reach from the

invert of the sewer pipe being laid to the top line strung on the three batter boards. The gauge rod shall be graduated and numbered each foot of its entire length. The gauge rod shall be equipped with either a plumb line or two spirit levels and the utmost care used to insure a truly vertical gauge rod at the time the reading is taken and pipe being set. In the event a laser beam is used to set line and grade for the pipe laying operation, the laser must be checked at the beginning of each day and at least once between manholes and at any other time the Engineer deems it necessary to ensure the proper line and grade of the pipe.

4100.3.4 ***Pipe Laying:*** Each pipe shall be laid on an even, firm bed, so that no uneven strain to prevent the pipes bearing on the sockets. Bell holes for bell and spigot pipe shall be dug at each point as hereinbefore specified. Each pipe shall be laid in conformity with the line and grade stakes given by the Engineer. Pipe laying shall commence at the manhole connection at the low point of the project and progress up-grade, unless otherwise expressly permitted by the Engineer. The bell-end of the pipe shall be laid up-grade. The alignment of all pipe lines between adjacent manholes shall be true to line and grade; the pipe line from manhole to manhole shall reflect the full bore of the pipe. The pipe shall be truly centered into the abutting pipe. Pipe laid in the ditch shall not be covered until approved by the inspector.

4100.3.5 ***Slope Anchors:***

1. Slope anchors shall be provided on all sewers with slopes of 20% or greater at the spacing denoted below. Slope anchors may also be required where velocity exceeds 15 feet per second.

2. Slope Anchor Spacing

Slope (%)	***Maximum Spacing (L.F.)***
20 to 35	36
36 to 50	24
Over 50	16

3. Concrete slope anchors shall be constructed in accordance with ASTM F1668 Standard Guide for Construction Procedures for Buried Plastic Pipe. These shall be located at pipe bells and shall be formed and poured as an anchor block with steel tie down bars. The bearing surfaces of the collar or anchor block shall be against undisturbed earth. The concrete used for slope anchors shall a Type B in accordance with Joplin City Standards.

4100.3.6 ***Pipe Laying (Force Mains):*** Pressure sewers (force mains) shall be installed to the slopes and depths shown on the drawings. If a detailed profile is not shown, main shall be installed to a continuous slope to prevent possible air entrapment at high spots of the line. Minimum depth of cover shall be 42 inches. Approved air relief valves shall be installed at all locations shown on the drawings. For materials other than ductile-iron pipe, the main shall be "snaked"

in the trench to accommodate minor expansion and contraction, but in no case shall the minimum side clearance be less than specified. Thrust blocks shall be installed at pipe deflections, bends, tees, and plugs and shall be adequate to resist both operating and testing forces or as shown on the drawings. Thrust blocks shall be complete and cured before pressure testing. Damage caused by failure to provide adequate thrust supports shall be corrected at no additional cost to the City of Joplin. Force mains shall be marked with warning tape placed from one to two feet above pipeline.

Tracer wire shall be installed along the entire length of the force main, and brought up to ground elevation at witness posts to facilitate the connection of locating equipment to the tracer wire from the force main. Witness posts shall be installed at all at horizontal changes in the alignment of the force main. Witness posts shall not be spaced more than 200 feet apart, and shall be installed on both sides of all creek crossings, RR crossings, street intersections, etc.

The manhole or structure which receives discharges from a public pressure main, along with the next two structures downstream, shall receive a treatment of anti-corrosive lining prior to initiating flows from a lift station.

4100.3.7 ***Sewer Laterals on District Sewers:*** On District Sewers one (1) tee or wye branch for lateral sewer, or house connection shall be furnished and laid to every lot, except where ***they may*** be required at distances greater or less, as the Engineer may direct. Lateral sewer piping shall be four (4) inches in diameter for all residential and six (6) inches for all commercial and constructed with PVC pipe unless otherwise specified by the Engineer and shall be capped with PVC fitting or other methods approved by the Engineer. The exact location of all tee or wye branches and other special pieces shall be carefully ascertained by a licensed surveyor or a permanent monument approved by the engineer may be installed and the approximate location supplied on the as built drawings. ***If the sewer is being laid within the street right-of-way all laterals shall extend to the right-of-way line or 2 feet behind the curb & gutter, whichever is greater.***

Taps onto an existing sewer main shall be made by means of coring a hole in the presence of the engineer. (Hammering or other breaking method is strictly prohibited.) Saddles for lateral tap connections shall be tightly fixed onto the main to prevent intrusions by water, roots, soil, gravel, etc.

Tracer wire on laterals placed within easements or public rights-of-way shall be installed in conformance to City standard details, including its terminal cleanout located within a protective enclosure.

Privately owned and operated pressure lines shall not connect to a public manhole or structure but shall connect directly onto the sewer main. Such connection points shall be reinforced with thrust blocks to prevent damage to the sewer main from discharges from the private force main.

4100.3.8 ***Joints*:** The interior of the sewer shall, as the work progresses, be cleared of all dirt, jointing material and superfluous materials of every description. On small pipe sewers

where cleaning after laying may be difficult, a swab or drag shall be kept inside the pipe line and pulled forward past each joint immediately after its completion. Joints for RCP with flexible rubber gaskets shall be made in accordance with manufacturer's recommendations. Bell and spigot, or tongue and groove ends of the pipe shall first be wiped clean before actual jointing operations are started.
Immediately prior to jointing, all surfaces of the joint shall be thoroughly cleaned and lubricated with soapy water or in accordance with manufacturer's recommendations. The tongue end shall be centered on grade into the groove end of the last downstream length of pipe and shoved home and properly seated with the application of steady pressure by a lever, wench or other suitable device. Care must be used to prevent displacement of the gasket during jointing.

Mechanical joints for ductile iron pipe shall be carefully made to assure that the spigot be centrally located in the bell. The surfaces coming in contact with the rubber gasket shall be thoroughly cleaned with a wire brush just prior to assembly to remove all loose rust or foreign material and the gasket brought toward the flange evenly by partially tightening the bottom and top bolts, then the side bolts, and last, the remaining bolts. The cycle should be repeated until all bolts are properly tightened. If effective sealing is not attained, the joint should be disassembled, thoroughly cleaned and re-assembled. Overstressing of bolts to compensate for improper installation shall be avoided.

4100.3.9 ***Pavement Repair****:* In general, this work shall conform to the requirements of section **1700.3.12** of the City's standard specifications.

4100.3.10 ***Gravity Pipe Tightness Testing*****:** To verify water tightness and to prove the integrity of the installed pipe, sewer main piping shall be subjected to low-pressure air testing. Low-pressure air testing shall be conducted and evaluated in accordance with ASTM F1417-11A - Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air or subsequent more current versions. The following is a condensed description of Time-Pressure Drop Method; by giving this condensed version, the City of Joplin does not waive any requirements of the full test method. Air testing shall be conducted one reach at a time, after all connections and service laterals have been plugged and adequately braced. Reach shall be sealed and pressurized to 4.0 psig. Pressure shall be maintained between 3.5 and 4.0 psig for minimum of 2 minutes to permit temperature equalization. Once temperature is equalized, decrease pressure to 3.5 psi for the start of the test. Disconnect the air supply and measure the time required for the pressure to drop to 2.5 psig. Pipe reaches of a given diameter will pass the air test if the time for the pressure drop is longer than the greater of the two corresponding values shown in the following table:

Nominal Pipe Diameter, D (inches)	Minimum Time (Min:Sec)	Time (Seconds) for Length, L (feet)
8	7:34	T = 1.520 x L
10	9:26	T = 2.372 x L
12	11:20	T = 3.420 x L
15	14:10	T = 5.340 x L
18	17:00	T = 7.692 x L

Nominal Pipe Diameter, D (inches)	Minimum Time (Min:Sec)	Time (Seconds) for Length, L (feet)
21	19:50	T = 10.470 x L
24	22:40	T = 13.673 x L
27	25:30	T = 17.307 x L
30	28:20	T = 21.367 x L

For pipe diameters greater than shown in the table above, consult ASTM F1417, Table 1, latest revision.

4100.3.11 ***Pressure Pipe Tightness Testing:*** Hydrostatic testing of force mains shall conform to AWWA C600 procedures as modified herein. Test shall be performed after backfill is complete. Contractor shall provide and install test plugs. Pressure test shall be conducted at 2.0 times the maximum operating pressure. Leakage test shall be conducted at the maximum operating pressure.

4100.3.12 ***Gravity Pipe Deflection Testing:*** Deflection testing shall be performed a minimum of thirty days after installation of final backfill on all flexible pipe such as PVC. The deflection test shall consist of hand-pulling a rigid ball or mandrel through the installed pipe in the presence of the Engineer. The rigid ball or mandrel shall have a diameter equal to 95 percent of the inside diameter of the pipe. If the rigid ball or mandrel fails to pull through the pipe, the section being tested fails the test and will be replaced.

4100.4 MEASUREMENT: Measurement will be made to determine the number of linear feet placed and accepted, for the purpose of making payments.

4100.5 PAYMENT: The cost of furnishing all labor, equipment, tools, and materials, and the performance of all work necessary to construct sanitary sewer pipe, testing, including all incidental work necessary at the locations specified herein, shall be included in the linear foot price listed in the Proposal as:

Sanitary Sewer Pipe	Per Linear Feet

END OF SECTION

4200 – STORM SEWER PIPE

4200.1 SCOPE: This section covers the requirements for all labor, equipment and materials for the installation of storm sewers pipes. Trenching guidelines are provided in a separate section.

4200.2 <u>MATERIALS, DEFINITIONS AND EQUIPMENT</u>:

4200.2.1 ***Reinforced Concrete Pipe (RCP):*** All RCP shall be in accordance with MODOT Section 724 and Section 726. End sections shall be flared and shall meet the concrete material, steel area, and workmanship requirements for Class III or A-III pipe or HE-111 to include horizontal elliptical RCP. Fittings shall be manufactured from green precast stock, carefully mitered, and shall have reinforcing cages welded together at the joint. Joints shall not have gaps larger than 1/3 the bell depth. RCP is allowed within all public right-of-way.

4200.2.2 ***Reinforced Concrete Boxes (RCB):*** Reinforced concrete box sections shall conform to MoDOT Section 733. Design tables shall be appropriate for the loading conditions. Designs not taken from the design tables shall be sealed by a registered professional engineer. Joints shall not have gaps larger than 1/3 the bell depth.

4200.2.3 ***Corrugated Metal Pipe (CMP) Aluminized:*** All CMP shall be in accordance with MODOT Section 724 and Section 725. Fittings shall be fabricated from the same material as the pipe. The pipe shall have a minimum cover of one foot with earth or crushed rock in addition to the required bedding. End Sections shall be reinforced concrete flared end sections meeting the requirements listed in this Section for RCP fittings. Connections between flexible and rigid pipe shall be Type B collars in the Missouri Standard Specifications. CMP shall not be allowed within public right-of-way.

4200.2.4 ***Corrugated High Density Polyethylene Pipe (HDPE):*** All HDPE shall be in accordance with MODOT Section 724, Section 730 and Section 1047. Manufacturers furnishing pipe to City of Joplin projects shall be included on MODOT's approved list. Joint coupling bands shall be of the same material as the pipe and shall, when fastened in place, provide the joint with the same or greater structural properties as the remainder of the pipe. The pipe shall have a minimum cover of one foot with earth or crushed rock in addition to the required bedding. End Sections shall be reinforced concrete flared end sections meeting the requirements listed in this Section for RCP fittings. Connections between flexible and rigid pipe shall be Type B collars in the Missouri Standard Specifications. HDPE shall not be allowed within public right-of-way.

4200.2.5 ***Polypropylene Culvert Pipe (PP):*** All PP pipe shall be in accordance with MODOT Section 724 and Section 730. Manufacturers furnishing pipe to City of Joplin projects shall be included on MODOT's approved list. Joint coupling bands shall be of the same material as the pipe and shall, when fastened in place, provide the joint with the same or greater structural properties as the remainder of the pipe. The pipe shall have a minimum cover of one foot with earth or crushed rock in addition to the required bedding. End Sections shall be reinforced concrete flared end sections meeting the requirements listed in this Section for RCP fittings. Connections between flexible and rigid pipe shall be Type B collars in the Missouri Standard Specifications. Polypropylene pipe is allowed within all public right-of-way in accordance with these specifications.

4200.2.6 ***Bedding Material*:**

4200.2.6.1 Rigid Pipe (RCP) material for bedding shall be limestone base having the gradation as follows:

Sieve Size	Percent Passing
1”	100
¾”	85-100
3/8”	15-55
#4	0-10

4200.2.6.2 Flexible Pipe (CMP, HDPE, PP) material for bedding and pipe zone backfill material shall be crushed angular and meet the following:

Sieve Size	Percent Passing
1.5”	100
½”	≤25
#4	≤15
#200	<12

4200.2.7 ***Temporary Plugs*:** Temporary plugs shall be a model recommended by pipe manufacturer and watertight to a static head of 25 feet in accordance with Section 724.3 of the Missouri Standard Specifications.

4200.3 CONSTRUCTION DETAILS

4200.3.1 ***Pipe Bedding:*** The sub-grade shall be excavated so as to provide space for at least four (4) inches of bedding material between the sub-grade and the pipe if the subgrade material is earth, and six (6) inches of bedding material between the subgrade and the pipe if the sub-grade material is rock. Bedding material shall be placed in the trench and carefully graded and tamped to the proper elevation so that the pipe, when placed, shall conform to the specified line and grade.

4200.3.2 ***Grade and Alignment:*** 1. All structures shall have a minimum of 2 offsets.
2. Pipe shall be staked on 50’ stations.
3. All staking shall be done using hub and tack unless deemed impractical by the Engineer.
4. The Engineer will provide the Contractor with line and grade information. It shall be the Contractor’s responsibility to install the sewer according to plans. Three (3) batter boards, a top line and grade pole or pipe laser shall be used for this purpose unless some other method of checking the inner lower grade and line is approved by the Engineer in writing. The Contractor must test the ditch or grade of the top line and sewer, and will be held responsible for the correct flow of storm sewers. Any apparent inaccuracy in grade stakes shall be called to the Engineer’s attention immediately upon discovery. The Contractor shall provide and maintain on the work at all times a pipe laser or a gauge rod of sufficient length to reach from the invert of the sewer pipe being laid to the top line strung on the three batter boards. The gauge rod shall be graduated and numbered each foot of its entire length. The gauge rod shall be equipped with either a plumb line or two spirit levels and the utmost care used to insure a truly vertical gauge rod at the time the reading is taken and pipe being set. In the event a pipe laser is used to set line and grade for the pipe laying operation, the laser must be checked at the beginning of each day and at least once

between structures and at any other time the Engineer deems it necessary to insure the proper line and grade of the pipe.

4200.3.3 ***Pipe Laying (Rigid Pipe):*** Installation of pipe shall proceed from the downstream end of the project with bell ends facing upstream. Alignment and grade shall be uniform between manholes, and a positive system of grade control shall be used for maintaining alignment. All pipe shall be handled carefully to avoid damage. Damaged pipe shall be repaired or replaced at the contractor's expense to the satisfaction of the engineer. Due to difficulty of compacting beneath wide pipes, loose bedding material shall be shaped to receive the full length of the pipe except where required to mate joints. The ends of the installed pipe shall be plugged whenever the work is not in progress. Joint installation shall follow the manufacturer's recommendation.

4200.3.4 ***Pipe Laying (Flexible Pipe):*** All pipe shall be handled carefully to avoid damage. Damaged pipe shall be repaired or replaced at the contractor's expense to the satisfaction of the engineer. Pipe shall be laid as shown on the plans, with bell ends upstream and with the spigot end entered the full length into the adjacent section of pipe. Any pipe that is not in true alignment or that shows any undue settlement after laying shall be taken up and re-laid at the contractor's expense. Camber shall be built into the pipe structure to allow for settlement from fill loads if shown on the plans or directed by the engineer.

4200.3.5 ***Post-installation testing/inspection***: To verify alignment and workmanship, installed pipe shall be inspected in accordance with MODOT Section 724. A general summary of inspection frequency is as follows:

Under pavement	100%
Storm sewer parallel to roadway	25%
Outside of pavement/roadway	At the discretion of the engineer

Item	Rigid	Flexible
Video Inspection	X	X
Cracks[1]	X	X
Joint Gap	X	X
Defects[2]	X	X
Deflection		X

1. RCP cracks over 0.01" to be documented. Required for remote or manual inspection.

Examples: Slabbing, damaged coating, racking, dents, protrusions, misalignment and excessive corrugating

4200.4 **MEASUREMENT**: Measurement will be made to determine the number of linear feet of storm sewer placed and accepted, for the purpose of making payments.

4200.5 Basis of Payment.

4200.5.1 The cost of furnishing all labor, equipment, tools, materials and the performance of all work necessary to construct storm sewer pipe, testing, all incidental work, and accepted quantities of pipe, complete in place, including all necessary tees, bends, wyes, coupling bands, cutting and joining new pipe to

existing pipe or structures, unless otherwise specified, will be paid for at the contract unit price per linear foot for each of the pay items included in the contract as:

Storm Sewer Pipe	Per L.F.

4200.5.2 Unless specified otherwise, no direct payment will be made for the following:

(a) Beveling, skewing or additional work required in laying pipe with beveled or skewed ends.
(b) Work involved in elongating pipe.
(c) Any required backfilling, except as specified in Sec 206.6.3 of the Missouri Standard Specifications.
(d) Construction of bedding or for bedding material.
(e) Furnishing and installing plugs.
(f) Material or work required for placing couplings on exposed ends of pipe.

4200.5.3 Payment for removal of unsuitable material and for backfilling will be made in accordance with Sec 206.6.3 of the Missouri Standard Specifications, unless the unsuitable material is a result of the contractor's operations, in which case the removal and backfilling shall be at the contractor's expense.

END OF SECTION

SECTION 4300 - CONCRETE MANHOLES

4300.1 SCOPE: The work shall consist of furnishing all materials, equipment and labor necessary for the construction of manholes and appurtenances at the location and in accordance with the details on the plans and as specified herein. Items not specifically mentioned, but necessary for completion of the work shall be performed.

4300.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

4300.2.1 ***Precast Concrete Manholes*:** Precast manhole risers, cones, and grade rings shall conform to ASTM C478. Precast grade rings shall be used for cast-in-place manholes. Minimum manhole diameter shall be 4 feet.

4300.2.2 ***Wall Thicknesses:*** Wall thickness shall conform to the following table:

	Wall Thickness, inches			
Manhole diameter	Precast Manhole		Cast-In-Place Manhole	
	depth 16' or less	depth greater than 16'	depth 12' or less	depth greater than 12'
4 ft	4	5	6	8
5 ft	5	6	6	8
6 ft	6	7	6	8

4300.2.3 ***Manhole Diameters*:** If not specified by the engineer in the proposal, Manhole diameters shall conform to the following table based upon the maximum diameter of pipe to be connected.

Pipe Diameter	***Inside diameter of Manhole (feet)***
8" to 18"	Four (4)
18" to 42"	Five (5)
48" to 54"	Six (6)
54" to 66"	Eight (8)
Greater than 66"	Special Junction Structure

4300.2.4 ***Eccentric Cones***: Concentric cones shall be used unless otherwise shown on drawings or Special Provisions.

4300.2.5 ***Flat Top Slabs:*** Flat slab tops may be used only on manholes ~~six feet or less in depth~~ with prior approval from City Engineer. Flat slab top shall be precast and designed to resist HS-20 loading with one-foot cover.

4300.2.6 ***External Dampproofing:*** External dampproofing shall be asphalt ASTM D449, Type A and shall be applied to all sanitary sewer manholes.

4300.2.7 ***Joint Sealing and Waterproofing*****:** Joint sealant for precast sections and castings shall be preformed, flexible, butyl rubber joint sealant, conforming to ASTM C990. Waterstops for pipe joints shall be 3/8-inch synthetic rubber O-rings or clamping type shoe. External joint waterproofing shall be a composite sheet material consisting of a butyl compound and an elasto-polymer backing sheet with a composite thickness of 80 mils and a minimum width of 6 inches.

4300.2.8 ***Ring and Covers*****:** Covers and rings shall be Neenah R-1668 or equivalent. Refer to standard drawing.

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4300.2.9 ***Manhole Steps:*** Manholes shall not be equipped with steps without Engineer's approval.

4300.2.10 ***Concrete Adjustment Rings:*** Concrete adjustment rings shall not exceed 12" total in height.

4300.3 CONSTRUCTION DETAILS

4300.3.1 ***Pipe Connections:*** Connecting pipes shall be encircled with a waterstop, and the wall opening filled with non-shrink grout. Pipe stubs shall be made with a bell end of pipe abutting the outside wall. Stub shall be stopped with watertight removable stopper.

4300.3.2 ***Manhole Bases:*** Bases shall be integral with cast-in-place section or shall be cast in place; unattached precast base shall not be used. See Standard Detail for dimensions of base.

4300.3.3 ***Inverts*****:** Invert channels shall be formed to a "U" shape, matching the lower half of the pipe cross section and extending to 3/4 height of the pipe. Channels connecting pipes of different sizes shall transition smoothly over the length of the manhole. When the pipes come in at differing angles, the channel shall be formed with as large of radius as possible. Channels shall be provided for all pipes including stub lines. Benches shall slope to the channel at 1:12 slope.

4300.3.4 ***Waterproofing and Sealing***: no more than Two grade rings shall be installed at each manhole. Thickness of rings shall be as required to adjust to grade as described below. If more than 12 inches of grade rings would be required, the manhole shall be reconstructed by either replacing the cone or barrels, as needed. Grade shall be matched within 1/2-inch. In paved areas the top of the cover shall match the elevation and slope of the finished pavement. In lawn areas, top of cover shall be level and 1/2-inch above adjacent lawn. In unimproved areas and drainage ways, the top shall be at the plan elevation or as directed by Engineer.

4300.3.5 ***Manhole Testing*:** Manholes may be subjected to visual inspection, and sanitary sewer manholes shall be subjected to hydrostatic testing or vacuum testing. Vacuum testing will be conducted only on newly constructed manholes. Manholes failing acceptance tests shall be repaired or rebuilt and retested

A. Hydrostatic test shall be conducted after a manhole has been in place for 28 days. Manholes shall be filled to the top or to 25 feet, whichever is less. Manhole shall be prefilled 12 hours in advance of testing. Test shall consist of filling the manhole, and measuring replacement water at the end of one hour. Exfiltration rate shall be less than 0.05 gallon per hour per vertical foot of manhole.

B. Vacuum testing shall use an Air-Loc Vacuum Manhole tester or approved equal. The time for the vacuum to drop from 10 inches Hg to 9 inches Hg shall be not less than the following:

Manhole Diameter	Time
4 feet	60 Seconds
5 feet	75 Seconds
6 feet	90 Seconds

C. Visual inspection shall evaluate the completeness of the manhole and the alignment of the invert channel.

4300.4 MEASUREMENT: Measurement will be made to determine the number of manholes installed. Measurement will also be made to determine the depth of the manholes. If specified on in the bid documents manhole extra depth shall be measured as additional depth from a point 6 feet below rim elevation to a point at the invert of the manhole.

4300.5 PAYMENT: The cost of furnishing all labor, equipment, tools, and materials, and the performance of all work necessary to construct concrete manholes, complete, including all incidental work necessary for connection to existing and proposed pipes shall be paid for at the unit price of each and manhole extra depth shall be paid at the unit of Vertical Feet:

Manhole, complete	Each
Manhole, Extra Depth	V.F.

END OF SECTION

STORM SEWER PIPE
SECTION 4400 - Storm Sewer Inlets & Junction Boxes

4400.1 SCOPE This Section covers construction of junction boxes, catch basins, area inlets, and field inlets for storm sewers; including removals of existing inlets, construction of boxes, lids and bases, construction of curb transitions and throat, and waterproofing.

4400.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

4400.2.1 ***Precast Boxes And Lids*:** Precast boxes and lids shall conform to the dimensions in the detailed drawings. Precast supplier shall meet quality assurance requirements listed in Part 1. As installed, walls may vary from plumb by not more than 4 percent. For street slopes greater than 4 percent, the top face of the box shall be sloped to match the street grade. Radiused precast tops shall be cast for a 20-foot radius. Steps are not required. Precast boxes may have openings for pipes pre-measured and cast in the box, or the openings may be cut in the field. Precast bases may be used with approval of the engineer.

4400.2.2 ***Cast-In-Place Boxes And Lids*:** Cast-in-place boxes and lids shall conform to the dimensions in the detailed drawings. Products and work shall conform to the requirements of concrete structures (see related work, Part 1). Walls shall not vary from plumb by more than 1/2-inch overall. Top face of box shall be sloped to match the adjacent street, to within a slope of 1/2-inch in 12 inches. Steps are not required.

4400.2.3 ***Manufactured Pipe Connectors*:** For locations where pipes are allowed to be butt connected at a field cut joint, connector shall be a manufactured, watertight, flexible connector made specifically for connecting the pipe materials encountered.

4400.2.4 ***Inlet Size*:** If not otherwise show on the installation drawings, use a standard size box. Standard box shall be 3' x 5' inside dimension. Minimum box size shall be 2-1/2' x 4', inside dimension, for a catch basin or field inlet. Minimum size shall only be used to avoid a utility conflict. Standard and minimum box size for a grated area inlet shall be 2' x 3", inside dimension. Use larger boxes only where indicated on the installation drawings. Wall thickness shall be 6 inches. Dimension tolerance shall be $\pm$ 1/4-inch in wall thickness, $\pm$ 1/2-inch in interior dimension. Top shall be planar to within 1/4-inch.

4400.2.5 ***Castings*:** Access covers and rings shall conform to ASTM A48, Class 35B, and shall be Deeter 1157 castings with 2018A lids or equivalent.

4400.3 CONSTRUCTION DETAILS:

4400.3.1 ***Pipe Connections: W*all openings shall be filled with non-shrink grout. Pipe stubs shall be made with a bell end of pipe abutting the outside wall.

4400.3.2 ***Demolition Of Existing Inlet*:** When inlet is a replacement of an existing inlet, the entire inlet, base, and lid shall be removed. Removal of adjacent surface improvements shall be to the limits marked in the field by Engineer. All excavated material shall be promptly removed from the site.

4400.3.3 ***Box And Lid Construction*:** New inlets shall be precast or cast-in-place. Cast-in-place box or lid may be combined with a precast lid or box. Lids shall be sloped to match the adjacent street slope. Precast boxes may be tipped out of plumb by no more than 1/2-inch in 12 inches to accomplish this result. Walls of cast-in-place boxes shall be formed on both sides. Casting against the wall of the excavation is not acceptable. Grout beds for the inlet tops shall extend the full length and width of the wall. Grout that weeps from the joint shall not be struck off, but shall be left for inspector's observation. **Edge of box, shall be a minimum of 15 ft. from the radius point of curvature.**

4400.3.4 ***Base, Invert And Pipe Connection To Box*:** The minimum base thickness shall be 8 inches measured at flowline. Minimum base thickness under precast wall shall be 8 inches. Temporary supports for precast box shall be concrete block or other non-biodegradable, non-rusting, dimensionally stable, manufactured support. Support by stone or concrete rubble is not acceptable. Cast-in-place base shall extend not less than 4 inches or more than 10 inches beyond outside face of wall. Sides of base shall be formed by separate forms or by vertical wall of excavation that is within dimension tolerances. Concrete for base shall extend a minimum of 4 inches up both the inside and outside of the precast wall to form a soil-tight seal. A 6-inch thick, reinforced precast base with cast-in-place invert shaping is acceptable. Where inlet has no inflow pipe, no channel is required, and invert shall be sloped to the flowline of the outflow pipe at no less than 2 percent nor more than 25 percent slope. Where inlet has one or more inlet pipes, construct invert channel. Invert channels shall be formed to a "U" shape, matching the lower half of the pipe cross section and extending to one-half the height of the pipe. Channels connecting pipes of different sizes shall transition smoothly over the length of the box. When the pipes come in at differing angles, the channel shall be formed with as large of radius as possible. Benches shall slope to the channel at 1:12 slope.

Where pipe openings in a precast box are cut in the field, saw kerf the outside to a minimum depth of 2 inches. To the extent clearance allows, saw kerf the inside to a minimum depth of 1 inch. Break out opening and cut reinforcing to clear pipe. Keep opening size small. If Engineer determines opening size is excessive or that excessive spilling occurred during break out, forms will be required on inside or both faces.

Connection of pipe to box shall form a soil-tight seal. Pipe shall be cut to skew and shall be recessed from 0 to 1 inch from the face of a cast-in-place wall, and 2 inches $\pm$ 1/2-inch projecting from the face of a precast wall. For cast-in-place construction, a soil-tight seal shall be the cast wall fully bonded to the pipe with no honeycomb or gaps. For precast construction, a soil-tight seal may be built as follows: the pipe opening shall be packed full of low slump concrete or non-shrink grout. Such packing shall extend at least 1/2-inch onto the inside face of the wall and 3 inches onto the outside face of the wall. If the extension sags away from the face of wall, the joint between the precast box and the packing for the opening shall be sealed with mastic and covered with 2 layers of 10-mil plastic sheet. Plastic sheet corrective measure is required on the outside face only.

4400.3.5 ***Transitions And Throat Construction*:** Dimension, cross section, and reinforcing of transitions and throat shall conform to the detail drawings. Concrete mix shall conform to concrete for curb and gutter. Transition sections shall have full gutter for the full length regardless of style of adjacent curb. Flowline of transition shall be straight grade. Curb shape in the transition shall match adjacent at the match end and shall be standard curb section at

the catch basin. Curb shape shall transition smoothly between these two shapes. Transitions and throat shall be cast monolithic. Transition curb shall end in a hand-packed, radiused placement supporting the corner of the lid. Tolerance in height of throat opening shall be ± 1/2-inch.

4400.3.6 ***Backfill And Restoration*****:** All fill shall be imported. Fill within 4 feet of pavements shall conform to the granular fill requirements for trenches (see related work in Part 1). Fill beyond these limits may be granular fill or may be a clean clay loam or sandy loam. Fat clay, lumpy, rocky, gravelly, or non-uniform material will not be accepted. The same source shall be used for fill for the entire project.

4400.3.7 ***Acceptance Testing*****:** Inlets shall be subjected to visual inspection by any of the following options prior to acceptance:

A. Visual inspection of inlet will evaluate the completeness of the inlet and the alignment of the invert channel, seal of pipe penetration seal, grout weep at the lid, height and width of throat, and conformity of transition to requirements.

B. Visual inspection of adjacent surfaces will evaluate the surface finish treatment, the grade match to the inlet, and elimination of areas where water may pond.

C. Inlets failing acceptance tests shall be repaired or rebuilt and retested.

4400.4 MEASUREMENT: Measurement will be made to determine the number of storm sewer inlets installed.

4400.5 PAYMENT: The cost of furnishing all labor, equipment, tools, and materials, and the performance of all work necessary to construct concrete structures, complete, including all incidental work necessary for connection to existing and proposed pipes shall be paid for at the unit price as:

Storm Sewer Inlet, Size	Each
Junction Box, Size	Each

END OF SECTION

DIVISION 4500

LIFT STATION FACILITIES

SECTION 4500 – LIFT STATION FACILITIES

4500.1 SCOPE: The work of this section shall consist of furnishing the components necessary for the construction of sewage lift station and appurtenances in accordance with the details and as specified herein including all tools, labor, supervision, equipment, appurtenances, and incidentals necessary for a complete and functioning wastewater pumping station. Items not specifically mentioned, but necessary for completion of the work shall be performed.

4500.2 MATERIALS, DEFINITIONS AND EQUIPMENT:

4500.2.1 ***Submersible Pumps***: All pumps shall be of submersible type and shall be designed to pump raw unscreened sewage. Duplex pumping units shall be required at all lift station sites. All nuts, bolts, washers, and other fastening devices coming into contact with the sewage constructed of Type 304 stainless steel. Submersible Sewage pumps shall be manufactured by CHICAGO, MEYERS, DAVIS EMU, GORMAN RUPP, FAIRBANKS MORSE, or approved equal.

4500.2.2 ***Pump Motor:*** The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled or oil filled watertight chamber, NEMA B type. The motor and pump shall be designed and assembled by the same manufacturer. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting current and torque. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shutoff through runout. Motor shall be provided with an adequately designed cooling system, and shall be guaranteed to run in a totally, partially or non-submerged condition continuously for a period of 24 hours without injurious damages.

4500.2.3 ***Pump Cable***: The pump cable shall be 50 feet of the "SO" type and in compliance with industry standards for loads, resistance against sewage, and of stranded construction. The cable shall enter the pump through a heavy-duty entry assembly which shall be provided with an internal grommet assembly to protect against leakage once secured and must have a strain relief assembly as part of standard construction.

4500.2.4 ***Hydraulic Sealing Flange***: The pump shall be supplied with a universal coupling which bolts to the pump discharge flange and shall accept the discharge elbow provided by the pump manufacturer. Seal of the pump at the discharge flange shall be accomplished by a simple downward linear motion of the pump with the entire weight of the pump guided to and pressing against the discharge connection; no part of the pump shall bear directly on the sump floor and no rotary motion of the pump shall be required for sealing. Sealing at the discharge shall be affected by a rubber lip to insure a positive leak proof system and for ease of removal. Metal to metal discharge connections will not be considered equal. The pump shall be guaranteed not to leak at the discharge flange.

4500.2.5 ***Guide Rails***: Shall be provided for each pump to permit raising and lowering of the unit. Rails shall be Type 304 stainless steel of adequate length to extend from the lower guide holder to the upper guide holder mounted on the access doorframe. Rails shall be provided with intermediate guide bar bracket for attachment to discharge pipe.

4500.2.6 ***Lifting System***: Each pump shall be furnished with a pump lifting chain positive- recovery system consisting of the following components: 50 feet (min.) stainless steel cable of diameter matching weight of lifting chain required, connected to a short length (approximately 10 links long) of high tensile strength proof-tested chain of required capacity, connected to the lifting eye of the pump; a forged "grip-eye" of wrought alloy steel, provided separately for connection to the end of the lifting chain or cable of the pump lifting device.

4500.2.7 ***Wet Well and Valve Pit Access Door***: Access door shall have ¼-inch aluminum diamond pattern plate door leaves capable of supporting a live load of 300 pounds per square foot. Angle frames shall be ¼-inch aluminum with an anchor frame around the perimeter of the assembly. Doors shall be equipped with stainless steel hinges, stainless steel pins, compression spring operators, and an automatic hold-open arm with release handle. A snap lock with removable handle shall also be provided. Hardware shall be stainless steel throughout. Factory finish shall be a mill finish, with bituminous coating applied to the exterior of the frame.

4500.2.8 ***Precast Concrete Basins***: Two (2) precast concrete basins, one (1) for the wet well and one (1) for the valve pit, shall be provided at each lift station location. The precast concrete basins for the lift station shall meet the requirements of Section 4300 – CONCRETE MANHOLES unless directed otherwise by this specification section. The basins shall be of circular configuration and shall be a minimum of 8-foot in diameter. Precast concrete wet well and valve pit shall have a precast concrete flat top cover designed to withstand an AASHTO HS20 highway loading. Flat top cover for the pump basin shall be integrally cast with an aluminum door assembly located per the pump manufacturer's requirements. The door assembly shall have attached to its frame, top rail supports at the center and sides, and shall also have attached a stainless steel lifting chain.

4500.2.9 ***Standby Power Generation***: Each lift station shall be provided with a fixed standby power generation unit. A reinforced concrete pad shall be provided and designed to adequately support the generating unit provided. Standard features shall include the following: Steel sub-base, double wall steel sub base fuel tank to provide 24 hours of service before refueling, isochronous governor, weather proof enclosure quiet site maximum 103db at 23 feet, four (4) cycle industrial diesel engine, electronic control system providing total genset system integration, including automatic remote starting/stopping in conjunction with automatic transfer switch. Vibration isolators shall be provided between the engine generator and heavy-duty steel base. Automatic battery charging alternator with solid-state voltage regulation. The generator shall be inherently capable of sustaining at least 250% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current support devices. Fuel level indicator and low fuel level switch for remote or local annunciation. A resettable line current sensing circuit breaker which protects the generator from damage due to its own high current capability. Each lift station shall be provided with an automatic transfer switch sized for the particular service necessary for lift station pumps. The generator set shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for five (5) years from date of start-up. The

complete genset and transfer switch units furnished under this section shall be Cummins, Kohler, Caterpillar or an approved equal.

4500.2.10 ***Fencing and Grounding***: A 6-foot high chain link fence shall be provided on the exterior of the lift station property. The fence shall contain both a 12-foot wide (minimum) double swing access gate and a single swing pedestrian entrance. The fence shall be provided with 3-strand barbed wire at 45-degree angle on top of the top rail. The fencing provided shall be grounded with a number 6 bare copper perimeter ground, 30inches deep and attached to a 5/8 inch by 8 foot copper clad ground rod located at each corner of the perimeter fencing. The fence grounding shall be connected to the pump electrical components by a number 4 bare copper wire. All connections shall be exothermic weld or compression type.

4500.2.11 ***Electrical Controls/Components***: All electrical components such as; starters, control transformers, relays, switches, alternators pilot lights, phase loss/reversal relays shall be housed in a Nema 4x, fiberglass enclosure. All conduit below grade with the exception of 90° ells shall be schedule 40 PVC. All conduit above grade exposed shall be galvanized rigid conduit. Any conduit entering a hazardous or corrosive wet well shall have an explosion proof non-ferrous stuffing box. Installed to seal off the transference of gases to the control panel, furthermore any conduit inside wet well shall be 40 mil PVC coated rigid galvanized conduit, fittings, etc. Any junction boxes or termination boxes located in wet well area shall be cast explosion proof type. All cables shall be supported with the use of stainless steel Kellum type cord grip connectors.

A. Separate conduits shall be provided for float cables and each pump's power cables.

4500.2.12 ***Floats***: A minimum of 4 mercury type float switches shall be provided to control pump operation at each lift station wet well.

4500.2.13 ***Monitoring and Alarm System***: A self-contained, completely automatic solid-state monitoring and alarm system shall be provided. The monitoring system shall be housed in a heavy gauge; UL listed indoor enclosure with provisions for wall mounting. The system shall be provided with continuously float charged batteries with 20-hour standby operation in the event of a power outage with a condensation heater and thermostat built into the enclosure. The system shall be capable of monitoring sixteen (16) independent alarm conditions. The system shall operate on a standard dial up telephone line. The system shall contain its own FCC approved telephone coupler and shall connect to the telephone network with a standard modular plug. The contractor shall obtain from the City of Joplin a listing of numbers to be programmed into the monitoring unit for operation. Conditions to be monitored shall be power outage, high water level, pump failure and any other conditions requested by the City for that particular lift station location. The unit shall be VERBATIM, by Raco manufacturing, or approved equal.

4500.2.14 ***Alarm Light***: An alarm light, visible from the nearest roadway, shall be provided at the lift station site. Conditions as indicated in section 4500.1.13 shall trigger operation of the alarm light. The alarm light shall be Adapta-Beacon, 49R-N5-40W with 92-LR lens and 52-LC dome cover or approved equal.

4500.2.15 ***Site Lighting***: Each lift station shall be provided <u>without</u> a site light.

4500.2.16 ***Discharge Force Main***: A minimum 4-inch diameter force main shall be provided for the lift station force main. Materials and construction methods for the piping shall be in accordance with section 4100 – Sanitary Sewer Main and standard details. Calculations shall be submitted to the City verifying that the minimum velocity in the pressure main will be greater than 2 feet per second. If the velocity within the force main is unable to maintain a minimum of 2 feet per second, calculations shall be submitted to the City of Joplin verifying the diameter of pipe required. An air relief valve shall be provided on the force main at all high points along the line.

4500.2.17 ***Piping and Fittings***: All piping and fittings within the lift station wet well and valve pit to 3 foot outside of the valve pit shall be ductile iron. Materials and construction methods for the piping shall be in accordance with section 4100 – Sanitary Sewer Main and standard details.

4500.3 CONSTRUCTION DETAILS:

4500.3.1 ***Site Layout***: A minimum 10-foot wide access road shall be provided at each lift station site. The access road shall be paved with a minimum 2–inch thick asphalt surfacing to a point at least 2 feet inside of the site entrance gate. Directly in front of the access drive and inside the site fencing, a 15-foot (minimum) wide-open area between the edge of the wet well and valve pits and site fencing shall be provided. All other areas of the lift station site shall have a minimum clearance of seven (7) feet between the outer edge of the wet well, valve pit, or control panel and the site perimeter fencing. The remainder of the site, not otherwise paved, shall be covered with a minimum of 4-inch thick crushed stone surfacing. The crushed stone surfacing shall extend to a minimum of 4-feet outside of the site fencing.

4500.3.2 ***All Electrical*** construction shall meet the current City of Joplin building code requirements for electrical installation, materials, and methods.

4500.3.3 All lift stations shall operate on three-phase power. Lift stations operating on single-phase power shall not be allowed. The three phase electrical supply shall not contain ghost legs.

4500.3.4 All areas of fill on the lift station site, around the wet well and valve pit, and underneath the electrical control panel and generating unit shall be sufficiently compacted to prevent settling.

4500.3.5 ***Testing***: Each pump shall be individually tested in the field with potable water to determine conformance with the published head discharge curve for that pump. A pressure gauge shall be attached to the discharge side of each pump to determine pressure discharge relationships. The valve on the discharge side of the pumps shall be utilized for throttling purposes, with wet well volume used as an indicator of water flow rate. Contractor shall supply water for testing, and pressure gauge, and shall conduct pump test in the presence of the Engineer.

4500.3.6 ***Guarantee***: The pump manufacturer shall furnish the Owner with a written warranty to cover the pump(s) and motor(s) against defects in workmanship and material for a period of five (5) years or 10,000 hours of operation under normal use and service.

4500.3.7 The warranty shall be in printed form and previously published as the manufacturer's standard warranty for all similar units manufactured. A copy of the warranty shall be provided to the City of Joplin.

END OF SECTION

DIVISION 5000

SEEDING, SODDING & MULCHING

5100.1 <u>SCOPE</u>: This section covers the furnishing of all labor, equipment, tools, seed and fertilizer and the performance of all work as shown on the plans. Where no sidewalks exist, the parkway shall be the area between the curb and the right-of-way line. Where there are existing sidewalks, the parkway shall be the area between the curb and the sidewalk. This section shall also cover all disturbed lawn, parkway and other grass area.

5100.2 <u>MATERIALS, EQUIPMENT, AND DEFINITIONS</u>:

5100.2.1 ***Topsoil***: Topsoil shall be 4 inches of "black dirt" and shall consist of a fertile, friable soil of loamy character, free of sub-soil, stumps, refuse or other foreign material. It shall contain a normal amount of natural humus and be reasonably free of rocks, roots, hard dirt, heavy or stiff clay, coarse sand, noxious weeds, noxious weed seeds, sticks, brush, and other litter. The topsoil shall be obtained from well-drained, arable land, and be of an even texture so that all the soil will pass a 1/2-inch screen. The topsoil shall not be infested with nematodes or with any other noxious animal life or toxic substances. Sandy loam of low fertility, even though mixed with leaf mold, manure, or other fertilizers, will not be accepted.

5100.2.2 ***Seed Mixture:*** The seed shall be of the following mixture as follows: The following percentage of purity and germination will be the minimum requirements in the acceptance of seed:

	Mixture	Purity	Germination
Kentucky Blue Grass	*50%*	80%	*65%*
Creeping Red Fescue	40%	*95%*	90%
White Clover	*5%*	*95%*	*85%*
Annual Rye Grass	*5%*	98%	90%

The seed shall be free from Johnson Grass, Canadian Thistle, or field bind weed seed, and shall not contain more than two percent (2%) of other weed seeds. A certification of this mixture shall be furnished to the Engineer prior to seeding.

5100.2.3 ***Fertilizer:*** Fertilizer shall be a mixture containing twelve (12) pounds each of soluble nitrogen, phosphoric acid and potash per one hundred (100) pounds.

5100.2.4 ***Mulching:*** Mulch shall be cereal straw from wheat or oat, prairie hay, sudan grass hay, or smooth brome grass hay. Mulch shall be free from noxious weeds as declared by the Missouri Department of Agriculture, Division of Entomology. Alfalfa hay shall not be used. Wet straw or hay shall not be used. Mulch for hydroseeding shall be wood cellulose fiber dyed to indicate coverage, easily dispersed and suspended in water

5100.2.5 ***Tackifier*****:** The tackifier for straw, paper, and wood mulch cover shall consist of a guar gum, plantago, starch, or other organic substance. It shall be mixed with water and distributed over the mulch at the manufacturers recommended rate for that substance and site condition.

5100.3 <u>CONSTRUCTION DETAILS</u>:

5100.3.1 ***Limits of Construction:*** Unless otherwise specified, all disturbed areas shall be graded as shown on the plan with at least two (2) inches of topsoil.

5100.3.2 ***Methods:*** Before final raking, areas to be seeded shall be fertilized with the specified mixture by spreading evenly at the rate of twelve (12) pounds per thousand (1,000) square feet of area using a mechanical spreader of the rotary type. The area shall then be raked to a smooth even surface, the soil loosened to a depth of at least one (1) inch and seeded. The seed shall be evenly distributed over the area at the rate of three (3) pounds per one thousand (1,000) square feet using a mechanical seeder.

5100.3.3 ***Mulch*:** All seeded turf areas shall receive mulch unless indicated otherwise on the drawings. Wood cellulose fiber mulch shall be applied with hydroseeding to produce a uniform coverage, acceptable to Engineer. Straw mulch shall be spread over broadcast or drilled seed as soon as planting is complete in the area. Straw mulch shall be applied at a rate of 3,500 lb/acre and shall be crimped into the soil to prevent washing or blowing. Hydroseed cellulose mulch shall be applied at a rate of 1,400 lb/acre. Refer to section 1400 for slope limits anchorage of mulch including hydroseed cellulose fiber.

5100.3.4 ***Seasonal Limitations*:** Seeding shall not be placed from June 1 to September 1 nor from November 1 to March 15 unless otherwise authorized by the Engineer.

5100.3.5 ***Temporary Seeding:*** Areas in which land disturbance activities have not taken place shall be seeded within 14 days of last activity.

5100.4 **MEASUREMENT**: Seeding, fertilizing, and mulching will be measured to the nearest square yard, acre, per linear foot or Lump Sum as specified in the proposal.
Topsoil will not measured for payment, but shall be incidental to the project.

5100.5 **PAYMENT**: The cost of furnishing all labor, equipment, tools, and materials, and the performance of all work necessary to complete Seeding, Fertilizing and Mulching shall be paid in the below units as specified in the proposal.

Seeding, Fertilizing and Mulching (Method)	Lump Sum
Seeding, Fertilizing and Mulching (Method)	L.F.
Seeding, Fertilizing and Mulching (Method)	Square Yard
Seeding, Fertilizing and Mulching (Method)	Acre

END OF SECTION

SECTION 5200 - SODDING

5200.1 SCOPE: This work shall consist of preparing the areas for sodding and placing approved live sod. The entire area designated for sodding shall be covered with sod except where the item Strip Sodding is indicated in the contract.

5200.2 MATERIALS, EQUIPMENT, AND DEFINITIONS:

Unless otherwise specified in the contract, the sod shall be Kentucky Bluegrass at least three (3) years old, densely rooted and thrifty. The sod shall contain a growth of not more than twenty-five percent *(25%)* of other grasses and clovers, be free from all prohibited and noxious weeds, and be reasonably free of all weeds. The sod shall be cut in strips of uniform thickness with a minimum depth of 1 to 1-1/4 inches; each strip containing at least 1/2 square yard and not more than one square yard. Sod shall be cut into strips, not less than 12 inches in width nor more than 9 feet in length. Sod for Strip Sodding shall not be subject to the area limitation but shall be not less than 4 inches in width and not less than 12 inches in length. At the time of sod lifting, the top growth shall not exceed three (3) inches in length. All sod shall conform to the laws of Missouri and shall be obtained from sources meeting the approval of the Department of Agriculture, Division of Entomology.

5200.3 CONSTRUCTION DETAILS:

5200.3.1 ***Seasonal Limitations*** Sod shall not be placed during a drought nor during the period from June 15 to September 1 unless authorized by the Engineer, and shall not be placed on frozen ground. No dry or frozen sod shall be used.

5200.3.2 ***Methods***: The sod bed shall be prepared, limed, and fertilized in accordance with Section 801 latest edition Missouri Standard Specifications for Highway Construction, except that lime fertilizer will not be required where strip sodding is designated. The be shall be in a firm but uncompacted condition with a relatively fine texture at the time of sodding. Sod shall be moist and shall be placed on a moist earth bed. Sod strips shall be laid along contour lines, by hand, commencing at the base of the area to be sodded and working upward. The transverse joints of sod strips shall be broken, and the sod carefully laid to produce tight joints. The sod shall be firmed, watered, and refirmed immediately after it is placed. The firming shall be accomplished by use of a lawn roller or tamper. On 3:1 slopes, or steeper, the sod shall be pegged with wood pegs approximately 1/2 inch by 12 inches driven into the ground, leaving about 1/2 inch of the peg above the sod, and spaced not more than 2 feet apart. Pegging of sod shall be done immediately after the sod has been firmed. When sodding is completed, the sodded areas shall be cleared of loose sod, excess soil, or other foreign material, and a thin application of topsoil shall be scattered over the sod as a top dressing, and the areas thoroughly moistened.

5200.3.3 ***Strip Sodding:*** In areas designated for Strip Sodding, the sod strips shall be laid in a horizontal line with tight transverse joints and a spacing of 18 inches between strips. The area where the sod strips are to be laid shall be trenched to a depth sufficient to insure complete embedment of the sod. The sod shall be firmed, watered, and refirmed immediately after it is placed. The firming shall be accomplished by the use of tampers or

other approved methods. A thin application of topsoil shall be scattered over the sod as a top dressing, and the areas thoroughly moistened.

5200.3.4 ***Protection:*** The Contractor shall keep all sodded areas thoroughly moist for 2 weeks after laying. The sod shall be living at the time of acceptance of the area.

5200.4 MEASUREMENT: Measurement will be made to the nearest square yard of approved sodded surface area, including the area between strips for strip sodding.

5200.5 PAYMENT: The accepted quantities of sodding will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for liming or fertilizing sodded areas.

END OF SECTION

DIVISION 7000
STREETLIGHTS

City of Joplin Roadway Lighting Design Guide

Objectives

The purpose of this guide is to provide guidelines and information required to design roadway lighting systems that achieves the following objectives in an economical and cost-effective manner:

1. To provide energy efficient lighting system that will meet standard design criteria with the minimum possible Unit Power Density (UPD) as per Illuminating Engineering Society of North America (IESNA, IES) and the American Association of State Highway and Transportation Officials (AASHTO) design guidelines.
2. To provide adequate and uniform lighting levels on the City roadways for drivers and pedestrians safety.

Scope of the Standard

The Classification of Roadways and their recommended Luminance Light Levels as per IESNA RP-8, Federal Highway Administration (FHWA), and AASHTO

Luminaires Available

The City of Joplin allows the installation of roadway lighting to all residents within the City limits. This is also based on funding and demand/design requirements. Based on limited funding the City has elected to only use a select variety of lighting materials as later described in this document. Should a resident/developer wish to install luminaires and poles other than our stock items, they are required to procure, install and maintain the luminaires. Empire District Electric provides a meter point to supply the power.

Basic Principles of Streetlight Design

There are five basic principles to consider when doing a lighting design:

1. Safety
2. Security
3. Limit the amount of light trespass
4. Environmental responsibility
5. Uniformity

Considerations

It is the responsibility of the developer or individual doing the lighting design to make sure they are making reference to IES, FHWA, or AASHTO and using the latest versions. When starting a lighting design, attention to the surrounding area and any special requirements must be taken into consideration, i.e. schools, shopping districts, airports. It is important to note that there are several different methods that can be used for calculating the roadway lighting levels. Each may produce different designs and provide different amounts of lighting levels through luminaire spacing and configurations.

Design Criteria

It is the City's intent to establish a standard fixture, pole type, etc. to help reduce the overhead and maintenance costs. All reference to pole types, fixtures, specs, etc. within this section are based on what the City of Joplin's

Public Works Department has decided to be the requirement. If the developer/individual does not want to meet these requirements, they are required to submit in writing that they will maintain and pay for the street lights and the City will not be responsible for them at all.

The City uses the Luminance method on all roadway and intersection designs, and the Illuminance method shall be used for intersections and cul-de-sacs. Lighting designs for curved sections with greater than 2,000-foot radius should be evaluated as if it were a straight section.

Pedestrian Conflict

The identification of pedestrian traffic in the area is to establish the Average Illuminance, Average to Minimum Uniformity Ratio and Minimum Illuminance.

- Per IES RP-8, there are three types of classifications:
  - Low Conflict Area: residential
  - Medium Conflict Area: schools and recreational centers
  - High Conflict Area: restaurants and shopping centers

Pedestrian Conflict is assumed to be the total number of people on both sides of the street within a 650-foot section. This number also includes those people crossing the street between the hours of 6pm and 7pm.

Table 1-1: Classification of Pedestrian Conflict

Low	10 or fewer pedestrians
Medium	11 to 100 pedestrians
High	Over 100 pedestrians

Table 2-2: Lighting Requirement by Pedestrian Conflict

PEDESTRIAN ACTIVITY	MAINTAINED AVERAGE HORIZONTAL ILLUMINANCE (LUX)	AVERAGE-TO-MINIMUM HORIZONTAL UNIFORMITY RATIO	MINIMUM MAINTAINED VERTICAL ILLUMINANCE (LUX)
HIGH	20	4	10
MEDIUM	5	4	2
LOW	3	6	.80

Light Arrangement Styles

There are several options available for the placement of luminaires. Some of these are as follows:

Figure 1: One Sided Arrangement

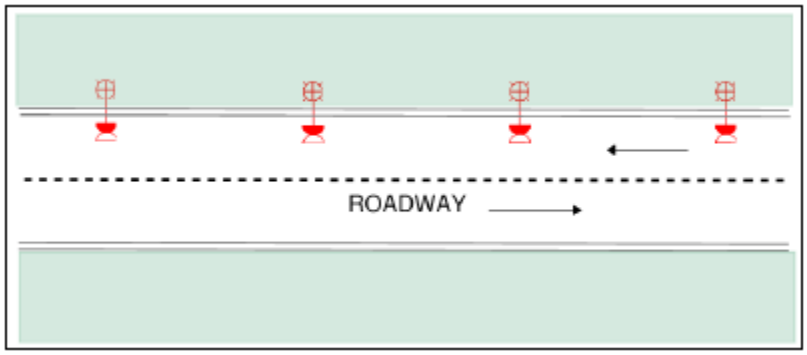


Figure 2: Two Sided Opposite Arrangement

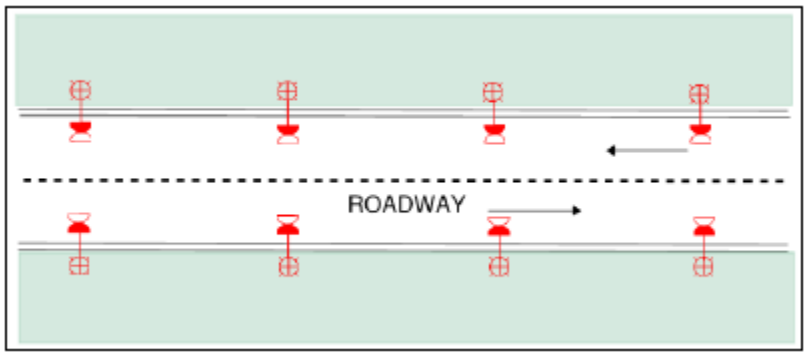


Figure 3: Two Sided Staggered Arrangement

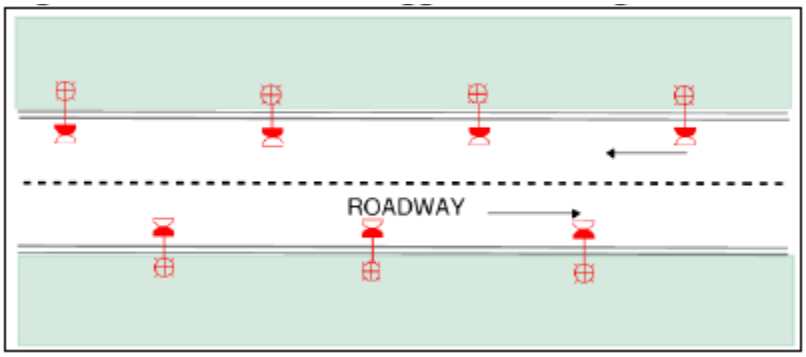
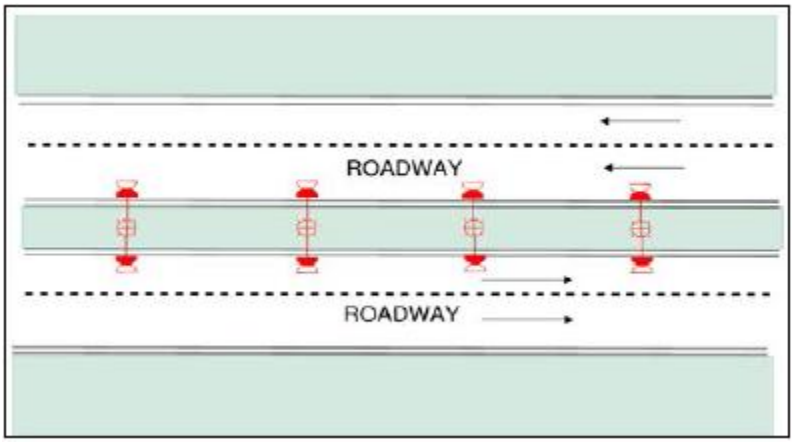


Figure 4: Double Davit Median Arrangement



Typically, a one-sided spacing is to be used on roadways with one to three lanes, staggered spacing on roadways with three to six lanes, and opposite spacing on roadways with five or more lanes. Median lighting is typically used when the median is of sufficient size to allow for the installation of a light standard while meeting the clear zone requirements and/or there are barriers in place.

Roadway Classification

To establish appropriate lighting levels for a given road, a classification system is used to separate roadways based on traffic volumes and use.

- Arterial – high volume through traffic
- Collector – roadway feeding an arterial with moderate to high traffic volume
- Local – roadway feeding an arterial or collector street with low traffic volume
- Alleyway – non-controlled access roadway located along the rear of, or between buildings for servicing or access purposes

Table 3: RP-8 Recommended Light Levels for Luminance and STV

Road Classification	Pedestrian Conflict Area	Lav	Lav/L Min	Lmax/Lmin	Lmax/Lavg	STV
Arterial	High	1.2	3	5	.3	4.9
	Medium	.9	3	5	.3	4.0
	Low	.6	3.5	6	.3	3.2
Collector	High	.8	3	5	.4	3.8
	Medium	.6	3.5	6	.4	3.2
	Low	.4	4	8	.4	2.7
Local/Alleyway	High	.6	6	10	.4	2.7
	Medium	.5	6	10	.4	2.2
	Low	.3	6	10	.4	1.6

Table 4: Illuminance for Intersections

Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3.0
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0
Local/Local	18.0/1.8	14.0/1.4	8.0/.8	6.0

Roadway Classification maps can be acquired by contacting the Transportation Engineer in the Public Works Department.

Typical Pole Height and Overhang
Table 5 shows the typical pole height for different roadway classifications and configurations

Table 6 shows the typical mounting spacing and arrangements

Table 5: Pole Height by Roadway Configuration

		Pole Height (ft)				
Road Classification	Pedestrian Conflict Area	1 Lane One Side	2 Lanes One Side	3 Lanes One Side	4 Lanes Opposite	5 Lanes Opposite
Arterial	High		40	40	40	40
	Medium		40	40	40	40
	Low		40	40	40	40
Collector	High		33	33	33	40
	Medium		33	33	33	40
	Low		33	33	33	40
Local/Alleyway	High	23	23	33		
	Medium	23	23	33		
	Low	23	23	33		

Table 6: *Roadway Lighting Spacing*

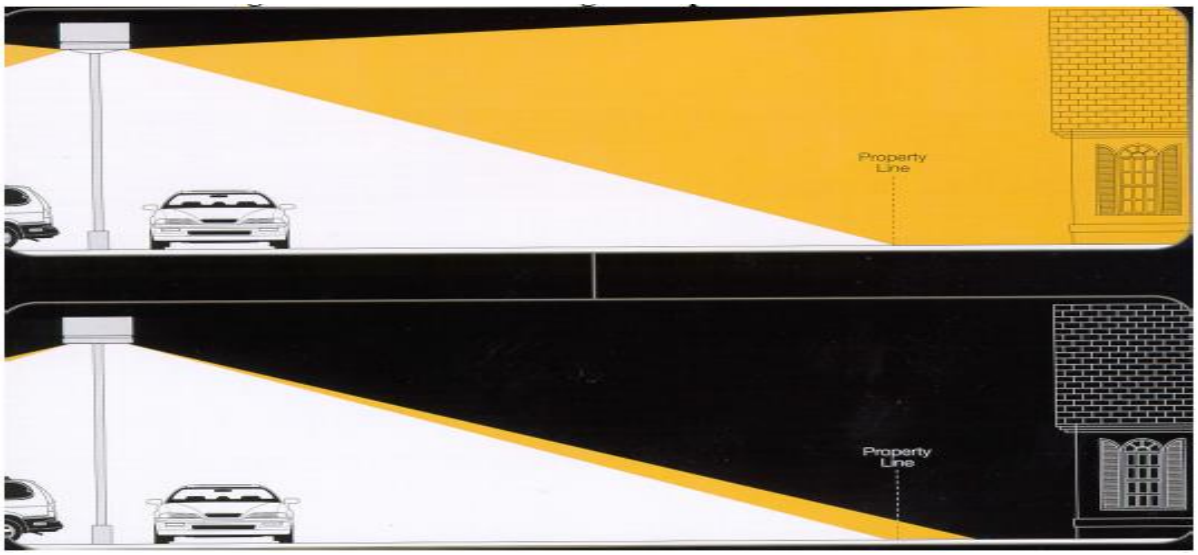
Road and Pedestrian Conflict Area		Luminance Criteria	Lamp Wattage	Input Wattage	Mounting Height	Arrangement	Spacing	Roadwidth	UPD
Road	Pedestrian Conflict Area	Cd/m^2	HID/HPS or LED equal	HID/HPS or LED equal			ft	ft	$Watts/m^2$
Arterial 44ft	High Medium Low	1.2 .9 .6	250	290	See Table 5	Opposite	275	44	.52
Arterial 52ft							275	52	.52
Arterial 72ft	High Medium Low	1.2 .9 .6	400	460			275	72	.50
Collector 44ft	High Medium Low	.8 .6 .4	150 150 100	190 190 138			250 285 320	44	.37 .33 .21
Collector 48ft	High Medium Low	.8 .6 .4	150 150 100	190 190 138			240 275 300	48	.36 .30 .20
Local 28ft	High Medium Low	.6 .5 .3	150 100 70	190 138 95		One Sided	200 250 300	28	.37 .29 .15
Local 36ft	High Medium Low	.6 .5 .3	150 150 70	190 190 95			200 200 250	36	.30 .30 .16

Luminaire Selection

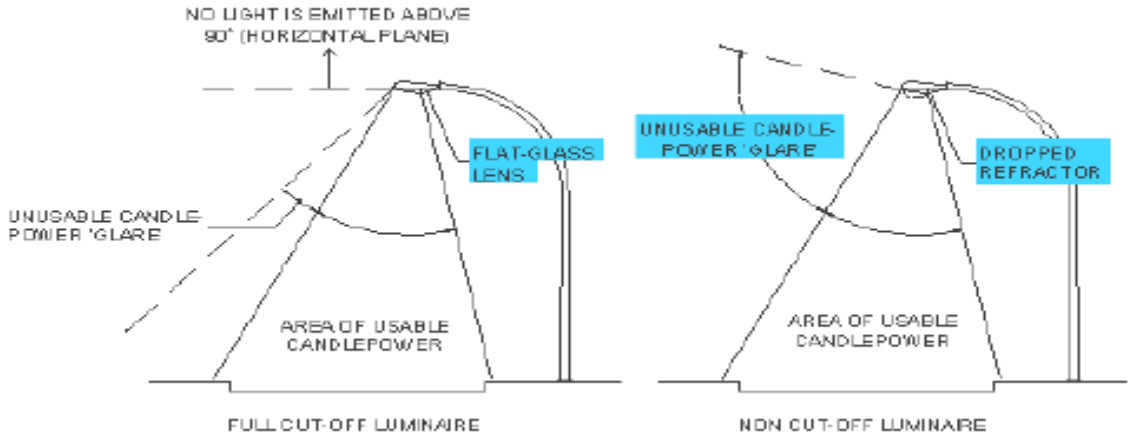
Lateral Light Distribution is the lighting pattern the luminaire puts out on the roadway. There are five types classified as Type I thru V. The higher the Distribution Type Number, the more light that will be spread across the roadway.

- Type I & II are for intersection lighting
- Type III & IV are for roadway
- Type V is mainly used for parking lots

All fixtures used must be “Dark Sky friendly” with full Cutoff Luminaire. The City requires LED luminaires with color index between 85 to 90 (color temp of 5000°K).



INSERT CITY OF JOPLIN SELECTED LED STYLE HEADS AND POLES HERE DO WE GO WITH BREAKAWAY POLES OR DIRECT BURY?



Physical Layout Considerations

Determining an appropriate physical location for the street light pole depends on a number of often conflicting requirements. The lighting design will determine appropriate spacing, but this must be worked into the plan for the subdivision, where there are many other facilities and structures which also need to be accommodated.

The developer will provide drawings of the proposed subdivision showing all pertinent structures including water and sewer lines, catch basins, fire hydrants, lot lines and proposed locations of driveways.

To effectively light each intersection, a light will typically be placed as close as possible to the intersection. Lights will then be spaced per the lighting design starting at the intersection.

Street light poles are typically installed on the property line between residential lots. This will likely result in an adjustment from the optimum streetlight spacing as determined by the lighting design.

Driveways are often designed to be adjacent to one another, streetlights should not be placed between them, but moved to the next lot line where there is no driveway. Placement of street lights near fire hydrants and catch basins should be avoided. This is to mitigate conflicts that may occur should excavation be required to repair hydrants or drains in the future.

When using one sided lighting arrangement along a continuous roadway, streetlight poles should remain on the same side along the entire length of the road. The lights should not change sides from block to block.

Underground feeds should originate from a pedestal, or transformer, located at the end of the block, on the same side of the road as the streetlights. Side lot easements should be avoided. Street crossings with underground conductors should be avoided. If a two-sided lighting arrangement is used, the lights should be fed from conductors running on both sides of the road. When road crossings are required, they will cross the road adjacent to an intersection and cross perpendicular to the roadway. Angled or diagonal crossings will not be permitted.

Installations on the outside of a curve should be avoided, due to the increased possibility of being struck by a vehicle running off the road. Where other constraints force the installation of streetlight poles on the outside of a curve, break-away bases may be required even though the speed limit is reduced in these areas as part of due diligence.

Clearances

For future maintenance and operations of the streetlights, and to minimize damage from the activities of others it is important to maintain certain minimum separations or clearances. In addition to the City's clearance requirements, other private utilities may also have requirements. To determine the proper clearance, both the City and if available, the other utility clearances must be considered. Use the strictest clearance.

Table 7: Streetlight Clearances

	STREETLIGHT BASE (ft)	STREETLIGHT CABLE (ft)
Fire Hydrants	3	3
Pedestals	3	3
Misc. Above Ground Facilities	3	3
Curbs/Sidewalks	2	3
Road way without Curbs/Sidewalks	5	3
Buried High Voltage Cables	3	n/a
Property Pins	3	3
Streetlight Base	n/a	2
Residential Driveway	3	n/a
Commercial Driveway	10	n/a

Electrical Design

Power Supply

The supply for a streetlight must be metered and must meet all Empire District Electric and City of Joplin requirements. A maximum of 3 connections can be made in a streetlight. Voltage drop may not be more than 8%. Luminaires are designed for use at 120-277 VAC.

Fusing/Protection

All streetlights are to be fused at either the transformer or the pedestal where the power supply to the circuit is being provided. Fusing at each luminaire is to be an inline fuse holder with 6 amp fuse. Fusing of overhead

streetlight feeds, if required, should be at the source point. Use a 15 amp fuse and a weatherproof fuse holder with connectors. See Empire District Electric for exact details and specifications.

All electrical designs must be approved by an electrical engineer and meet all inspection requirements by the City of Joplin and Empire District Electric.

DIVISION 9000
TRAFFIC SIGNALS

MATERIALS, DEFINITIONS, AND EQUIPMENT

SECTION 9100.0 Equipment and Materials

9100.1 Schedule of Unit Prices

9100.2 Testing and maintenance of Signal Equipment

9100.3 Guarantee

9100.4 Pull Boxes

9100.5 Conduit System

9100.6 Wiring

9100.7 Concrete Bases

9100.8 Bonding and Grounding

9100.9 Bonding and Grounding

SIGNAL APPURTENANCES

SECTION 9200.0 Signal Faces

9200.1 Controller Cabinets

9200.3 Damaged Equipment

9200.4 Measurement and Payment

9200.5 Actuated Controller Unit

9201.0 Actuated Controller Unit

INTERSECTION MATERIALS AND EQUIPMENT

SECTION 9300.0 Controller Cabinet and Auxiliary Equipment

9300.1 Inductive Loop Vehicle Detector

9302.1 Video Image Detector System

9302.2 Magnetometer Detection System

9302.3 Magnetometer Detection System

TRAFFIC SIGNALS AND POLES

SECTION 9400.0 Vehicle traffic signal heads

9400.1 Optically limited signal

9400.2 Pedestrian Traffic Signal Heads

9400.3 Pedestrian Push Buttons

9400.4 Traffic Signal Poles

9401.0 General

9401.1 Traffic Signal Pedestals

9401.2 Traffic Signs

9401.3 Traffic Signs

AUXILLARY SYSTEMS

SECTION 9500.0 UPS Battery Backup System

9501.0 Ethernet Switch - Fiber Link

9502.0 Ethernet Switch – Copper Link

9503.0 Traffic Monitor System

9504.0 4.9 GHz Outdoor Wireless Base Station

9505.0 4.9 GHz Wireless Bridge

9506.0

FIBER OPTIC COMMUNICATIONS SYSTEM

SECTION 9600.0 Fiber Optic Hub

9601.0
9601.1 Fiber Optic Hub Cabinet
9601.2 Fiber Optic Hub Cabinet – Indoor
9601.3 Fiber Optic Double Hub Cabinet
9601.4 Auxiliary Hub – Pole Mount Powered
9602.0 Fiber Optic Cable & Installation
9602.1 Fiber Optic Communications
9602.2 Fiber Optic Cable Testing

SECTION 9700.0 STANDARD PLANS

9000.0 GENERAL:

This section covers the requirements for all labor, equipment, materials, and quality of work for the construction and installation of a traffic control signal(s) installation and communication infrastructure necessary for a complete, in place and operational, traffic controlled signalized intersection as described in the project plans.

The Missouri Standard Specifications for Highway Construction, Series 2004, Missouri Highways and Transportation Commission, as modified by these specifications, or other appropriate special provisions shall apply to this Standard. The installation of the traffic control signals and appurtenances shall be in conformance with the Manual On Uniform Traffic Control Devices, latest edition.

9100.0 MATERIALS, DEFINITIONS, AND EQUIPMENT:

9100.1 Equipment and Materials:

Equipment and materials shall be of new stock unless the plans provide for the relocation of or the use of fixtures furnished by others. New equipment and materials shall be the product of reputable manufacturers of electrical equipment, and shall meet Engineer approval.

1. Eight (8) copies of shop drawings shall be furnished for steel mast arm poles to be furnished on the Project. Eight (8) copies of catalog cuts and manufacturer's specifications shall be furnished for all standard "off-the-shelf" items.

2. Engineer review of shop drawings and catalog cuts shall not relieve the Contractor of any responsibility under the Contract documents.

3. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), and all material and work shall conform to the requirements of the National Electrical Code (NEC), the Standards of the American Society for Testing Materials (ASTM), the American Standards Association (ASA), and local ordinances. Miscellaneous electrical equipment and materials shall be UL approved.

4. Wherever reference is made in these specifications or in the standard provisions to the code, the safety orders, the general order, or the standards mentioned above, the reference shall be construed to mean the code, order, or standard that is in effect at the date of advertising of these Specifications.

5. Certification from the manufacturers of all electrical equipment, signal supports, the Contractor stating said material complies with these Specifications shall supply conduit and cable.

6. Any existing traffic signal equipment designated to be removed on the project shall remain the property of the City of Joplin. The Contractor shall deliver any removed equipment to the City of Joplin Public Works Department.

7. Any mention or reference to a specific product or brand-name found herein is not intended to allow sole-sourcing. Approved equal items may be substituted, if approved by the engineer. Request for approval of substitution must be submitted a minimum of ten (10) business days prior to bid opening. Request must be submitted in writing along with adequate supporting documentation to verify equality of product (i.e. catalog cut sheets, product certifications, etc.).

9100.2 Schedule of Unit Prices:

Complete and forward to the Engineer three (3) copies of a list of unit costs for each item listed on the Schedule of Unit Prices attached to the Specifications by the preconstruction meeting. The unit costs will be used to prepare progress reports by the Contractor and be verified by the Engineer and/or Inspector. The unit costs will also be used to establish the total cost for any Extra Work Orders or reductions in work related to traffic signal installation work items unless otherwise negotiated.

9100.3 Testing and Maintenance of Signal Equipment:

Notify the Engineer the date the signal or signal system will be ready for testing once the project is open to traffic.

1. Upon authorization of the Engineer, place the signal or signal system in operation for a consecutive 30-day test period. The signal(s) shall not be placed into operation without prior notification and authorization of the Engineer. Any failure or malfunction of the equipment furnished by the Contractor, exclusive of minor malfunctions (such as lamp burnouts) occurring during the test period, shall be corrected at the Contractor's expense and the signal or system tested for an additional 30 consecutive day period. This procedure shall be repeated until the signal equipment has operated satisfactorily for 30 consecutive days.

2. A representative from the manufacturer and/or supplier of signal controller shall be at the project site when the signal controllers are ready to be turned on, to provide technical assistance including, as a minimum, programming of all necessary input data. All required signal timing data shall be provided by the Engineer.

3. After signal turn on and prior to final acceptance of the completed traffic signal system, the Contractor shall respond, within 24 hours, to perform maintenance or repair of any failure or malfunction reported.

9100.4 Guarantee

In addition to warranties or guarantees on specific traffic signal equipment listed elsewhere in these specifications, the Contractor shall fully guarantee the traffic control signal installation furnished as part of the contract against defective equipment, materials and workmanship for 12 months. Should any defect develop under normal and proper operating conditions within these specified periods after acceptance of the completed installation by the City of Joplin, this malfunction shall be corrected by, and at the expense of the Contractor, including all labor, materials, and associated costs. The Contractor shall transfer all required equipment warranties on the date of final acceptance to the City of Joplin.

9100.5 Pull Boxes

This specification covers furnishing all labor, materials, equipment, and appliances, and perform all operations in connection with pull boxes for use on traffic signal projects, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract. Pull boxes may be cast-in-place concrete, precast concrete, preformed polymer concrete or preformed fiberglass reinforced polymer concrete. Pull box dimensions shall be as shown on the plans. Each pull box shall be equipped with cable hooks as shown on the plans. Cable hooks shall be galvanized steel or brass with a minimum diameter of 3/8 inch and a minimum length of 5 inches.

1. Cast-in-place concrete pull boxes shall be constructed with a mixture in accordance with Section 3100. Material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Section 3100. Placing, finishing and curing shall be in accordance with Section 3100. Pull boxes shall be cast in a neat and workmanlike manner. Forms will be required for the inside of the pull box walls; and if the excavation is irregular, forms will also be required for the outside surfaces of the walls. An outside form shall be installed across all trenches leading into the pull box excavation. The ends of all conduits through the walls shall fit tightly against the form.

2. Precast concrete pull boxes shall be constructed with a mixture in accordance with Section 3100. Material, proportioning, mixing, slump and transporting of concrete shall be in accordance with Section 3100. Placing, finishing and curing shall be in accordance with Section 3100.

3. Preformed pull boxes shall withstand a wheel load of 20,000 pounds. Pull box walls may be either flared or vertical. Pull boxes shall have a collar or ring at the top that will allow for securing the concrete apron. Metal conduit, if used in preformed pull boxes, shall be electrically bonded to one another inside each pull box.

4. Pull Box Covers - Each pull box shall be equipped with a bolt down cover. The threaded hole that receives the cover lock-down bolt shall be open at the bottom to allow the cleanout of sand, dirt and other debris. Lock-down bolts shall be stainless steel or brass with a penta-head. Frames and covers for cast-in-place and precast concrete pull boxes shall be cast iron in accordance with AASHTO M 105, Class 30, and shall be of the dimensions and weights shown on the plans. Preformed pull box covers shall be polymer concrete and shall have a minimum wheel load rating of 20,000 pounds. A lift opening shall be provided on all covers. Covers for pull boxes to be used for traffic signals shall be embossed with "SIGNALS". Covers for pull boxes to be used for fiber optics shall be embossed with "FIBER OPTICS".

5. Placement – Pull boxes shall be installed at a maximum spacing of 500 feet. Pull boxes shall be installed at locations as shown on the plans. Pull boxes placed in traveled ways, auxiliary lanes, shoulders and low profile islands shall be concrete. A pull box placed in a sodded area or shoulder shall have a concrete pad around the perimeter. Concrete pads will not be required for pull boxes installed in concrete shoulders. Concrete for pad shall be in accordance with Section 3100. The top surface of all pull boxes shall be flush with surfaced areas and approximately one inch above earth or sodded areas.

6. Installation - Conduit shall enter the pull box in the side of the box and shall extend a minimum of 2 inches and a maximum of 4 inches. If it becomes necessary to increase the excavation depth and extend the pull box, no direct payment will be made. The excavated opening outside the pull box shall be wide enough to allow compaction of the backfill material. Cinders, broken concrete, broken rock or other hard or undesirable material shall not be used for backfilling. The backfill material shall be placed in layers not to exceed 6 inches deep, and each layer shall be thoroughly compacted before the next layer is placed. Where preformed pull boxes are used, the holes for the conduit shall be drilled as recommended by the manufacturer. The holes shall be round and no more than ½ inch larger than the conduit.

7. Drains - Drains for pull boxes shall be constructed as shown on the plans.

8. Substitutions - If the contractor wishes to substitute a pull box that is a different type than shown on the plans, it must be approved by the City of Joplin engineer. No additional payment shall be made for substitutions of pull boxes. If a double concrete pull box is specified, no substitutions will be permitted.

9. Measurement and payment - Pull boxes shall be measured per each, including all specified material. Payment will be considered full compensation for all labor, equipment and material to complete the described work for each pull box. Work will include all excavation, removal and disposal of all material encountered within the limits of the work. No direct payment will be made for any incidental items Necessary to complete the work unless specifically provided as a pay item in the contract.

9100.6 Conduit System

This specification covers furnishing all labor, materials, equipment, and appliances and perform all operations in connection with conduit for use on traffic signal projects, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

1. Rigid Metallic Conduit - Except for rigid aluminum conduit, rigid metallic conduit shall be galvanized on both the inside and the outside surfaces. The weight of zinc coating shall be no less than 0.5 ounce per square foot of coated surface, as determined in accordance with AASHTO T 65. The interior or exterior surface, or both, may be given a coating of suitable material to facilitate installation of wires and cables and to permit the conduit to be readily distinguished from pipe used for other purposes.

a. Rigid Steel Conduit, Zinc Coated - Rigid steel conduit, zinc coated, (GRC) shall be in accordance with ANSI C80.1, except as noted herein.

b. Intermediate Metal Conduit - Intermediate metal conduit (IMC) shall be in accordance with ANSI C80.6, except as noted herein.

c. Rigid Aluminum Conduit - Rigid aluminum conduit (RAC) shall be in accordance with ANSI C80.5.

d. Fittings for Rigid Metal Conduit - Fittings shall be in accordance with ANSI C80.4.

e. Fittings for Intermediate Metal Conduit - Fittings shall be in accordance with UL 1242, except the coating shall meet the same requirements as the conduit with which the fittings are used.

2. Rigid Non-Metallic Conduit - Rigid non-metallic conduit shall be either polyvinyl chloride (PVC) or high-density polyethylene (HDPE).

a. Polyvinyl Chloride Conduit - PVC conduit, bends, couplings and fittings shall be in accordance with UL 651.

b. High Density Polyethylene Conduit - HDPE conduit shall be in accordance with ASTM D 3035 SDR11.

c. Fittings for Polyvinyl Conduit - Fittings for PVC conduit shall be in accordance with UL 514. Cement used for the fittings shall be in accordance with the conduit manufacturer's recommendations.

d. Fittings for High Density Polyethylene Conduit - Fittings for HDPE conduit shall be in accordance with ASTM D 2683. Epoxy used for the fittings shall be in accordance with the conduit manufacturer's recommendations.

3. Fiber Optic Cable Conduit - The conduit containing only fiber optic cable shall be PVC, HDPE, or rigid metal in accordance with this Section, and shall be orange in color. A No. 14 AWG stranded copper tracer wire or a pull tape with a tracer wire shall be installed in the PVC or HDPE conduit.

4. Conduit Systems - The contractor shall furnish and install rigid steel, intermediate metal, PVC schedule 40, or HDPE conduit, as indicated on the plans. Conduit shall be placed a minimum of 18 inches below finished grade and shall slope to a pull box at a minimum rate of 0.5 percent unless otherwise shown on the plans. A change in direction of conduit shall be accomplished by bending the conduit uniformly to a radius that will fit the location, or by the use of standard bends or elbows. The minimum radius of the bend shall be six times the internal diameter of the conduit. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. If it becomes necessary to cut and thread steel conduit, exposed threads will not be permitted. All conduit and fittings shall be free from burrs and irregularities. All conduits shall be cleaned and swabbed before cables are installed. All fittings shall be tightly connected to the conduit. Open ends of conduit placed for future use shall be capped or plugged. If approved by the engineer, conduit may be installed either by trenching or pushing; however, payment will be made by the method specified in the contract for that conduit.

5. Metal Conduit - All metal conduit ends shall be provided with a bushing to protect the cable from abrasion. All metal conduits shall be electrically bonded by conduit clamps and bare No. 6 AWG stranded copper wire. All metal conduits in the controller base shall be electrically bonded to the power company ground.

6. Polyvinyl Chloride Conduit - A bare No. 6 AWG stranded copper wire shall be installed in each conduit and attached to the ground lug in signal posts, except as otherwise specified. All bare ground wires shall be electrically bonded. All bare ground wires in the controller base shall be electrically bonded to the power company ground. PVC containing only fiber optic cable shall contain a bare or green-jacketed No. 14 AWG stranded copper tracer wire

instead of a bare No. 6 AWG copper ground wire. Tracer wire shall not be pulled into the controller cabinet or bases. An additional 6 feet of tracer wire shall be coiled in each pull box through which the fiber optic cable passes. Tracer wire in pull boxes shall be capped, not electrically bonded to any ground wires labeled "TRACER." Ground wire and tracer wire shall be at the contractor's expense.

7. Conduit in Trench - Trenches shall be excavated to the width and depth necessary for conduit installation. All trenches shall be backfilled as soon as practical after the installation of conduit. Cinders, broken concrete and other hard or objectionable material that might cause mechanical damage to the conduit shall not be used for backfilling within 6 inches of the top of the conduit. The bottom of the trench shall be free of such material before the conduit is placed. Conduit shall not be placed without approval of the trench from the engineer. Backfill material shall be deposited in the trench in layers not exceeding 6 inches deep and each layer shall be compacted to the approximate density of the adjacent material by an approved method before the next layer is placed. Red burial tape with "CAUTION-BURIED CABLE BELOW" shall be installed in all trenches at approximately one-third to one-half of the depth of the trench. All disturbed areas shall be restored to the satisfaction of the engineer.

8. Pushed Conduit - If pushed conduit is specified, the conduit shall be installed without disturbing the existing surface. Pushed conduit may be placed by jacking, pushing, boring or other approved means.

9. Conduit in Median - If conduit in median is specified, the conduit shall be placed on the existing pavement prior to construction of the raised median. If conduit is to placed in concrete traffic barrier, the conduit shall be held rigidly in place before placement of the concrete.

10. Measurement and Payment - Final measurement of conduit will not be made, except for authorized changes in construction or where appreciable errors are found in the contract quantity. Where required, measurement of conduit will be made to the nearest linear foot as shown on the plans. The revision or correction will be computed, and added to or deducted from the contract quantity. Payment will be made per linear foot, and considered full compensation for all labor, equipment and material to complete the described work for conduit. Work will include all excavation, removal and disposal of all material encountered within the limits of the work. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

9100.7 Wiring

This specification covers furnishing all labor, materials, equipment, and appliances, and performing all operations in connection with wiring for use on traffic signal projects, in

strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

Contractor furnished equipment that will become the property of the City of Joplin shall be of new stock unless stated otherwise in the contract documents. Electrical conductors and associated equipment shall be in accordance with applicable requirements of ICEA, IMSA, NEMA,RETMA, NEC, NFPA and regulations of the National Board of Fire Underwriters and shall meet the approval of the engineer.

1. Conductors - Except as noted, all conductors shall be soft drawn, Class B or C stranded copper wire in accordance with ICEA S-6-402, Part 2. Solid conductors may be used only for grounding where connected to a ground rod.

2. High Voltage Power Cable - The voltage rating for high voltage power cable supplying primary electrical power shall be 5 KV for primary voltages less than 5000 volts, and 15 KV for voltages of 5000 volts and greater. The specific type of cable shall be as recommended by the utility company.

3. 120-240 VAC Power Cable - Low voltage power cable shall be 600-volt, single conductor cable and thermoplastic or thermosetting polyethylene insulated. All cable shall be plainly marked on the outside with the manufacturer's name and identification in accordance with industry practice. Insulation type shall be THW, RHH, RHW, RHW-2 or USE. Average thickness of insulation shall be no less than specified in the following table with a minimum thickness of 90 percent thereof.

AWG No.	Thickness, Mils
14-10	45
8-2	60
1-4/0	80
213-500	95
501-1000	110

4. Cable-Conduit - Cable-conduit shall consist of one to four low voltage power cables with an insulated sized electrical neutral and a bare safety ground, factory installed in black polyethylene conduit intended for direct burial. The conduit shall be plainly marked on the outside with manufacturer's name and identification in accordance with industry practice and shall be in accordance with ASTM D 3485. Cable-conduit shall be accompanied by the manufacturer's certification stating the conduit is in accordance with the requirements of this specification.

5. Pole and Bracket Cable - Pole and bracket cable located in the signal pole that supplies electrical power to highway lighting shall consist of two single conductors. Wire size shall be No. 10 AWG in accordance with the requirements of low voltage power cable. Insulation type shall be THW, THHW, RHH, RHW, RHW-2, USE or UF. Average insulation shall be a minimum of 45 mils.

6. Multi-Conductor Cable -Multi-conductor cable for traffic signals shall be No. 14 AWG, rated at 600 volts. The cable shall be in accordance with IMSA Specification No. 19-1.

7. Induction Loop Detector Cable - Induction loop detector cable shall be No. 12 AWG USE wire made up of non-twisted turns in single slot as indicated in drawings or as recommended by manufacturer of the detector amplifier.

8. Loop Detector Lead-In Cable - Lead-in cable used between the loop detector and the controller shall be two-conductor, twisted, shielded No. 14 AWG wire rated at 600 volts. The cable shall be in accordance with IMSA Specification No. 50-2.

9. Wiring - The controller cabinet shall be equipped with a 600-volt heavy-duty one-piece mechanical screw connector offset tang assembly attached to a barrier terminal strip for terminating field conductors. Each mechanical screw connector shall accommodate up to four No. 12 AWG conductors. The connector shall be mounted horizontally on the inside back of the cabinet, approximately 6 inches from the bottom of the cabinet.

All wiring to the terminal strips, except the incoming field circuits, shall be performed by the controller manufacturer. The terminal strips shall accommodate at least:

a. Two terminals for the power supply

b. An unfused terminal for neutral side of power supply line

c. One terminal for each signal lamp circuit and one terminal for the common return from each signal face.

d. If detectors are used:

i. Two terminals for each detectors

ii. Screw terminal strips mounted vertically on the side of the cabinet approximately 6 inches from the bottom of the cabinet.

iii. All inductive loop detector inputs shall be protected with two 30-volt MOVs with a 30-j rating. An MOV shall be connected

between each field terminal and cabinet ground.

e. Terminals for interconnect cable when the controller is to be hard-wire (7-wire) interconnected shall be fused and provided with a 150-volt MOV with an 80 j rating.

f. Terminals for closed loop system interconnect cable (twisted pair) shall be fused and provided with a 30-volt MOV with a 30 j rating.

10. Back Panel Wiring - Regardless of the number of phases specified on the plans, all load switch positions shall be completely wired for use. A flash transfer relay socket shall be provided for each pair of load switch positions. All controller harness wiring shall be connected to labeled terminals on the front of the panel.

11. Traffic Controller Assemblies - Wiring: All wiring shall be insulated, stranded copper wire and shall be neatly bundled and secured with plastic cable ties. For double controller cabinets, all wiring for each intersection shall be terminated in the same compartment of the cabinet as the signal controller for that intersection. Incoming field circuits shall be routed horizontally from the conduit to the back of the cabinet, then vertically to the terminal block. All terminals shall be labeled and not be visibly obstructed. All field leads shall be identified by means of round aluminum identification tags with a minimum thickness of 0.1 mils attached to the cables with a copper wire to correspond with the plans. The outgoing signal circuits shall be of the same polarity as the line side of the power supply, and the common return of the signal circuits shall be of the same polarity as the line side of the power supply. The power supply shall be provided through three single conductor cables. The ground side of the power supply shall be carried throughout the controller in an continuous circuit, and shall be secured to a ground bus bar in an approved manner. All field conductors shall be terminated in the controller cabinet.

12. Traffic Controller Assemblies – Back Panel Wiring: All wiring on the backside of the controller back panel shall be neatly bundled and secured with plastic cable ties. Any multi-colored cable between the controller or auxiliary equipment and the back panel shall be contained in an expandable braided sleeve. All wiring shall be discrete insulated wires and shall be soldered directly to lugs on the back of terminal blocks and sockets. Printed circuit boards shall not be used.

13. Polyvinyl Chloride Conduit - A bare No. 6 AWG stranded copper wire shall be installed in each conduit and attached to the ground lug in signal posts, except as otherwise specified. All bare ground wires shall be electrically bonded. All bare ground wires in the controller base shall be electrically bonded to the power company ground. PVC containing only fiber optic cable shall contain a bare or green-jacketed No. 14 AWG stranded copper tracer wire

instead of a bare No. 6 AWG copper ground wire. Tracer wire shall not be pulled into the controller cabinet or bases. An additional 6 feet of tracer wire shall be coiled in each pull box through which the fiber optic cable passes. Tracer wire in pull boxes shall be capped, not electrically bonded to any ground wires labeled "TRACER." Ground wire and tracer wire shall be at the contractor's expense.

14. Wiring - Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, yellow to yellow, and green to green. Circuits shall be properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables. All cable runs shall be continuous and unspliced from the connections in the terminal block of the signal head or disconnect hanger to the terminal strip in the controller cabinet, from the signal terminal block to another signal terminal block or as shown on the plans. When a terminal compartment is provided, all cable runs shall be continuous from the terminal compartment to the terminal strip in the controller cabinet. When parallel connections are required from an overhead signal head on a mast arm to a side-mounted signal head, cable shall be routed from the controller to the terminal compartment of the signal on the mast arm and then parallel-circuited back to the side mounted signal. All other conductor cable combinations to signal heads shall be as shown on the plans or as directed by the engineer. Where double controller cabinets are specified, wires shall be sorted between the controller and first pull box such that field wires enter the associated controller compartment. Slack for each cable shall be provided by a four foot length in each pull box and two foot length in each signal pole, pedestal, and controller base. Coil cable slack in pull box and place on the hooks.

15. Power Cable Installation - Power cable runs shall be continuous and unspliced from the power disconnect switch located on the power supply to controller cabinet terminals. Power cable shall be encased in conduit of the size shown on the plans. Energized power cables shall run to circuit breakers. The neutral cable shall be terminated on the ground bus bar in the controller cabinet.

16. Pole and Bracket Installation - Where luminaires are required, pole and bracket cable shall be installed between the luminaire and the power source at the base of the post. Each luminaire shall be connected to the power source by a separate No. 12 AWG two-conductor cable. A premolded fused connector assembly shall be installed on each conductor between the source cable and the pole and bracket cable. The assembly and cable shall be insulated with a protective rubber boot designed for the premolded connector.

17. Induction Loop Installation: Induction loop dimensions shall be as shown on the plans. The engineer will determine the exact location of loops. Each induction loop shall be connected to the detector by a separate lead-in cable. No. 12 AWG USE cable shown on the plans is an approximation of cable

quantity required to construct the induction loop. If the number of turns shown on the plans is not in accordance with the manufacturer's recommendation for the sensing units furnished, the plans will be revised, the induction loop cable shall be installed in accordance with manufacturer's recommendations. Induction loop detector lead-in cable will be shown on the plans as two-conductor No. 14 AWG cable. Should the manufacturer recommend a different type of cable, the two-conductor cable shall be revised to the manufacturer's specification, but will be considered completely covered by the contract unit price for loop detector lead-in cable. Cable for loop detectors shall be continuous from the terminal strip in the controller cabinet to a splice with the detector leads in the pull box adjacent to the detector. The conductor splice shall be soldered without an open flame. The soldered splice shall then be capped and inserted into a direct buried splice kit.

18. Identification - Where practical, color codes shall be followed such that the red insulated conductor connects to the red indication terminal, orange to yellow and green to green. Circuits shall be properly labeled in the controller cabinet and all pull boxes by means of round aluminum identification tags with a minimum thickness of 0.1 mils, attached to the cables with copper wire. Information stamped on the tags shall identify equipment served by the conductor cable in accordance with designations used on the plans.

19. Pulling Cable - Cables shall be pulled through conduit by a cable grip providing a firm hold on exterior coverings. Cable shall be pulled with a minimum of dragging on the ground or pavement. Frame-mounted pulleys or other suitable devices shall be used for pulling cables out of conduit into pull boxes. Lubricants may be used to facilitate pulling cable. Polyester rope will not be permitted to facilitate pulling of cable. Slack in each cable shall be provided by a 6-foot loop coiled in each pull box and a 3-foot loop coiled in each junction box. All signal posts and controllers shall be grounded by bare No. 6 AWG stranded copper wire.

20. Tracer Wire - A tracer wire shall be installed in all conduits with the exception of conduits between detector loops and hand holes. The tracer wire shall be a #10 A.W.G., single conductor, stranded copper, Type THHN, with UL approval and an orange colored jacket. The tracer wire shall be spliced in the hand holes and controller to form a continuous network. The splice shall be a soldered connection and then covered with a wire nut.

21. Measurement and Payment: Final measurement of cable will not be made, except for authorized changes in construction or where appreciable errors are found in the contract quantity. Where required, measurement of conduit will be made to the nearest linear foot as shown on the plans. The revision or correction will be computed, and added to or deducted from the contract quantity. Payment will be made per linear foot, and considered full compensation for all labor, equipment and material to complete the described work for conduit. Work will include all excavation, removal and disposal of

all material encountered within the limits of the work. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

9100.8 Concrete Bases

This specification covers furnishing all labor, materials, equipment, and appliances, and performing all operations in connection with concrete bases for use on traffic signal projects, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

1. Concrete - All concrete used for concrete bases shall be in accordance with Section 3100.

2. Concrete Bases - Excavation for bases shall be made in a neat and workmanlike manner. While concrete is being placed, forms shall be level and sufficiently rigid to prevent warping or deflection. Concrete shall be of a mixture in accordance with Section 3100. Conduit, ground rods and anchor bolts shall be held rigidly in place before and during concrete placement. Tops of all bases shall be finished level and the perimeter edged to a radius of ½ inch. Exposed surfaces of bases shall be finished in a workmanlike manner as soon as practical after removing forms. Concrete shall be placed, finished and cured in accordance with Section 3100.

3. Post Bases - Concrete bases for posts shall be in accordance with the dimensions shown on the plans. Metal forms no less than 26 inches highs shall be used for all Type A bases. The top 12 inches of Type B bases shall be formed. Reinforcing steel for concrete bases shall be in accordance with the plans and project specifications. Anchor bolts for steel posts and mast arms shall be as shown on the fabricator's approved shop drawings. Conduit shall extend above all post bases a nominal 4 inches.

4. Controller bases - Concrete bases for controllers shall be constructed as shown on the plans. Aprons will be considered part of the controller base. A minimum of four anchor bolts shall be used for single controller cabinets and a minimum of six anchor bolts shall be used for double controller cabinets. The size of anchor bolts for controller cabinets shall be as specified by the cabinet manufacturer. A ground rod shall be placed into the ground with a minimum of 8 feet of earth contact as shown on the plans. Bases for double cabinets shall have two ground rods. Conduit shall extend above all controller bases no more than one inch. Bases for double controller cabinets shall have two conduits to the first pull box, on positioned in each compartment. All conduit openings in the controller cabinet or controller cabinet base shall be sealed

with a pliable duct sealant.

5. Measurement and Payment - Final measurement of concrete for bases will not be made, except for authorized changes in construction or where appreciable errors are found in the contract quantity. Where required, measurement of concrete for bases, including all specified material, will be made to the nearest 1/10 cubic yard as shown on the plans. The revision or correction will be computed, and added to or deducted from the contract quantity. Accepted concrete bases will be paid for at the contract unit price per cubic yard of concrete. Payment will be considered full compensation for all labor, equipment and material to complete the described work, and will include all excavation, removal and disposal of all material encountered within the limits of the work.

9100.9 Bonding and Grounding

This specification covers furnishing all labor, materials, equipment, and appliances and performing all operations in connections with bonding and grounding for use on traffic signal projects, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

1. All conduit, steel poles and pedestals shall be bonded to form a continuous system, and be effectively grounded. Bonding jumpers shall be No. 6 A.W.G. bare copper wire or equal connected to the ground rod by Cadweld connectors. Bare copper ground wires shall be connected together by an approved mechanical crimp type of connector. Split bolt connectors will not be used.

2. Grounding of the conduit and neutral at the service point shall be accomplished as required by the National Electric Safety Code, except bonding jumpers shall be No. 6 A.W.G. or equal.

3. Ground electrodes shall be provided at each signal pole and at the controller as detailed on the plans.

4. A No. 6 A.W.G. bare copper ground wire shall be installed in all P.V.C. conduit that carries 120 volt signal cables.

5. Measurement and Payment – Bonding and grounding shall be considered subsidiary to wiring and conductor work, therefore, no final measurement or individual payment will be made for this item.

9200.0 SIGNAL APPURTENANCES

This specification covers furnishing all labor, materials, equipment, and appliances, and performing all operations in connection with signal faces, controller cabinets, and pole erection for use on traffic signal projects, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

9200.1 Signal Faces:

All traffic signal displays shall be installed as indicated on the plans. All overhead displays located on each mast arm shall have each red indication set at approximately the same elevation, unless otherwise directed by the engineer. During the course of` construction and until the signals are placed in operation, signal faces shall be covered or turned away from approaching traffic. When ready for operation, they shall be securely fastened in position facing toward approaching traffic and plumb.

9200.2 Controller Cabinets:

The controller cabinets shall be installed at the location indicated on the plans with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller, unless otherwise directed by the engineer. The controller cabinets shall be installed on pre-placed caulking material on the concrete base. After the cabinet is installed in place, the Contractor shall also place caulking material around the base of the cabinet.

9200.3 Pole Erection:

All poles shall be erected so as to be vertical under normal load, with mast arms oriented at 90 degrees to the curb line, unless otherwise specified. The bases shall be securely bolted to the cast-in-place concrete bases. Leveling shall be accomplished by the use of metal shims and/or one nut or two nuts on each anchor rod or as directed by the pole manufacturer. One nut shall be turned on each anchor rod and the pole placed in position on these nuts. The top nuts shall then be turned into place loosely and the pole adjusted to the vertical position by adjusting both the upper and lower nuts. After leveling the poles, expansive type grout shall be troweled between the pole base and the foundation for gaps of 1" or greater. Exposed edges of grout shall be neatly finished to present a pleasing appearance. A weep hole shall be placed in the grout. Each pole shall be grounded by installing a No. 6 AWG bare copper ground wire between the pole and the ground rod at the foundation.

9200.4 Damaged Equipment:

If the painted or galvanized surface of any equipment is damaged in shipping or installation, such equipment shall be retouched or repaired in a manner satisfactory to the engineer.

9200.5 Measurement and Payment: Measurement and payment of these items is addressed in other sections of this specification.

9201.0 Actuated Controller Unit

1. The local intersection controller shall be an EPAC3108 M52 Series controller unit manufactured by Eagle Traffic Control Systems. The controller shall be fully compatible and interchangeable with the existing local controllers in the City of Joplin System operating as an ACTRA ATMS System or MARC-NX System.

2. The controller to be provided shall provide two-phase through eight-phase operation. The controller shall be fully functional to operate in either a TS-2/Type 1 or a TS-1 controller cabinet environment. The controller unit shall be provided with the NEMA defined "A", "B", "C", and manufacturer specific "D" connectors, an RS-232 Serial Port that allows controller unit programming without referencing the controller unit system address, an RS-232 Serial Port that allows controller unit programming requiring reference to the controller unit system address, an SDLC Serial Port as defined by NEMA TS-2 and a communications port that is either designed for fiber optic interconnect using Local Ethernet Switch or Backbone Ethernet Switch as shown on the Plans for this project. Controller units shall be supplied with Local Ethernet Switch, unless otherwise specified in the Plans and Specifications. The Local Ethernet Switch unit shall include a power adapter for front panel connection. The controller may also be required to have an internal modem installed when specified that would include either a FSK copper modem with "D" cable connection, RS-232 Serial DB-9 connector internal modem, or RS-232 Serial SM fiber optic internal modem.

3. The controller shall provide fully prompted, menu driven programmability.

4. The controller shall provide the following internal functions:

a. Software compatible to the control and data protocol of the on-street master and central office computer.

b. Provision of a local time base scheduler including automatic accommodation for day light savings time.

c. Provision for local coordination control.

d. Provision for local preemption control with at least six (6) programmable internal preemption sequences.

e. Provide data uploading and down loading capability.

f. Process system and local intersection detector activity and accumulate samples of vehicle count, occupancy, and speed.

g. Provide local control of remotely selected NEMA and special functions.

h. Ability to handle up to 80 detectors. Detectors shall include the ability to have a single detector input be assigned to phase extension, system volume and occupancy, and lane count concurrently. Lane count shall include as a minimum 24 isolated detector assignments for the purpose of accumulating 15-minute volume counts for each detector. Controller memory shall allow accumulation of a minimum of sixteen hours of data, 15-minute counts for 24 detectors, before requiring data uploads to the central computer.

i. Perform local report generation with printer capability, including intersection status and performance.

j. Provide the capability to communicate with the on-street master by means of hard-wire, fiber optic or radio interconnects. The controller shall be capable of operating in each type of system without additional modifications, other than installation of the appropriate modem and interface.

k. The controller unit shall utilize digital timing concepts for interval settings for all phases and shall contain vehicular and pedestrian circuits and timing functions for all phases.

l. The controller equipment furnished shall be new, of the latest model, fabricated in a first-class workmanlike manner from good quality material. The manufacturer shall replace free of charge to the Contractor and/or Owner any part that fails in any manner by reason of defective material or workmanship within a period of 12 months from the date that the equipment was placed into operation following installation.

5. The controller unit shall use modern integrated circuits and computer technology to the fullest extent feasible and incorporate digital timing techniques. All component parts and terminals shall be readily accessible when the controller modules are removed from the cabinet for adjustments, testing or service. The controller unit shall be designed so that the length of interval, portion, and period or unit extension shall not deviate by more than plus or minus 100 milliseconds of its set value as measured from the zero crossing of 60 Hz, 120 VAC.

6. Certification of a manufacturer's controller assembly by an independent testing laboratory shall be provided to the Engineer. This certification shall indicate that the manufacturer's controller assembly is in accordance with the test procedures as specified in the NEMA Standard No. TS1-1983. Certification to NEMA Standard No. TS-2, current edition at the time of bid shall be acceptable.

7. All components shall be amply de-rated with regard to heat dissipating capacity and rated voltage so that, with maximum ambient temperatures and maximum applied voltage, a material shortening of life or shift in values shall not occur. The design life of all components under 24 hours a day operating conditions in their circuit applications shall be not less than five (5) years.

8. The controller unit shall provide for setting of the timing of each interval or period by means of keyboard and, additionally, by electronic communication with a personal computer equipped with manufacturer specific software. Each phase shall have identical control parameters that may be independently set for each phase.

9. The controller unit shall be capable of providing functions with the minimum timing ranges and timing increments as defined in NEMA Standards TS-2.16.4.6. Indications shall be provided and appropriately labeled to facilitate the determination of the operation of the controller unit.

10. All operator keyboard entered data shall be retained in a memory medium that does not require battery backup.

11. Means shall be provided to control the flashing of pedestrian signals during the pedestrian clearance interval(s), Yellow and All Red or Yellow interval only.

12. The signal phasing and interval sequence shall be as shown on the plans.

13. The controller shall provide multi-phase operation and shall be fully actuated with means for receiving actuation on all phases. The controller shall permit a non-actuated mode of operation on any of the phases by assertion of the vehicle recall function of the desired phase.

14. During coordinated operation if phases are placed in a pedestrian recall mode of operation to operate the controller as a pretimed controller, the

WALK intervals of the non-coordinated phases shall automatically adjust with changes in the timing plans to provide the maximum amount of WALK interval possible in the phase. The adjustment of the WALK interval for the non-coordinated phases shall be similar to the adjustment in the WALK interval for the coordinated phases with timing plan changes.

15. Basis of Payment - Payment shall be per each traffic signal controller unit installed, and fully operational to the satisfaction of the engineer.

9300.0. INTERSECTION MATERIALS AND EQUIPMENT

9300.1. Controller Cabinet And Auxiliary Equipment

1. The traffic signal controller cabinet shall consist of an unpainted aluminum controller cabinet box of the size and general construction as shown in the plans. Controller cabinets shall be cast aluminum or 0.125 inch reinforced sheet aluminum alloy and shall be of clean-cut design and appearance. All equipment inside the controller cabinet box, including the traffic signal controller unit, shall also be included in this pay item as described in this specification. All components necessary to complete the Traffic Signal Controller Cabinet shall be new and supplied by the contractor unless stated otherwise in the plans and specifications.

2. The cabinet and auxiliary equipment shall conform to the requirements of the National Electrical Manufacturer′s Association (NEMA) Standard TS2 Type 2, most current revision, and to these specifications. The hybrid cabinet shall feature direct communications from the controller to the detection components and from the controller to the malfunction management unit (MMU). Back panel operation shall be TS-1 standard operation.

3. Cabinet: The controller cabinet box shall be made of sturdy unpainted aluminum having no sharp edges, corners or projections. The cabinet shall contain two aluminum shelves for the controller and associated equipment. The cabinet shall be furnished with all of the hardware necessary for assembly and installation. Cabinet to be mounted on a metal riser shall be mounted using a 15-inch high aluminum riser manufactured from the material similar to the cabinet. Cabinet installation shall be in accordance with the Plan drawings.

4. Cabinet Door: A hinged door shall provide complete access to the interior of the cabinet. Door holds shall be provided that secure the door in an open position. Various opening angles shall be provided with at least one stop providing a 90 degree opening from the closed position. The doors shall fit against a rain-tight non-gassing sealed neoprene gasket. Each main cabinet door shall have a No. 2 Corbin cabinet lock and provisions for locking with a padlock. The handles for each door shall swing outward.

5. A maintenance panel containing test switches shall be located on the inside of the main door. These switches shall include the following: Controller Power; Auto/Run/Stop Time; and, Signal Flash/Auto.

6. Where possible, door switches should be protected with a barrier or cover to reduce the possibility of accidental contact with the door switches when the door is open for maintenance.

7. The controller and conflict monitor shall be wired on the same power terminal and be simultaneously controlled by a controller "On – Off" switch on the inside panel of the controller cabinet door.

8. One AC+ convenience duplex outlet with a 3-wire grounding type receptacle shall be provided and be easily accessible. This receptacle shall be separately fused from the main AC+ circuit breaker. Additionally, two six position duplex, circuit breaker protected outlets shall be installed on the left side of the cabinet for powering auxiliary devices.

9. Police Compartment: A smaller police compartment with a hinged door and skeleton key lock mechanism shall be recessed into the main door. Access to the police door compartment shall not provide access to the interior of the controller cabinet. Within the police door shall be terminal block terminations for a future manual control cord with one button. Three control switches shall be provided. The three switches, from left to right, shall have the following functions:

a. Controller On/Off – Removes signal displays to signal heads when in off position.

b. Auto/Flash – Coverts from normal field displays to emergency flash display when in flash mode.

c. Controller/Manual – Transfers control of the green indication time from the traffic signal controller to the manual control cord when in manual mode.

d. The three, two-position switches shall be labeled with permanently attached metal tags.

10. When provided, and in manual control, the green indication shall advance to the next phase/phases allowed according to programmed ring structure only upon pressing of the manual control cord button. All yellow and red time shall be timed by the controller using its pre-programmed settings.

11. Two keys shall be furnished for each type lock used. The door hinges and pins shall be of corrosion-resistant metal. Pins shall be rolled or solid rod, at least 1/8 inch in diameter, except if continuous hinges are furnished, the pins

shall be continuous the full length of the hinges, and shall be no less than 1/16 inch in diameter.

12. Cabinet Fans: Cabinets housing solid state controllers shall have a thermostatically controlled ventilating fan with exhausting capability in an enclosure of at least 150 cubic feet per minute (0.07 m3/s) for cabinets up to 30.5 cubic feet (0.9 m3) and at least 250 cubic feet per minute (0.12 m3/s) for cabinets 30.5 cubic feet (0.9 m3) and more, installed in the top of the cabinet. Cabinets shall be supplied with a replaceable furnace-type fiberglass filter of at least one square foot (0.06 m2) area mounted behind louvers in the lower one-fourth of the door. The filters shall be of the dry type and easily removed and replaced and be of standard dimensions commercially available. The cabinet duct fan unit shall be fused separately and wired after the main AC+ circuit breaker.

13. Cabinet Light. The cabinet shall be furnished with two LED lighting panels. One light panel shall be secured to the top of the controller cabinet. One light panel shall be secured to bottom of the lowest controller cabinet shelf to illuminate the field wiring and front of the back panel. Securing method shall allow removal of the panel for modular replacement. Securing method shall not insert a hole into the metal panel holding the light panel. Each light panel shall consist of 6 super bright Silver Circuit LEDs. Each panel shall draw approximately 15 watts. Both LED light panels shall be controlled by a single on-off switch. The lamp shall be wired into the main cabinet power circuit and not obtain power from the convenience outlet. A light on/off switch shall be mounted facing the door and within 8 inches of the main door when closed. Light switch shall be permanently labeled CABINET LIGHT.

14. All field terminals shall be suitably identified and accessible without removal of equipment contained in the cabinet.

15. The cabinet shall be provided with a 12-position back panel. Load switches 1 through 8 shall correspond directly to phases 1 through 8. Pedestrian phases 2, 4, 6, 8 shall correspond directly to load switches 9, 10, 11, 12. If other phases or overlaps are called for in the plans, the contractor may modify this standard – to the least extent necessary to provide the required phase and overlap assignments. The back panel in all controller cabinets shall be hinged at the bottom to permit the top of the panel to be rotated forward and down to an angle of no less than 45 degrees with all components, including load switches, attached for maintenance purposes. The bottom of the back panel shall be no less than 6 inches (150 mm) above the bottom of the cabinet. Stops shall be installed so that the hinge supports the back panel in the horizontal position.

16. All cabinet wiring shall be neatly trained throughout the cabinet and attached to the interior panels using nonconductive clamps or tie-wraps. Except wiring leading to the devices outside the controller cabinet, all wiring

in the cabinet shall be factory assembled. Factory-assembled bundles of cables shall be laced or tied or enclosed in a sheathing material. The cabinet wiring shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors. Except where terminated by direct soldering, all wires shall be provided with terminal lugs for attachment to terminal blocks using screws. All wires shall be identified and labeled in accordance with the cabinet wiring prints.

17. All 120 VAC wire insulation shall have a minimum rating of 600 volts; 24 VDC wire shall have a minimum rating of 300 volts.

18. Molded composition barrier type terminal blocks shall be used for termination of the incoming and outgoing signals within the cabinet assembly. Each terminal block shall be of one-piece construction with a minimum of twelve terminals. Each terminal shall have a threaded contact plate with a binder head screw. The terminal blocks shall have a minimum rating of 600 volts. All terminals shall be identified and labeled in accordance with the cabinet wiring diagram.

19. The terminal block facilities shall be arranged in function groupings and mounted to either panels or brackets fastened to the interior walls of the cabinet. Each terminal block shall be retained using either machine or self-tapping screws and shall be easily removed and replaced.

20. The minimum terminals are as follows:

a. Terminal with circuit breaker with integral power line switch for the incoming power line.

b. Terminal unfused for the neutral side of the incoming power line.

c. Terminals for all required auxiliary equipment.

d. Terminals for vehicle phase detector and pedestrian push button cables. Terminals for vehicle detectors include AC+, AC neutral, relay common, relay closure, and the loops or probes from the field.

e. Terminals for system detectors shall be provided on cabinets where inductive loop leads are specified. When specified, these terminal blocks shall be a separate terminal block and labeled with the detector numbers.

f. Terminals and bases for signal flasher and outgoing signal field circuits.

g. Terminals for all controller input and output circuits including those circuits not used on the project.

h. Terminals for interconnect.

21. Adequate electrical clearance shall be provided between terminals. The controller, auxiliary equipment, panel(s), terminals and other accessories shall be so arranged within the cabinet that they will facilitate the entrance and connection of incoming conductors.

22. The outgoing signal circuits shall be of the same polarity as the line (+) side of the power service. The incoming signal indication conductors shall be common and of the same polarity as the grounded (-) side of the power service. The neutral (-) side of the power service shall be connected to the cabinet in an approved manner to a copper ground bus located on the panel with the main AC+ circuit breaker. The neutral conductor shall not be connected to the Earth Ground unless the power service feeder is within 25 feet of the cabinet when installed. Grounding rods shall not be installed in the controller base. See Plan drawings for grounding rod installation and connection. The cabinet shall, in turn, be connected to an earth ground through a ground rod, mounted external to the cabinet at the nearest hand hole or junction box.

23. Electrical Design: The distribution of the 120 VAC throughout the cabinet shall not occur until the AC+ has first passed through the power protection devices.

24. The cabinet shall be provided with power protection devices that include the main AC+ power circuit breakers, radio interference suppressors, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controller and auxiliary equipment. The protection devices shall be mounted on a panel that is securely fastened to an interior wall of the cabinet.

25. Each cabinet shall contain a separate aluminum power panel containing the following equipment:

a. Two Type B circuit breakers. One 40 amp breaker shall interrupt power to the controller and signals. The second Type B circuit breaker shall be an auxiliary 15 amp breaker that interrupts power to the traffic signal controller unit.
b. One mercury contactor controlling power to the signal bus.
c. One radio frequency line filter.
d. One line surge protector.
e. One terminal block for alternating current power input.
f. One ground bus terminal block.
g. One isolated neutral bus terminal block.

26. Radio interference suppressors (RIS), adequate in number to handle the power requirements for the cabinet, shall be wired in series with and after the main AC+ circuit breaker. The RIS shall be designed to minimize interference in all broadcast, transmission and aircraft frequency bands.

27. The controller cabinet shall be furnished with a lightning arrestor on the AC service. The surge suppressor shall be an SHA-1210 manufactured by EDCO Inc., or approved equal that meets or exceeds the following requirements:

a. The unit must be capable of withstanding repeated 20,000-ampere surges (minimum of 25).

b. The unit must have internal follow current limiters (resistive elements).

c. The unit shall contain a minimum of three (3) active clamping stages.

d. The unit must self-extinguish within 8.3 milliseconds after trailing edge surge.

e. Parallel impedance of limiters must be less than 15 ohms.

28. Modular Design: Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller or auxiliary device can be replaced with a similar unit (modular design), without the necessity of disconnecting and reconnecting the individual wires from terminals. This may be accomplished by means of a multiple pin twist lock connector, a spring connected mounting or approved equivalent arrangement.

29. Traffic Signal Controller Unit: Refer to the Standard Specifications, City of Joplin for this pay item. One traffic signal controller unit shall be included as part of this pay item.

30. Load Switches: All load switches shall conform to the triple-signal solid-state type load switch as specified in the NEMA Standard No. TS1-1983. Dual-signal type load switches shall not be allowed. LED indicator lights shall be provided on the front of the load switch to designate the active circuit. Regardless of the number of phases specified on the plans, all load switch positions shall be completely wired for use. All load switches shall be included as part of controller cabinet pay item.

31. Flash Operation: The unit shall contain a power and flash transfer relay assembly to transfer the AC+ power and operation from the controller and load switches to the solid state flasher. This transfer relay assembly shall be

controlled by either the "AUTO-FLASH" mode switch located on the Police Panel or the conflict monitor. The flasher shall remain operational with the controller removed from the cabinet. The rate of flash shall be 50-60 flashes per minute with equal on and off intervals. The cabinet shall be wired to flash red in all approaches. All red indications – circular and arrow sections to an approach - shall flash at the same time. The approaches shall be separated over the two channels of the flash loadswitch so that opposing directions flash at the same time, crossing directions flash during the off stage. A minimum of two flasher units shall be installed in each controller cabinet.

32. The plug-in transfer relays shall be rated at a minimum of 10 amps per pole and shall be enclosed in a transparent case for protection against dust and for visual observance of operation. A minimum of four flash transfer relays shall be installed in each controller cabinet.

33. Malfunction Monitor Unit: The MMU shall monitor the operation of the traffic signal controller according to TS-2 definitions. The MMU shall monitor the operation of the field indications by TS-1 definitions. In the event of a power interruption, the MMU shall be capable of automatic reorientation upon power resumption and shall require no manual initiation or switching to allow the traffic controller to resume normal operation when all components and incoming power meet NEMA acceptable definitions. The MMU shall connect to the controller using a TS-2 BIU definition cable.

34. The MMU shall utilize liquid crystal displays providing four indicators which display an active Red, Yellow, Green, and Walk input for each channel monitored. The conflict monitor shall have extended features allowing the display of multiple indications for a single phase occurring on a signal head to be recognized as a conflict.

35. The conflict history of the MMU shall be accessible by communication with the traffic signal controller unit through central office software. The MMU shall be IP addressable and have a built in Ethernet communication port.

36. Detector Card Rack: The controller cabinet shall be wired with a 14-slot TS-2 detector rack and power supply. This unit shall be supplied and fully wired for non-inductive loop application utilizing the BIU cabling for generating detector inputs to the controller unit unless specified otherwise in the Plans. The detector card rack shall be wired so that any TS-2 two-channel detection card may be inserted and be made functional without additional cabinet wiring changes. When inductive loop detectors are specified, all slots shall be wired for use of two and four channel detector devices and shall include detector panels mounted on the lower left side of the cabinet for field connections.

37. Video Image Detection: See Standard Specifications, City of Joplin.

38. Magnetometer Detection System: See Standard Specifications, City of Joplin.

39. Inductive Loop Detectors: See Standard Specifications, City of Joplin.

40. CMIC Enclosures: Each cabinet shall be equipped with two each combination splice/termination enclosures, regardless of fiber optic cable installation shown on the plan set. Enclosures shall be SEICOR Model MIC-024 Series or preapproved equal. The enclosures shall be mounted under the controller unit shelf and above the back panel on the left side, opposite from the power source input. Each enclosure shall be provided with two each 12 position splice trays and 24 each termination ST connectors, ceramic ferrule, single-mode compatible, in front panel-mounted ST Couplers arranged in two rows. Each row of ST Couplers shall have two sets of 6 couplers. The top row shall be for fiber incoming and the bottom row shall be fiber departing, or as shown on the Plans as terminated fibers. All fibers used in any single tube shall be terminated or spliced. Unused tubes of fiber shall be coiled and be a minimum length of ten feet. All fibers terminated shall be secured in a fan out kit prior to the splice or the junction to the pigtail.

41. All connections in the cabinet to external devices shall be by duplex fiber Patch Cords of a length to easily reach the devices but not so long as to be pinched or cut by other devices, door openings, etc. Contractor shall provide patch cords in quantity needed to complete the fiber connections shown in the wiring plan set. All splices shall be a fusion splices. Fusion splices to pigtails shall utilize a 900 micron coated pigtail. All fusion splices to pig tail connectors shall use heat shrink with a metal strip for support. The pigtail splice connection shall be provided with a second heat shrink that covers the entire section of the splice area that includes a portion of the fan out kit on one side to the 900 micron coated area of the other side. Fusion splices to individual splices shall be enclosed in a splice tray in non-metallic guides.

42. Field Wiring: All cables shall be neatly trained as a single bundle to exit the conduit and proceed immediately as a unit to the left side of the cabinet. The cable bundle shall be wire-tied to prevent unintended relocation of cables. Cables not terminated on the left panel shall be laid on the cabinet floor adjacent to the cabinet wall and follow the cabinet wall clockwise around the cabinet to reach its destination. In this manner the resulting, neatly trained cables shall leave the concrete floor largely visible and available for placement of tools for maintenance.

43. Exposed ground wires shall be grouped together as a single unit to as few terminal points as practical. Ground wires shall be terminated fairly taut. The objective is to minimize opportunity for accidental contact of a tool between a ground cable and an energized cable, which may damage electrical equipment. The engineer shall be the sole judge as to whether electrical cabling within the

cabinet has been trained in a workmanship manner satisfactory to accept the installation.

44. Documentation: The manufacturer shall provide three sets of computer drafted controller cabinet prints drawn in a fashion to spatially represent the components inside the controller cabinet. The cabinet prints shall identify all hardwired components in the cabinet corresponding to their labeling in the cabinet. The contractor shall provide two copies of all current manuals for the associated equipment. The copies shall be delivered in clear, plastic, open, reusable bags suitable to protect the manuals from water damage while stored in the cabinet. The contractor shall place the documentation in the cabinet.

45. Cabinet wiring diagrams shall include two sheets. One sheet shall indicate the manufacturer point to point wiring of the terminal facility complete with all harnesses for the controller unit and the conflict monitor. This drawing shall be an unaltered generic drawing. The second drawing shall indicate the electrical connections of all equipment and terminal connections for the traffic control cabinet for each cabinet provided. The drawings shall include pictorial representations of the intersection geometrics and phasings. Detectors shall be positioned for each approach and lane, being tagged with its harness (rack/slot) assignment. The controller cabinet shall be positioned and shown as a rectangle with the two crossing diagonal lanes. In addition to the three sets of wiring diagrams specified above, one Mylar copy shall be provided to the Engineer at the time of turn on at the intersection.

46. The entire controller unit shall be warranted to be free from defects in workmanship and materials for a minimum of one year from date of acceptance. Any parts found to be defective shall be replaced free of charge.

47. The City shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, then a list of those exceptions must be detailed on the certification.

48. The Signal Equipment Supplier shall provide a customized intersection graphic (CPU) depicting the local intersection for each intersection provided. The customized intersection shall include the following: correct number of lanes by function for each approach; graphically correct orientation of the intersection layout; proper phase assignment by lane; proper pedestrian phase assignments; street names on the lanes; key landmark indicators shown in the graphics. The Engineer will provide an 8 ½ x 11 pictorial of the intersection geometrics and the key landmark indicators to be shown in the graphic. System detectors shall be shown on the graphic and labeled in accordance with the card rack/slot plus system detector assignment numbers. Orientation for all intersection displays shall be North as top of screen.

49. The addition of any local intersections requires the (CPU) Master Map to be modified. The Signal Equipment Supplier shall provide a corrected map graphic for each intersection added to the group. The map graphic shall include geometrically proportioned locations of the intersections plus locations of all system detectors for each location. A table shall be provided on the graphic which displays the current assignment of detectors by DR., DR2, CS1, CS2, NA1, and NA2. Modified maps shall be loaded into the computer system and viewed for proper operation. Orientation of the map shall be as selected by the Engineer to best display the System Operation.

50. Burn-in Period: The traffic signal controller cabinet shall operate continuously for 30 days after turn on without a conflict flash occurrence. If the intersection experiences a conflict flash condition, the contractor shall be present on site within four hours and shall stay until the intersection is operating normally. If the contractor does not respond, the city shall address the outage under emergency maintenance. All charges, by city forces or by private contractor, shall be the responsibility of the contractor to pay directly. Final payment will not be released until receipts of the paid charges have been received by the engineer. Upon reinstatement of normal operation, the 30 day burn-in period will be restarted. The contractor shall send the city a letter informing the city that the burn-in period is complete. Upon verification by the engineer that the burn-in period has run for a full 30 days, payment for Traffic Signal Controller Cabinet may be released.

51. Measurement and Payment: Payment shall be per each traffic signal controller cabinet with all components as described in this section. Items covered under this pay item include all items, components, and modules housed in the traffic signal controller cabinet other than field wiring. The following list is not all inclusive but provided for illustration. The following items are included under this pay item: Traffic signal cabinet, Local Ethernet Switch, traffic signal controller unit, malfunction monitor unit, load switches, flasher switches, flash transfer relays, terminal blocks, shelving, detector rack, detector device(s), and fiber optic termination enclosures.

Example of items that shall be included in this pay item, if specified in the special provision or signal plans, include: pre-emption cards, pre-emption card racks, pre-emption power supply, battery backup units, traffic monitor system, etc.
Payment shall be made for each traffic signal controller cabinet provided, installed, wired in a high-quality workmanship-like manner and fully operational to the satisfaction of the Engineer.

9302.0. VEHICLE DETECTION

9302.1. Inductive Loop Vehicle Detector

1. This specification contains the minimum design and operating requirements for solid state, digital inductive loop vehicle detectors capable of detecting the presence of a moving or standing vehicle.

2. A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and a sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.

3. Sensor (Amplifier) Unit

a. The sensor unit shall be solid state, digital, providing detection channel(s) with a minimum inductance range of 50 to 1500 micro-henries. Output circuits of the sensor unit shall be provided by relays. Vehicle presence shall result in a continuous call indication.

b. Utilize EDI LM602TR, dual channel, NEMA card rack compatible detector units or preapproved equal.

4. The sensor unit shall have the following qualities:

a. Sensitivity adjustment to allow as a minimum the selection of high, medium or low sensitivity.

b. Be capable of providing reliable detection of all licensed motor vehicles.

c. Provide an indicator light for visual indication for each vehicle detection.

d. Will not require external equipment for tuning or adjustment.

e. Provide operation in the pulse mode or presence mode. Mode to be switch selective on the front panel of the unit.

f. Provide a self-tuning system which is activated automatically with each application of power. Automatic and continuous fine tuning shall

be provided to correct for environmental drift of loop impedance.

g. Provide for fail-safe operation (continuous call) in the event of detector loop failure.

h. Each detector channel shall respond to a frequency shift in an increasing and/or decreasing value as occurs with temperature shifts in the pavement without requiring a locked call during the period of returning.

5. The sensor unit shall be capable of normal operation without interference and false calls between sensor units ("crosstalk") when installed in the physical environment of the controller cabinet and the electrical environment of the associated electronic equipment installed therein, including other detectors.

6. It shall be possible to install the connecting cable in the same conduit as the signal cables, power cables and other detector cables without affecting the normal operation of the detector.

7. Loop detector sensor units shall conform to current requirements of NEMA Standard TS1-1983 for installation in both a TS-1 and TS-2 detector rack assembly.

8. A documentation package shall be supplied with the sensor units which shall include two complete sets of schematic diagrams; descriptive parts lists; and instructions for maintenance and operation of the units.

9. Detector assignments shall be as defined on the plans.

10. Guarantee: The equipment furnished under this specification shall be new, of the latest model, fabricated in a first-class workmanship manner from good quality material. The detector sensor unit shall be warranted to be free from defects in workmanship and materials for one year from date of shipment. Any parts found to be defective shall, be replaced free of charge.

11. The Owner shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, then a list of those exceptions must be detailed on the certification.

12. Basis of Payment: Payment shall be per each inductive loop sensor unit installed in traffic signal controller cabinet with all functions as described in this section.

9302.2. VIDEO IMAGE DETECTOR SYSTEM

1. This specification sets forth the minimum requirements for a system that detects vehicles on a roadway using only video images of vehicle traffic. The video detection system shall consist of one to four video cameras, a video detection processor (VDP) for each camera which mounts in a standard TS-2 detector rack; a detector rack mounted SDLC module, surge suppressor for each video input, an EACCESS Ethernet Module, and a pointing device.

2. The system shall include software that detects vehicles in multiple lanes using only the video image. Detection zones shall be defined using only an on board video menu and a pointing device to place the zones on a video image. Up to 24 detection zones per camera shall be available. A separate computer shall not be required to program the detection zones.

3. The VDP shall process video from one video source. The source can be a video camera, DVD or video tape player. The video shall be input to the VDP in NTSC or PAL composite video format and shall be digitized and analyzed in real time. The VDP shall detect the presence of vehicles in up to 24 detection zones per camera. A detection zone shall be approximately the width and length of one car, except for applications utilizing count operation where the loop may be smaller in size.

4. Detection zones shall be programmed via an on-board menu displayed on a video monitor and a pointing device connected to the VDP. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. The VDP shall store up to three different detection zone patterns. The VDP shall be able to switch to any one of the three different detection patterns within 1 second of user request via menu selection with the pointing device or by remote access via an Ethernet IP Address link. Each configuration shall be uniquely labeled for identification and the currently active configuration indicator shall be displayed on the monitor.

5. The VDP shall detect vehicles in real time as they travel across each detector zone. The VDP shall have an EIA232 port for communications with an external computer. A Windows™-based software designed for local or remote connection and providing video capture, real-time detection indication and detection zone modification capability shall be provided with the system or a Web Browser based software system.

6. The VDP shall transfer the current active vehicle calls to the SDLC card for processing to the controller as valid detection calls. Each detector zone shall be assignable as a single detector or a collection of several zones as a single detector input. All inputs and monitoring of phase signal status shall be accomplished by the SDLC Module. The SDLC shall provide one or more modules as required to support a minimum of 64 detector inputs from the VID System to the traffic controller.

7. The system shall be capable of automatically detecting low-visibility conditions such as fog and respond by placing all defined detection zones in a constant call mode. A user-selected output shall be active during the low-visibility condition that can be used to modify the controller operation if connected to the appropriate controller input modifier(s). The system shall automatically revert to normal detection mode when the low-visibility condition no longer exists.

8. A minimum of 24 detection zones shall be supported and each detection zone shall be user definable in size and shape to suit the site and the desired vehicle detection region. The VDP shall provide up to 24 output channels of vehicle presence detection per camera through a standard detector rack SDLC Modules using one or more modules. A single detection zone shall be able to replace multiple inductive loops and the detection zones shall be logically OR'ed as the default or may be logically AND'ed together to indicate vehicle presence on a single phase of traffic movement.

9. Detection zone outputs shall be configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse, extend, and delay outputs shall be user definable between 0.1 to 25.0 seconds. Up to six detection zones shall be capable to count the number of vehicles detected. The count value shall be internally stored for later retrieval. The zone shall also have the capability to calculate and store average speed and lane occupancy at bin intervals of 10 seconds, 20 seconds, 1 minute, 5 minutes, 15 minutes, 30 minutes and 60 minutes. This recording is separate and in addition to the use of the detector inputs into the traffic controller count or system inputs.

10. The VDP shall provide dynamic zone reconfiguration (DZR) to enable normal detector operation of existing channels except the one where a zone is being added or modified during the setup process. The VDP shall output a constant call on any detection channel corresponding to a zone being modified. The VDP shall output a constant call for each enabled detector output channel if a loss of video signal occurs. The VDP shall also output a constant call during the background learning period.

11. The VDP, SDLC Module and EACCESS Module shall be specifically designed to mount in a standard NEMA TS-1, TS-2 type detector rack, using the edge connector to obtain power and provide contact closure outputs. No adapters shall be required to mount the VDP or other modules in a standard detector rack. Detector rack rewiring shall not be required. The VDP and EM shall include detector output pin-out compatibility with industry standard detector racks.

12. The VDP and other modules shall operate in a temperature range from -34°C to +74°C and a humidity range from 0%RH to 95%RH, non-condensing. The VDP and other modules shall be powered by 12 or 24 volts DC. These modules shall automatically compensate for the different input voltages. VDP power consumption shall not exceed 300 milliamps at 24 VDC.

13. The VDP shall include an EIA232 port for serial communications with a remote computer. The VDP EIA232 port shall be multi-drop compatible. This port shall be a 9-pin "D" subminiature connector on the front of the VDP. The VDP shall utilize flash memory technology to enable the loading of modified or enhanced software through the EIA232 port without modifying the VDP hardware.

14. The front of the VDP shall include detection indications, such as LED's, for each channel of detection that display detector outputs in real time when the system is operational. The front of the VDP shall include one BNC video input connector suitable for RS170 video input. The video input shall include a switch selectable 75-ohm or high impedance termination to allow camera video to be routed to other devices, as well as input to the VDP for vehicle detection. RCA type connectors/jacks for video input are not allowed. Video shall not be routed via the edge connectors of the processor. The front of the VDP shall include one BNC video output providing real time video output that can be routed to other devices. The front panel of the VDP and EM shall have a detector test switch to allow the user to place calls on each channel. The test switch shall be able to place either a constant call or a momentary call depending on the position of the switch.

15. The contractor shall install a four port video server, IP Addressable for viewing all four cameras of a four-camera VID installation remotely on a separate computer. This requirement is in addition to the single display transmission via the Ethernet Access Module. The video feed from the VDP shall be coupled to feed both the video server and the E-ACCESS Module device. The video server shall be connected to the Ethernet switch as a separate input and addressable device. The four port video server shall be MPEG 2 or MPEG 4 video compression. Software for the video server shall be furnished and installed on the central computer at Traffic Operations.

16. A coaxial cable shall be used between the camera and the VDP in the traffic cabinet and shall be Belden 8281. The coax cable shall be a factory lead cable from the camera to a connection point at either the mast arm mount or the base of the mast arm pole. This lead cable is to insure a proper camera point of installation. From the connector point a second Belden 8281 cable shall be installed continuously without splice to the VDP. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. BNC plug connectors shall be used at both the camera and cabinet ends. The coaxial cable, BNC connector, and crimping tool shall be approved by the supplier of the video detection system, and the manufacturer's instructions must be followed to ensure proper connection.

17. The power cabling shall be 16 AWG three conductor cable with a minimum outside diameter of 0.325 inch and a maximum diameter of 0.490 inch. The cabling shall comply with the National Electric Code, as well as local electrical codes. The contractor installed video detection camera shall be supervised by factory-certified installers as recommended by the supplier and documented in installation materials provided by the supplier.

18. The camera enclosure shall be equipped with separate, weather-tight connections for power and setup video cables at the rear of the enclosure. These connections may also allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole using a lens adjustment module (LAM) supplied by the VDP supplier. Video and power shall not be connected within the same connector.

19. Camera placement height shall be as shown on the Plans and over the traveled way on which vehicles are to be detected. For optimum detection the camera should be centered above the traveled roadway. The camera shall view approaching vehicles at a distance not to exceed 350 feet for reliable detection (height to distance ratio of 10:100). Camera placement and field of view (FOV) shall be unobstructed and as noted in the installation documentation provided by the supplier.

20. Each traffic controller cabinet shall be provided with an Ethernet Access Module (E-ACCESS Module). One Ethernet Access Module shall be provided for each four camera systems installed in a controller cabinet. This interface device shall provide capabilities to enable multiple rack-mounted video detection processors to be locally and remotely accessed from a single point via one set of user interface devices. Up to four video detection processor chains (video detection processor and extension modules) shall be accommodated.

21. The device shall allow the operator to switch video output display for any of the attached rack-mounted video detection processors by pressing a

momentary switch or by using the remote access software or Web Browser. All local programming and setup parameters for the video detection processor shall be user accessible through the interface unit without requiring the user to swap user interface cables between video detection processors. An internet browser-based remote access firmware shall also be available for remote setup and diagnostics. Browser-based remote access software shall not require any proprietary software to be installed on the user's personal computer. The interface unit shall support streaming video technology using MPEG-2 standards to allow the user to monitor video detection imagery.

22. This interface device shall occupy no more than two slots in the detector rack and shall provide a loop-type handle for easy installation and removal. This device shall be powered by 12 or 24 volts DC and shall not consume more than 6.25 watts. The unit shall automatically compensate for the different input voltages and shall be hot-swappable. Video Ports - The interface unit shall accommodate a maximum of four composite video inputs and one video output.

23. Video inputs and video output shall be made via BNC connectors to ensure secure connections. RCA or other straight friction plug-in type connections shall not be allowed. Video inputs shall use a factory supplied "octopus" cable to accommodate the four video inputs. Provisions shall be made to accommodate the mating cable to utilize jack screws for securing the octopus cable. The interface unit shall accommodate either monochrome or color video signals conforming to NTSC or PAL video standards. The interface unit shall interface with up to four video detection processors using RJ-45 interface connectors. The interface unit shall support the use of USB pointing devices. The unit shall support either a USB mouse or trackball. Pointing devices shall not require vendor specific pointing device software drivers.

24. The Ethernet port shall be integrated within the interface unit. The Ethernet port shall conform to 802.3 Ethernet specifications and shall auto-sense between 10 and 100 Mbps data rates. Industry standard TCP/IP (UDP and TCP packets) protocol shall be supported. The Ethernet connection shall be made through a RJ-45 connector.

25. Each installation shall include a minimum of one to four video cameras. Video detection cameras used for traffic detection shall be furnished by the video detection processor (VDP) supplier and shall be qualified by the supplier to ensure proper system operation. The camera shall produce a useable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from nighttime to daytime, but not less than the range 1.0 lux to 10,000 lux. The imager luminance signal to noise ratio (S/N) shall be more than 50 Db.

26. The camera shall be digital signal processor (DSP) based and shall use a CCD sensing element and shall output color video with resolution of not less than 470 TV lines. The CCD imager shall have a minimum effective area of 768(h) x 494(v) pixels. The camera shall include an electronic shutter control based upon average scene luminance and shall be equipped with an auto-iris lens that operates in tandem with the electronic shutter. The camera shall utilize automatic white balance.

27. The camera shall include a variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry by means of a portable interface device designed for that purpose and manufactured by the detection system supplier. The horizontal field of view shall be adjustable from 5.4 to 50.7 degrees. This camera configuration may be used for the majority of detection approaches in order to minimize the setup time and spares required by the user.

The lens shall be a 10x zoom lens with a focal length of 3.8mm to 38.0 mm. The lens shall also have an auto-focus feature with a manual override to facilitate ease of setup.

28. The camera shall incorporate the use of preset positioning that store zoom and focus positioning information. The camera shall have the capability to recall the previously stored preset upon application of power. The camera electronics shall include automatic gain control (AGC) to produce a satisfactory image at night. The camera shall be color.

29. The camera shall be housed in a weather-tight sealed enclosure. The enclosure shall be made of 6061 anodized aluminum. The housing shall be field rotatable to allow proper alignment between the camera and the traveled road surface. The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view. The camera enclosure with sunshield shall be less than 6" diameter, less than 18" long, and shall weigh less than 6 pounds when the camera and lens are mounted inside the enclosure.

30. The enclosure shall be design so that the pan, tilt and rotation of the camera assembly can be accomplished independently without affecting the other settings. The camera enclosure shall include a proportionally controlled heater, where the output power of the heater varies with temperature, to assure proper operation of the lens functions at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure. The glass face on the front of the enclosure shall have an anti-reflective coating to minimize light and image reflections. The glass face shall also employ a special coating to minimize the buildup of environmental debris such as dirt and water.

31. When mounted outdoors in the enclosure, the camera shall operate satisfactorily in a temperature range from -34 °C to +60 °C and a humidity range from 0% RH to 100% RH. Measurement of satisfactory video shall be based upon VDP system operation. The camera shall be powered by 120-240 VAC 50/60 Hz. Power consumption shall be 45 watts or less under all conditions. An optional DC power configuration shall be available for 12 VDC operation.

32. The camera enclosure shall be equipped with separate, weather-tight connections for power and video cables at the rear of the enclosure. These connections may also allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole using a lens adjustment module (LAM) supplied by the VDP supplier. Video and power shall not reside within the same connector. The video signal shall be fully isolated from the camera enclosure and power cabling.

33. The video image detection system shall interface with the Central Office Computer System utilizing the VRAS Software System for remote operation on local laptop computers and the WEB Browser of the ATMS System. All software shall be modified to add any new intersection to the central system software system.

34. Basis of Payment: Payment shall be per each video image detector system installed in traffic signal controller cabinet with all functions as described in this section. The VID Cameras shall be paid for on a per unit basis complete with fifty (50) feet lead-in cable to the nearest connection terminal point, termination enclosure, and contractor installed lead-in cable from the termination point to the traffic controller cabinet.

9302.3 MAGNETOMETER DETECTION SYSTEM

1. This specification sets forth the minimum specifications for a system that detects vehicles on a roadway using battery powered magnetometers utilizing wireless communications to transmit detection information to the controller and a central server.

2. The wireless battery powered Magnetometer (vehicle) Detection System shall consist of one or more Vehicle Sensor Nodes per lane, Wireless Repeaters mounted on the side of the roadway, one or more Access Point mounted on the side of the roadway, and Contact Closure and Extension Interface Card. Communications between the Vehicle Sensor Node and the Access Point shall be wireless.

3. The Vehicle Sensor Node shall detect a Vehicle by measuring a change in the earth's magnetic field near the Vehicle Sensor Node caused by the vehicle (i.e. magnetometer type detection). The Vehicle Sensor Node shall transmit detection information within 125ms of a detected event. The Vehicle Sensor Node shall automatically recalibrate in the event of a detector lock.

4. Each VDS system shall consist of one or more Vehicle Sensor Node's per lane located as identified on the intersection plans. Communications between the Vehicle Sensor Node and the Access Point shall be wireless.

5. The RF link among the Access Point, Wireless Repeater, and Vehicle Sensor Node shall conform to the following:

a. The RF link shall utilize an IEEE approved wireless communications protocol.

b. Communications is allowed only in an unlicensed band.

c. The Vehicle Sensor Node and Wireless Repeater shall be reconfigurable by a user over the wireless interface to avoid interference from other users of the communications band. A minimum of 16 channels shall be provided for this purpose.

d. The RF link budget shall be 93dB or greater.

e. The Access Point to Vehicle Sensor Node (or Wireless Repeater to Vehicle Sensor Node) RF range shall be at least 150 feet for an Access Point/ Wireless Repeater installed at 24 feet above the roadway and at least 100 feet at 18 feet above the roadway.

f. The Wireless Repeater to Access Point RF range shall be at least 750 feet when both units are installed 18 feet above the roadway.

g. Each Vehicle Sensor Node shall transmit a unique identifying code.

h. The Vehicle Sensor Node shall respond within 100 seconds when the Access Point is powered on.

i. When no Access Point is present or powered on, the Vehicle Sensor Node is not required to detect Vehicles.

j. The Access Point shall have the capability to transmit detection information to a centralized server over a cellular data connection, or an Ethernet connection, or a serial link. This link shall be installed when specified on the Plans.

k. The Access Point shall have the capability to transmit detection information to a NEMA TS-1 or TS-2 traffic controller to provide real time detection information via a standard contact-closure based input shelf or a TS-2 BIU. The required contact input interface shall be per the Plans, retrofit TS-1 cabinets shall be provided with the Contact Closure and TS-2 cabinets shall be provided with the TS-2 BIU interface.

l. The Vehicle Sensor Node, Wireless Repeater and Access Point shall be capable of accepting software and firmware upgrades without the requirement to upgrade chip sets – that is, upgrade of software shall be Flash Memory.

6. The Vehicle Sensor Node shall consist of a magnetometer, a microprocessor, a wireless transmitter and receiver, and a battery and shall conform to the following:

a. The Vehicle Sensor Node components shall be contained within a single housing.

b. The Vehicle Sensor Node housing shall comply with NEMA 6P and IP68 standards.

c. The Vehicle Sensor Node components shall be fully encapsulated within the housing to prevent moisture from degrading the components.

d. The Vehicle Sensor Node shall be able to operate at temperatures from -37˚F to +176˚F.

e. The Vehicle Sensor Node housing shall be capable of being installed in a 4 inch cored hole that is 2.25" deep.

f. The Vehicle Sensor Node shall be designed to operate from its battery for a minimum of ten years of life under normal traffic conditions.

7. The Access Point shall be the communication hub of the Sensor network and shall conform to the following:

a. The Access Point shall be powered via 48V DC, 3W or via non-isolated external 10 to 15V DC, 2W power. Power shall be provided by the Contact Closure Card.

b. The Access Point shall be able to communicate to up to 24 Vehicle Sensor Node's.

c. The Access Point shall have at least one powering option that provides 1500V isolation and 5KV surge protection.

d. The Access Point shall operate in the -37˚F to +176˚F temperature range.

e. The Access Point shall meet NEMA 4X and IP67 standards.

f. The Access Point shall be no larger than 12" H x 8" W x 4" D.

g. The Access Point shall weigh no more than 3 lbs.

h. The Access Point shall communicate to the controller via the Contact Closure and optional Extension Contact Closure Board(s) or TS-2 BIU Interface Card.

i. The Access Point shall be able to communicate back to a computer/server via Ethernet.

8. A Wireless Repeater shall be provided if required and shall conform to the following:

a. The Wireless Repeater shall extend the effective communication range of the Sensor to the Access Point an additional 750'.

b. The Wireless Repeater shall be battery powered.

c. The Wireless Repeater battery shall be field replaceable.

d. The Wireless Repeater shall operate in the -37˚F to +176˚F temperature range.

e. The Wireless Repeater shall meet NEMA 4X and IP67 standards.

f. The Wireless Repeater shall be no larger than 5" H x 4" W x 4" D.

g. The Wireless Repeater shall weigh no more than 3 lbs.

9. The Contact Closure and Extension cards shall provide detector outputs to the controller and shall conform to the following:

a. The Contact Closure shall communicate with the Access Point via an Ethernet cable.

b. The Contact Closure and Extension shall directly plug in to standard TS-1 and TS-2 NEMA detector racks, operator switch selectable.

c. Each Contact Closure and Extension cards shall provide up to 4 channels of detection.

d. The Contact Closure and Extension shall be able to provide pulse or presence detection outputs.

e. The Contact Closure and Extension card shall provide for up to 31 seconds of delay. The Contact Closure and Extension card shall provide up to 7.5 seconds of extension. The front panel of the Contact Closure and Extension cards shall provide: LED's displaying - Detection Channel Status; Line Quality; and, Fault Monitoring.
f. The Contact Closure and Extension card shall provide Ten Configuration DIP switches to enable Presence or Pulse Mode, Delay, and Extension.

g. The Contact Closure and Extension card shall provide Rotary Switch to program time functions for delay and extension function.

h. Two Ethernet style RJ45 connectors.

i. The Contact Closure and Extension cards shall be powered by 11 to 26 VDC.

j. The Contact Closure card shall provide power to the Access Point over the Ethernet cable.

k. The Contact Closure and Extension cards shall be surge protected to GR-1089 standards.

l. The Contact Closure and Extension cards shall operate -37˚F to +176˚F temperature range.

m. The Contact Closure and Extension cards shall operate in up to 95% humidity (non-condensing).

n. The Access Box shall provide a communication link between the Access Point and Contact Closure.

o. The Access Box shall have 3 Ethernet style RJ45 connectors.

p. The Access Box shall not exceed 2-3/8" x 1-1/2" x 7/8" in size.

10. The MDS shall include the SENSYS software necessary to configure the Vehicle Sensor Node, Wireless Repeater, and Access Point.

11. The MDS shall include the SENSYS software necessary to store and retrieve detection data.

12. Installation: The Contractor shall purchase one each Circular Core Drill device from the detector manufacture that is designed to properly core the four inch hole and shall furnish the device to the Engineer after installation of the detectors, the core is subsidiary to all pay items, there will be no separate payment for this item.

13. The Contractor shall furnish and install factory provided epoxy fill for the roadway based on the pavement surface where the detectors are being installed, that being asphalt or concrete. The Contractor shall be required to utilize the proper epoxy when temperatures are below or above the standard epoxy type rating.

14. The Contractor shall furnish and install the number of detector cards and Expansion Modules required providing one detector input to the traffic controller for each detector Sensor installed, as shown on the Plans. The Contractor shall be responsible to modify existing detector racks to accommodate the new detector, to include modification of the backplane of the detector rack for shared channel applications (crossover links between channels) where not currently installed. The Modules shall include a SDLC NEMA TS-2 interface card with Ethernet Port for providing remote monitoring of the system operation. The SDLC Module with Ethernet Port shall be considered incidental to the installation.

15. The Contractor shall provide factory or factory representative turn-on support for all radio installations to implement the radio and device programming. Radio transceivers shall utilize devices that are compliant with IEEE 802.15.4 standards and are able to operate on any of the allocated 16 channels of the 2.4 to 2.48 GHz spectrum. The factory support shall include the programming of the embedded Sensor time slots and shall provide a written copy of the final design to the Engineer plus one copy for the traffic controller cabinet. One software set of device programming (GUI), if other than standard WEB Browser via SNMP protocol, shall be provided for each intersection where devices are installed. The factory representative shall certify proper installation of the devices, the radio links, device settings and the traffic

controller detector assignments. The factory representative shall provide an on-site computer support and shall link to the Contractor furnished and installed Access Box for all programming.

16. The Contractor shall furnish and provide a training course for the programming of the detectors by a Factory Technician or their field representative on the design, operation, and maintenance of the Detector Sensing System and the supplied GUI program. The GUI software, Contractor furnished to the City, shall provide real time management and monitoring of the Detector Sensing System as well as the Event Processing Software. One copy of the Event Processing Software shall be provided. The Event Processing Software shall be installed and made operational on a City supplied SQL Server connected to the traffic network.

17. The Access Point and Wireless Repeater shall be installed within range of the Sensors as specified by the manufacturer.

18. The flush mount Sensors shall be installed in the roadway using the following procedure:

a. The roadway shall be core drilled to provide a 4" diameter hole, 2.25" deep.

b. A small layer of sand sufficient to cover the bottom of the hole shall be applied.

c. The Sensor shall then be placed on top of this layer of sand in the correct orientation.

d. The Sensor shall be fully encapsulated with the epoxy to the lip of the cored hole.

19. The supplier shall provide a limited two-year warranty on the detection system. The warranty period shall commence on the date the Engineer accepts the traffic signal project for final payment.

20. During the warranty period, technical support shall be available from the supplier via telephone within 24 hours of the time a call is made by a user, and this support shall be available from factory-authorized personnel or factory-authorized installers.

21. Standard updates to the software shall be available from the supplier without charge.

22. The supplier shall maintain an ongoing program for customer support for the system. This support shall be via telephone, email or personnel sent to the installation upon receipt of an purchase order at the suppliers then current pricing and terms of sale for technical support services.

23. All documentation shall be provided in the English language.

24. Method of Payment: Wireless, battery powered Magnetometer Detection System will be measured by the unit for each specified item. Any items not specifically identified as pay items, but required for the installation and operation of the detection system will be considered subsidiary to all pay items necessary to complete the work.

25. Basis of Payment: Work completed, accepted and measured as provided above, will be paid for at the contract unit price bid for Wireless Battery Powered Magnetometer Advance Detection System, which price shall be full compensation for training, onsite supervision by the manufacturer's representative, furnishing all materials, fittings, brackets, clamps, equipment, tools, labor, and incidentals necessary to complete the work. Payment will be made under:

Pay Item	Unit
Vehicle Sensor Node	Each
Access Point	Each
Wireless Repeater	Each
Contact Closure Card	Each
Extension Card for Contact Closures	Each

9400.0 TRAFFIC SIGNALS AND POLES

9400.1 VEHICLE TRAFFIC SIGNAL HEADS

1. This section of the specifications describes the minimum acceptable design and operating requirements for vehicular signal heads with twelve (12) inch diameter lens openings, including all fittings and brackets as shown on the plans. All components of the vehicular signal heads furnished under this specification shall comply with the latest version of the Institute of Transportation Engineers Standard(s) for Adjustable Face Vehicle Traffic Control Signal Heads. All the indications of the vehicle signals will use LED modules.

2. Where shown on the plans, 5" back plates shall be furnished and attached to the signal faces to provide a dark background for signal indications. Backplates shall be constructed of one piece durable black plastic capable of withstanding a 100 M.P.H. wind.

3. Mounting brackets shall be as shown in the standard details.

4. Signal head housings shall be 12” black body, UV resistant , polycarbonate commercially manufactured to be compatible with traffic signal mounting brackets utilizing serrated locking fittings. Signal head housings shall be modularly designed. Doors and lenses shall be provided with suitable water-tight gaskets and doors shall be suitably hinged and held securely to the body of the housing by simple locking devices of non-corrosive material.

5. The middle section of each three-section signal assembly shall be equipped with a six position terminal block for termination of field wiring. The middle section of each five-section signal assembly shall be equipped with an eight position terminal block for termination of field wiring. Each five indication signal shall be equipped with an eight (8) position terminal block.

6. Door fronts shall be black in their entirety. The color shall be an integral part of the materials composition.

7. Lenses shall be twelve (12) inches in diameter. Lenses shall be polycarbonate.

8. The visors for each signal section shall be durable black polycarbonate not less than 0.10" in thickness. Visors shall be designed to fit tightly against the door and to not permit any perceptible filtration of light between it and the housing door. Visors shall be tunnel-type at least 9 1/2" long and angle slightly downward.

9. The traffic signals shall be provided with LED Modules for every signal head face.

10. The LED vehicle signals shall be installed in traffic signal housings rated as a 12” signal housing commercially manufactured with a durable polycarbonate material and be compatible with traffic signal mounting brackets utilizing serrated locking between signal sections. The LED module shall be a self-enclosed, sealed unit, with electrical connections to be terminated on the standard terminal block, spade termination, mounted in the traffic signal section. The signals shall be 120 VAC rated and shall be compatible with either public utility or backup power sources of a 60-hertz, +/- 5-hertz with a voltage variance between 80 and 135.

11. All electronics in the signal shall meet NEMA temperature rating of –40 to +74 ºC. The enclosure shall conform to NEMA Moisture Resistance Standard 250-1991 for Type 4 enclosures (ITE 6.4.6.2 Moisture Resistance). The signal electronics shall meet FCC Title 47, Subpart B, Section 15 Regulations for Electrical Noise dissemination. The electronics shall be provided with an operating power factor correction of a minimum of 0.9 and shall be provided with fuse and transient suppression incorporated for line and

load protection.

12. The traditional “ball” signal display shall have the following characteristics:

Red Signal Display (Dialight 433-1210-003)
Luminous Intensity # (cd)339
Dominant Wavelength (nm)622
Lens TintTinted
Typical Wattage at 25 ºC6
Meet or exceed ITE VTCSH Part 2 Latest Edition

Yellow Signal Display (Dialight 433-3230-001)
Luminous Intensity # (cd)678
Dominant Wavelength (nm)590
Lens TintTinted
Typical Wattage at 25 ºC12
Approved by Caltrans

Green Signal Display (Dialight 433-2270-001)
Luminous Intensity # (cd)678
Dominant Wavelength (nm)505
Lens TintClear
(Note: Green Tint shall be acceptable.)
Typical Wattage at 25 ºC14
Meet or exceed ITE VTCSH Part 2 Latest Edition

13. The traditional “arrow” signal display shall have the following characteristics:

Green Arrow Display (Dialight 430-2374-001)
Dominant Wavelength (nm)505
Lens TintTinted
(Note: Green Tint shall be acceptable.)
Typical Wattage at 25 ºC7

Yellow Arrow Display (Dialight 430-3334-001)
Dominant Wavelength (nm)590
Lens TintTinted
Typical Wattage at 25 ºC9

14. Arrow signals shall have power factor correction and temperature compensation. Arrow light pattern shall appear as a completely filled arrow.

15. LEDs may be AlInGaP construction. Substitution of other LED designs shall require approval by the engineer.

16. Basis of Payment: Payment shall be per each signal head assembly with all components as described in this section. Pay item shall state the number of sections in the signal head assembly. Configuration of signal head assembly shall be shown in the plan sheets. Each signal head assembly shall include the mounting bracket and backplate. Each signal face shall have a visor. Payment shall be made for each traffic signal head assembly provided and installed to the satisfaction of the engineer.

9400.2 OPTICALLY LIMITING SIGNAL

1. This section of the specifications describes the minimum acceptable design and operating requirements for Optically Limiting Vehicular Signal heads with twelve (12) inch diameter lens openings, including all fittings and brackets as shown on the plans. All the indications of the vehicle signals will use optically limiting LED modules.

2. An optically limiting signal head shall consist of the number and type (arrow or circular section) signal faces as prescribed in the plans. Each face shall consist of sectors of LEDs that can be user-programmed (on or off) to direct light in the intended vector and limit light in the unintended vector.

3. The optically limiting signal head shall draw wattage no greater than 22 watts per signal face when all LEDs are lit. The individual signal heads shall compensate their load so that a single face – regardless of programmed setting – can maintain sufficient current draw through the loadswitch under normal operation to avoid inappropriate conflict flash events without the introduction of a background current load.

4. The optically limiting signal head shall be programmable from the controller cabinet with no adjustment required at the signal head other than initial mounting and preliminary aiming. The signal faces shall be capable of being programmed with the intersection under normal traffic signal control.

5. The optically limiting signal head shall contain a sensor detecting ambient light conditions and automatically compensate the optically limiting signal head lumen output to balance against background lighting. The lumen compensation feature shall be a pre-programmed sliding adjustment making continuous small adjustments, rather than a discreet level choice mechanism. Within programming options, the user shall be able to choose to enable or disable the light compensating feature.

6. The optically limiting signal head shall not require any physical unit to be mounted in front of the lens to perform properly.

7. Because the lumen output of the unit is intentionally variable, and intentionally limited to meet the design needs of the location, the engineer shall be the sole judge of whether light output of the optically limiting signal head is

acceptable.

8. The signal heads shall include a minimum 5 year warranty.

9. Signal head housings shall be yellow UV resistant polycarbonate.

10. Backplates shall be black polycarbonate.

11. Mounting brackets shall be as shown in the standard details.

12. Individual signal faces shall be the same nominal dimensions as the standard signal heads supplied for the project.

13. Signal visors shall be black polycarbonate, tunnel-shaped.

14. LEDs may be AlInGaP construction. Substitution of other LED design shall require approval by the engineer.

15. Basis of Payment: Payment shall be per each signal head assembly with all components as described in this section. Pay item shall state the number of sections in the signal head assembly. Configuration of signal head assembly shall be shown in the plan sheets. Each signal head assembly shall include the mounting bracket and backplate. Each signal face shall have a visor.

Contractor shall provide the Engineer one set of all programming equipment necessary to program the optically limiting signal head per construction project. Compensation for the programming equipment shall be incidental to the unit price of the optically limiting signal heads listed on the project. For each intersection containing an optically limiting signal head, instruction manuals detailing the optically limiting signal head programming procedures shall be placed in the traffic signal cabinet.

Contractor shall program the optically limiting signal head settings with the direction of a city traffic staff member. Contractor shall provide on-site instruction to each city traffic staff member present during installation to allow each to make future adjustments unassisted.

16. Payment shall be made for each optically limiting signal head assembly provided, mounted, installed, programmed, and fully operational to the satisfaction of the Engineer.

9400.3 PEDESTRIAN TRAFFIC SIGNAL HEADS

1. This section of the specifications describes minimum acceptable design and operating requirements for pedestrian traffic signal heads with LED "MAN" and "HAND" symbol messages and an LED digital countdown display in the lower section for countdown heads, including all fittings and brackets, as specified on the plans. The pedestrian signal head shall comply with the latest version of the Institute of Transportation Engineers Standards on Pedestrian Traffic Signal Heads.

2. A pedestrian signal LED shall consist of a single section measuring 16 inches high by 18 inches wide. The current symbol display, walking white man or Portland orange upraised right hand, shall appear on the viewer's left side of the single section pedestrian signal head.

3. A countdown pedestrian signal LED shall consist of a single section measuring 16 inches high by 18 inches wide. The current symbol display, walking white man or Portland orange upraised right hand, shall appear on the viewer's left side of the single section pedestrian signal head. The remaining time value, counted in seconds, shall appear on the viewer's right side of the single section pedestrian signal head.

4. Symbols and letters shall measure 9 inches in height. Width dimensions shall vary to appear proportionate to height. Symbols, walking man/upraised hand, shall appear alternately in the same quadrant of the pedestrian signal head. The outline of the unlit symbol shall not be visible with the lit symbol. Symbols and letters shall appear to be backlit from a single light source through a masked lens. Symbols and letters shall not consist of individual points of light ordered in a line or shapes to create the full letter or symbol. Symbols shall be fully filled evenly with light.

5. Pedestrian countdown timer shall display begin display of a running countdown beginning with the end of the WALK display. The countdown shall begin at the full pedestrian flashing DON'T WALK time and end at zero coinciding with the beginning of solid DON'T WALK time. The pedestrian signal head shall learn the flashing DON'T WALK time from experience, requiring no user programming of the flashing DON'T WALK time into the signal head. If the flashing DON'T WALK time is shortened during an emergency pre-emption routine of one cycle, the pedestrian countdown timer shall display the permanent flashing DON'T WALK time the next cycle. If the flashing DON'T WALK time is altered, the countdown pedestrian signal LED shall learn the new value after no more than three occurrences and alter the flashing DON'T WALK time display to match.

6. The signal heads shall include a minimum 5 year warranty.

7. Maximum power consumption shall be no greater than a total of 13 watts for all features of the countdown signal head. Power factor shall be 0.90 or greater. Harmonic distortion shall be less than 20%. Minimum luminance (in candelas per square meter) shall be 1400 for orange and 2200 for white. Symbol colors shall conform to ITE specifications for LED pedestrian signals.

8. The pedestrian signal head shall be of modular construction consisting of a signal housing, a sealed LED Module, an egg crate visor, and mounting hardware. The signal housing shall be yellow polycarbonate body with black face. The signal housing door shall be hinged on one side with tool-less screw-down clamps holding the door closed on the other. A gasket shall prevent water from entering the housing. An electrical terminal block in the housing shall connect the incoming power cables to the countdown signal head. The sealed LED shall be pre-wired with spade connections allowing its wires to be connected to or disconnected from the terminal block in the housing without tools. The egg crate visor shall be single-piece black polycarbonate at least 8.5 inches deep. Mounting hardware shall match that shown in the plans.

9. Basis of Payment: Payment shall be per each signal head assembly with all components as described in this section. Each signal head assembly shall include the mounting hardware. Each signal face shall have a visor. Payment shall be made for each countdown pedestrian signal head – LED assembly provided, mounted, installed, and fully operational to the satisfaction of the Engineer.

9400.4 PEDESTRIAN PUSH BUTTONS

1. Pedestrian push button detectors shall be manufactured by Polara Engineering, Inc. The button shall be An OBDLM2-N (Momentary LED Indication and Tone, Oval Housing, Moveable Arrow). The push button assembly shall fit on a Pelco SE-2039/SE-0267 body.

2. The push button shall be weatherproof and of sturdy design. The entire assembly shall be weather tight, secure against electrical shock, and able to withstand continuous hard usage. The button shall us a piezo driven solid-state switch.

3. The housings shall be made of aluminum alloy and furnished with suitable mounting hardware. The oval pedestrian pushbutton and arrow assembly shall be yellow powder-coated aluminum. The Pelco body shall have a natural finish.

4. Push button signs shall be furnished and shall conform to the requirements of the Manual On Uniform Traffic Control Devices (M.U.T.C.D.). Signs shall be R10-4A or R10-3A, as indicated on the plans.

5. Basis of Payment: Payment shall be per each pedestrian push button assembly with all components as described in this section. Each pedestrian push button assembly shall include the mounting hardware. Payment shall be made for each pedestrian push button assembly provided, mounted, installed, and fully operational to the satisfaction of the Engineer.

9401.0 TRAFFIC SIGNAL POLES

9401.1 General

1. This specification covers furnishing all labor, materials, equipment, and appliances, and performing all operations in connection with poles and pedestals for use on traffic signal projects, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

2. Posts and Mast Arms - A grounding lug shall be provided for all units. A grounding conductor shall provide grounding continuity for all metallic, noncurrent carrying poles in one circuit.

3. Steel Pedestal Posts - Steel pedestal posts shall be 4 ½ inch outside diameter schedule 40 steel pipe. The base shall be cast iron, free from imperfections, and shall be provided with a suitable plastic, fiberglass or cast door for wiring access. The grounding lug shall be inside the base. The bolt circle and hole diameter shall be as shown on the plans. After fabrication, posts and bases shall be fully galvanized.

4. Aluminum Pedestal Posts - Aluminum pedestal posts shall be schedule 80 straight tubing of 6063-T6 aluminum alloy in accordance with ASTM B 210, with a 4 ½ inch outside diameter. The pedestal base casting shall be either permanent mold casting of Alloy 356.0 F, in accordance with ASTM B 108, or sand castings of Alloy 356.0 F, in accordance with ASTM B 26. The base shall be free from imperfections and shall be provided with a suitable door for wiring access. The base and post shall be joined by a threaded connection. Welded connections will not be permitted.

The grounding lug shall be provided inside the base. All hardware shall be non-ferrous metal or stainless steel.

5. Signal Post and Mast Arm Pre-Approval - Fabricators shall submit six copies of shop drawings and supporting calculations to engineer. Submittals shall be approved by engineer in writing prior to fabrication of the signal posts and mast arms. Shop drawings shall indicate complete design details required

for post and mast arm fabrication, including material grades and thicknesses, welding and orientation of any longitudinal seams. The projected areas and weights of signs and signals used in the design of the post and mast arm combinations shown on the plans may be submitted. Design details for all possible post and mast arm combinations shown on the plans may be submitted. Shop drawings shall provide post and mast arm installation hardware details. All welding procedures shall be prepared by the manufacturer as a written procedure specification and shall be submitted with the shop drawings for approval. Approval of the weld procedures will be required before approval of the shop drawings. Shop drawings shall indicate the specific approved welding procedure to be used for each joint. Shop drawings and supporting stress calculations shall be signed and sealed by a registered professional engineer in the State of Missouri. Upon written approval, pre-approved drawings may be used on any project where the design conditions of the shop drawings are not exceeded.

6. Steel Posts and Mast Arms Fabrication - Steel posts and mast arms shall be continuously tapered, hollow shafts fabricated as one continuous shaft or as individual segments at least 10 feet long, joined together using electrically welded, intermediate, transverse, full penetration, circumferential joints. Steel posts and mast arms shall be fabricated from basic oxygen or open-hearth steel sheet. The continuous, tapered, hollow shafts or individual segments shall be manufactured from one or two lengths of steel sheet, with one or two continuous, welded, longitudinal seams. The longitudinal seams in the mast arm shall be located outside of the upper half of the cross section of the member. Where transverse, full penetration, circumferential welds are used, the fabricator shall furnish to the engineer written certification that 100 percent of all such welds have been radiographed or ultrasonic tested by an independent testing agency using a qualified non-destructive testing technician, as described in Section 6.14.7 of ANSI/AWS D1.1 Structural Welding Code-Steel and equipment calibrated annually. The testing agency shall be approved by the engineer prior to fabrication. Post base and mast arm attachment plates shall be plate steel attached to the larger end of the shafts by continuous welds on the inside and outside of the shaft. After manufacture, the material shall have a minimum yield strength of 48,000 psi. The post and mast arm manufacturer shall be certified under the AISC certification program, Conventional Steel Building, or higher category. Evidence of current AISC certification will be required prior to the approval of shop drawings, and lapsing of the certification will be cause for the manufacturer’s removal from the approved list of suppliers. Steel posts, luminaire bracket arms, mast arms, nut covers and plat steel bases shall be hot-dip galvanized inside and out after fabrication, visual inspections and NDT testing. Galvanized material shall be handled in such a manner to avoid damage to the surface. Any galvanized material on which the coating has been damaged will be rejected or required to be repaired and approved.

7. Steel Post and Mast Arm Appurtenances - A handhole equipped with a suitable metal cover shall be provided in the post near the base, and 12 inches above the mast arm connection if luminaire mounting is specified. A grounding lug or connector shall be provided inside the post near the handhole. A removable rain tight metal pole cap shall be provided on the top of the post and on the small end of each mast arm. All handhole covers and metal caps shall be securely attached to the post or arm with a galvanized steel chain and shall be held in place by screws. The chain shall be attached to the inside of the post or arm and shall be of sufficient length to allow maintenance access. An aluminum or stainless steel identification tag shall be provided with all posts and mast arms as shown on the plans. The letters and numbers on the tag shall be embossed or engraved. The post tag shall be attached to the pole 6 inches above the top of the handhole. The mast arm tag shall be attached 3 inches from the base of the end cap. The base plate shall be equipped with four cast steel or cast iron nut covers in accordance with AASHTO M 103 or M 105, or four aluminum nut covers and shall have four galvanized or stainless steel screws for securing covers to the pole. All poles, shoe bases, base plates and cast steel or cast iron nut covers shall be fully galvanized after fabrication. All anchor bolt nuts shall be completely covered by nut covers. Luminaire bracket arms, when specified, shall be included with post and mast arm. The contractor may furnish posts with the shape, gage and dimensions meeting or exceeding those required by the plans and specifications, provided shop drawings are submitted and approved in accordance with this Section.

8. Steel Post and Mast Arm Welding - Welding and fabrication of the assemblies shall be in accordance with the ANSI/AWS D1.1 Structural Welding Code-Steel. All requirements of the welding code for tubular structures will apply to the fabrication for the post and mast arm shafts and shall include any welds used to attach these members to plates or other hardware. The manufacturer shall employ qualified personnel to perform all visual and nondestructive testing (NDT) required. In addition to the visual inspections and the NDT that may otherwise be required by the welding code, the manufacturer shall perform 100 percent magnetic particle (MT) testing of circumferential fillet welds used to attach the flange plate to the larger end of the mast arm shaft. NDT personnel shall be qualified as set form in the Code. Qualifications of NDT personnel shall be submitted to the engineer for approval.

9. Post Erection - Post bases shall be securely anchored to concrete bases. Pedestal posts shall be erected vertically without the use of leveling nuts. All posts shall be raked as directed by the engineer. All signal posts shall be grounded by a bare No. 6 AWG stranded copper wire running from the ground lug inside the post to a clamp fastened on metal conduit at the top of the concrete base to a ground rod or through nonmetallic conduit to the ground bus in the controller.

10. Measurement and payment - Posts shall be measured per each, including all specified material. Payment will be considered full compensation for all labor, equipment and material to complete the described work for each post. Work will include all excavation, removal and disposal of all material encountered within the limits of the work.

No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

9401.2 TRAFFIC SIGNAL PEDESTALS

1. This section of the specifications describes minimum acceptable design, material and fabrication requirements for aluminum traffic signal pedestals.

2. The length of the pedestal, from the bottom of the base to the top of the shaft shall be as shown on the plans. The pedestal shaft shall be fabricated of aluminum tubing with a wall thickness of not less than 0.237 inches. It shall have a satin brush or spun finish. The top of the shaft shall have an outer diameter of four and one-half (4-1/2) inches and be provided with a pole cap.

3. The pedestal base shall be cast aluminum, square in shape, with a hand hole. The size of the hand hole shall be at least four (4) inches by six (6) inches and equipped with a cover which can be securely fastened to the shaft with the use of simple tools. Bases shall have a minimum weight of twenty (20) pounds and shall have a four (4) bolt pattern uniformly spaced on a 12-1/2 inch diameter bolt circle. The exterior of the base shall be smooth and have a neat appearance.

4. The base shall meet or exceed 1985 AASHTO breakaway requirements. Test reports from an FHWA approved independent laboratory shall be provided certifying tests have been accepted and approved by the FHWA as compliant to AASHTO breakaway requirements.

5. Four (4) three-fourths (3/4) inch by fifteen (15) inch hot rolled steel anchor bolts shall be supplied, complete with all hardware required for installation. The anchor bolts shall have a right angle bend at the bottom end and be hot dip galvanized at the threaded end.

6. Certification: The fabricator shall certify that the pedestals are capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure.

7. Measurement and payment - Pedestals shall be measured per each, including all specified material. Payment will be considered full compensation for all labor, equipment and material to complete the described work for each pedestal. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

9401.3 TRAFFIC SIGNS - This specification covers furnishing all labor, materials, equipment and appliances and performing all operations in connections with traffic signs, in strict accordance with the specifications and drawings, and subject to the terms and conditions of the contract.

1. Traffic Signs – Traffic Signs shall be mounted on the mast arms utilizing a universally adjustable mast arm mounted sign bracket. The street name signs shall be white letters, Series C Caps, 8-inches high on a green background. The sign shall have a white border, 0.75 inches wide. The thickness of aluminum sign blanks shall be 0.125 inches and the height shall be 18 inches. The corners of the sign blank shall have a 1.5" radius. The sheeting material for all signs shall be encapsulated lens sheeting.

2. Measurement and payment – Measurement and payment for traffic signs shall be for each.

9500.0 AUXILLARY SYSTEMS

9501.0 UPS Battery Backup System

1. Each traffic controller shall be provided with an uninterruptible power supply and be integrated into a UPS Battery Backup system. The UPS Battery Backup System shall include a minimum of an Uninterruptible Power Supply (UPS), Transfer Switches, Batteries and electrical connections necessary to provide a complete and operational system. The UPS Battery Backup System shall be installed in a separate cabinet that is mounted onto the new or existing traffic controller cabinet and electrically connected to the traffic controller cabinet.

2. The UPS shall be a line-interactive type and provide voltage regulation and power conditioning when using utility power source. The UPS shall provide reliable emergency power to the traffic signals in the event of a power failure or interruption. The transfer of power from the utility power to the battery power, and reverse to normal operation, shall not interfere with the normal operation of the traffic controller, conflict monitor, or other peripheral devices within the traffic controller cabinet. The traffic controller cabinet shall not default to FLASH Mode during the transition from utility power to battery power or from battery power to utility power. Cabinet wiring shall be designed to exclude traffic video monitoring operation from functioning during power transition to battery power and shall re-energize normal traffic video monitoring when power is restored to utility power. All other functions within the controller cabinet including network operation shall retain functionality on battery backup operation.

3. The UPS shall support an input voltage from 85 VAC to 175 VAC based on a nominal input voltage of 120 VAC. The UPS shall have the ability to provide input line regulation to increase or decrease line voltage operation.

Low voltage input shall have two voltage boost modes; boost mode 1 shall increase an incoming voltage from 94 VAC to a nominal voltage of 115 VAC, and mode 2 shall increase an incoming voltage from 85 VAC to a nominal voltage of 101 VAC. High voltage input shall have two voltage "buck" [decrease] modes; buck mode 1 shall decrease an incoming voltage from 154 VAC to a nominal voltage of 124 VAC, and mode 2 shall decrease an incoming voltage from 175 VAC to a nominal voltage of 142 VAC. Additionally, a Hysteresis voltage range shall be provided such that the UPS shall reject VAC above the 130 VAC level and below the 100 VAC levels and accept voltage levels within the 105 VAC and 128 VAC. Output of the UPS shall be 120 VAC when operating on line voltage at a range of plus/minus 10% and shall be 120 VAC when operating in backup mode at a range of plus/minus 6%. Out put frequency shall be maintained at 60 hertz in both on line and backup modes. Line qualification shall be user selectable to values of 3, 10, 20, 30 and 50 second intervals as a minimum. Default line qualification shall be 3 seconds.

4. The UPS shall be provided with a current limiter capability of limiting current up to 16 amperes to the output set at 10 amperes. The UPS shall automatically sense line frequency and set operation to 60 hertz. The unit shall be provided with an EMI (Electro-Magnetic Interference) filter and transient suppression. UPS output shall be sinusoidal with a total harmonic distortion of less than 3% based on resistive load.

5. The UPS shall have an efficiency of greater than 98% when operating on line voltage and be greater than 84% when operating in backup mode. The total transfer time between line voltage and backup modes or between backup to line voltage shall be less than 6 ms.

6. The UPS shall be provided with a battery charger with operation being at the 48 VDC and with a charger current user programmable for 3, 6, and 10 amperes. The battery charger shall have a maximum float voltage of 56 VDC. The battery charger shall automatically cease charging operations when the battery temperature is 50 degrees Celsius.

The battery charger shall be temperature compensated controlled with a user selectable setting for millivolt/degree Celsius/Cell of -2.5, -4 and -6 as a minimum. A minimum low battery warning setting of 47 VDC (40%) shall be provided and a low battery shutdown set for 42 VDC based on a 10.5 VDC per battery.

7. The UPS power supply shall be provided with operation safety protection for both the hardware and user functions. This protection shall include an input circuit breaker rated at 250 VAC @ 20 Ampere, and a 50 Ampere battery circuit breaker and electronic short circuit protection when the UPS is operating in the backup mode. The UPS shall be provided with a load monitoring and overload warning complete with automated shutdown for loads

in excess of design capacity. Alarm shall be set when the active load is at 95 to 105 % rated output; shutdown and alarm shall commence and be complete when actual load is above 106 % within two minutes, and be complete within one minute when actual load is above 115 % of rated load. The fault alarm shall be cleared when the overload is removed and the power line service returns for both levels of overload. The UPS shall cease operation when the actual load exceeds 115 % rated load and the UPS is in backup mode. The UPS shall be provided with a surge suppression protection device that shall have a clamping voltage of 150 VAC, with a response time of less than one nanosecond. This surge protection device shall be a plug-in module that is field replaceable and shall be provided with an LED indicator that turns off (is deactivated) when the module protection is no longer valid. The surge protection device shall be provided for protection against incoming surges from the power line (Utility Service).

8. The UPS shall provide battery protection and alarm when operating conditions exceed acceptable levels. A temperature alarm shall be provided when the battery ambient level exceeds 75 degrees Celsius and shall clear when the ambient temperature is reduced below 70 degrees Celsius. The battery operation (backup mode) shall cease when the internal ambient temperature of the battery exceeds 110 degrees Celsius and stay off until the battery ambient temperature is reduced below 90 degrees Celsius and power line is restored.

9. The UPS shall provide over voltage protection for excessive output voltage from the UPS. The UPS shall electronically shutdown if the measure output voltage of the UPS exceeds 132 VAC. The UPS shall automatically protect the battery, when battery probe is not installed, at a charger level of 52 VDC. The UPS shall disable the battery charger in two seconds when the battery voltage exceeds 59 VDC and automatically resume charge when the battery voltage reduces to a level of 57 VDC. An alarm condition shall be reported for battery levels in excess of 59 VDC. The UPS battery shall be provided with a user field replaceable variable speed fan, microprocessor and PWM controlled, that shall operate when ambient temperature is equal or greater than 40 degrees Celsius. The fan shall have an alarm function when the fan is set to operate and is not physically turning.

10. The UPS shall be provided with safety locks to prevent improper installation. This protection shall include reverse polarity protection against electrical feedback to the utility service that complies with UL 1778 and CSA C22.2 No. 107.1.3 requirements and safety standard EN50091-1-1-2 and EN60950. Besides passing the Immunity Standards, EN61000-4-2, 3, 4, 5, 6 and 8 and EN6000-3-2 Standards, the manufacturer's nameplate label shall display agency approval mark "cCSAus".

11. The UPS shall be provided with an SNMP Ethernet port for remote programming and monitoring, complete with password and remote operation software or browser application. Additionally, the UPS shall be provided with an RS-232 port for local programming and a LCD display for local control for monitoring of alarm logging events. The UPS shall be provided with a minimum of five SPDT relay contacts for user programming of alarms or other controls for operation. A sixth SPDT relay contact set shall be provided to output the alarms for a secondary remote alarm system that is factory programmed.

12. The UPS shall be provided with a Manual Bypass Switch Operation and Automatic Transfer Switch. The UPS shall be provided with a Battery Heater Mat that shall function when power line voltage is present and temperature ranges indicate the advantage of heating the batteries for enhanced performance, activating at five degrees Celsius and deactivating at temperatures at or above fifteen degrees Celsius. The Manual Bypass Switch shall be provided for manual connection or disconnection and testing. The Automatic Transfer Switch shall automatically transfer the load from the power line to UPS power and back when the incoming line voltage is impaired and then corrected for proper operation. The heater pad shall be sized for the battery array installed.

13. The batteries shall be Gel Cell Valve Regulated Lead Acid (VRLA) type specifically designed for outdoor application using a “Float Service” to provide 100 % runtime capacity without initialization charging. Batteries shall be constructed using Silver Allow positive plates and shall have a five year full replacement warranty, non-prorated. Battery capacity rating at 20 hours shall be 94 Amp Hours, 12 VDC – each battery. Battery design for the UPS shall be either four or eight units per design application. Batteries shall be installed and connected to operate at the 48 VDC design. The battery design and sizing shall provide a minimum of four hours backup time for full operation (signals in color) and nine and one half hours of backup operation in Flash mode. Full operation is defined as 500 watts for signals in color and 125 watts for signals in Flash mode per each four battery unit installation. The contractor shall furnish either the four or eight battery design based on the signalized intersection design and power requirements for each intersection. The UPS shall be provided with a Battery Charge Maintenance Management System to equalize charging of batteries with different battery life ratings and to allow adding new batteries to existing sites without changing all existing batteries at a single time. This management system shall comply with CSA C22.2 No. 107.1 and UL 1778 Standards for safe operation of batteries under unattended applications.

14. Basis of Payment: Payment shall be per each UPS Battery Backup System installed with all components as described in this section. Each UPS Battery Backup System shall include the mounting hardware. Payment shall be made for each UPS Battery Backup System provided, mounted, installed, and fully operational to the satisfaction of the Engineer.

9502.0 Ethernet Switch – Fiber Link

1. This specification contains the minimum design and operating requirements for a solid state, digital transceiver for Ethernet applications utilizing fiber optic cabling. Two separate devices shall be provided based on the installation requirements. One device shall be the Backbone Ethernet Switch and the second device shall be the Local Ethernet Switch. Some installations may require one or more of each device as shown on the Plans or in the specifications. Each Ethernet switch shall be provided with a Ethernet to Serial Converter, 4-Port, DeviceMaster RTS device with DB-9 connectors and DB-9 connector cables. Each Ethernet switch shall be GarrettCom or IFS layer 2+ switch and shall be compatible with existing installed switches without the necessity for linking via a Layer 3 Switch.

2. Backbone Ethernet Switch: Each device shall be provided with a minimum of connectivity for four (4) 1 GB Ethernet ports where two ports shall be equipped with open transceivers for 1 GB transmitting fiber optic 1 GBIC drivers [40 Km range] and two 10/100/1000 Mb RJ-45 copper port. The Plans or specifications shall specify the number of 1 GBIC drivers to be provided and the range of the driver [20 Km to 70 Km]. Where not specified in the Plans or specifications, a minimum of two each 40 Km range 1 GBIC fiber optic line drivers shall be provided in the modules and one CAT-5 cable for the 10/100/1000 Mb RJ-45 copper port. Each Backbone Ethernet Switch shall be provided with two (2) each 10/100 Mb SM fiber 20 Km fiber ports. Each Backbone Ethernet Switch shall be provided with a minimum of eight (8) RJ-45 10/100 copper ports unless otherwise specified.

3. Each device shall support 802.1q VLAN-aware wire speed bridging, 802.1d Spanning Tree protocol, proprietary and 802.1w Rapid Spanning Tree protocol, 802.3 10-Base-T, 802.3u 100 Base-T, 100 Base-FX, 802.3 ab 1000 Base-T, 1000 Base-FX, 802.1p Class of Service prioritizing, and full support of IGMP for IP Multicasting and filtering.

4. The device shall include a minimum of one (1) input Alarm contact. The device shall be provided with a 120 VAC input capable of proper operation as specified by NEMA. The device shall support proper operation under temperature ranges of – 40 to +70 degrees centigrade. All devices shall be NEMA rated and UL Listed.

Each device shall be provided with two each SM fiber patch cord connectors for connection to the 1 GB line drivers and ST connection to the field termination panel; two each SM fiber patch cord connectors for connection to the 10/100 SM line drivers and ST connection to the field termination panel; and, six each CAT-5 cables. All patch cords and cables shall be one nominally meter in length.

5. Each device shall be provided with management protocol software interfacing for SNMP, remote access, time synchronization, secure access, remote access and event logging. All cables and software for management shall be provided. All license fees shall be included for operation in a ring and/or mesh topology.

6. Each 10/100Base Port shall support 10 or 100 Mbps mapping/limiting.

7. Basis of Payment: Payment shall be per each Backbone Ethernet Switch programmed and installed with all components as described in this section. Each Backbone Ethernet Switch shall include the mounting hardware. Payment shall be made for each Backbone Ethernet Switch provided, programmed, mounted, installed and fully operational to the satisfaction of the Engineer.

8. Local Ethernet Switch: Each device shall be provided with a minimum of connectivity for one (1) 1 GB Ethernet ports where the port is a 10/100/1000 Mb RJ-45 copper port. Each Local Ethernet Switch shall be provided with four (4) each 10/100 Mb SM fiber 20 Km fiber ports. Each Backbone Ethernet Switch shall be provided with a minimum of eight (8) RJ-45 10/100 copper ports unless otherwise specified.

9. Each device shall support 802.1q VLAN-aware wire speed bridging, 802.1d Spanning Tree protocol, proprietary and 802.1w Rapid Spanning Tree protocol, 802.3 10-Base-T, 802.3u 100 Base-T, 100 Base-FX, 802.3 ab 1000 Base-T, 1000 Base-FX, 802.1p Class of Service prioritizing, and full support of IGMP for IP Multicasting and filtering.

10. The device shall include a minimum of one (1) input Alarm contact. The device shall be provided with a 120 VAC input capable of proper operation as specified by NEMA. The device shall support proper operation under temperature ranges of – 40 to +70 degrees centigrade. All devices shall be NEMA rated and UL Listed. Each device shall be provided with two each SM fiber patch cord connectors for connection to the 10/100 SM line drivers and ST connection to the field termination panel; six each CAT-5 cables and one (1) each crossover CAT-5 cable of a color unique to the other straight lined cables. All patch cords and cables shall be one nominally meter in length.

11. Each device shall be provided with management protocol software interfacing for SNMP, remote access, time synchronization, secure access, remote access and event logging. All cables and software for management shall be provided. All license fees shall be included for operation in a ring and/or mesh topology.

12. Each 10/100Base Port shall support 10 or 100 Mbps mapping/limiting.

13. Basis of Payment: Payment shall be per each Local Ethernet Switch programmed and installed with all components as described in this section. Each Local Ethernet Switch shall include the mounting hardware. Payment shall be made for each Local Ethernet Switch provided, programmed, mounted, installed, and fully operational to the satisfaction of the Engineer.

9503.0 Ethernet Switch – Copper Link

1. This specification contains the minimum design and operating requirements for a solid state, digital transceiver for Ethernet applications utilizing twisted pair copper cabling.

2. The device shall be provided with a minimum of connectivity for four (4) copper pairs for transmitting and four (4) copper pairs for receiving Ethernet data traffic plus be provided with a minimum of four (4) ports of 10/100 Base-T connectors, RJ-45 copper. Each device except the central office version shall be rated as Drop and Add capable and shall support point to point applications where Drop and Add features are not mandated by the specific application. Each device installed in a point to point application shall be expandable by simple field termination, without the addition of any hardware, to a Drop and Add application. Addition or removal of line conditioners when changing the operation shall not be deemed to be addition of hardware. Expansion of copper pairs shall be available for extended bandwidth for up to eight (8) ports of copper pairs per device. Drop and Add devices shall be provided with eight (8) ports where four ports are for incoming and four ports are for outgoing signal.

3. Each device shall support 802.1q VLAN-aware wire speed bridging, double tagging (VLAN Stacking), L2 Ethernet prioritizing, and L3 (ToS/Diff/Serv) classification with four (4) traffic classes. Each device shall support Rapid Spanning Tree Protocol, Spanning Tree Protocol, Mesh topology, bandwidth monitoring and Multicast/Broadcast limiting operation. Each copper pair shall be rated to operate under ideal conditions with not less than 5 Mbps through band performance in the point to point application and with not less than 2.75 Mbps through band performance in the Drop and Add application for extended range applications and up to 5 Mbps for applications operating at a limited one mile range. End to end delay shall be nominally 2-4 ms delay.

4. The device shall include sealing current technology to improve and maintain the copper pair circuit connectivity. The device shall include two (2) input Alarm contacts and one (1) output Alarm contacts. The device shall be provided with an 120 VAC input capable of proper operation in VAC ranges of 90 to 220 VAC, 47 to 63 Hertz. The device shall support proper operation under temperature ranges of – 40 to +65 degrees centigrade. All devices shall be NEMA TS-2 rated and UL Listed.

5. Each device shall be provided with management protocol software interfacing for SNMP, remote access, time synchronization, secure access, remote access and IEEE 802.3ah EFM OAM compliance.

6. Each 10/100Base Port shall support 10 or 100 Mbps mapping/limiting. The device shall be ACTELIS or pre-approved equal.

7. Basis of Payment: Payment shall be per each Copper Base Ethernet Switch programmed and installed with all components as described in this section. Each Copper Base Ethernet Switch shall include the mounting hardware. Payment shall be made for each Copper Base Ethernet Switch provided, programmed, mounted, installed, and fully operational to the satisfaction of the Engineer.

9504.0 Traffic Monitor System

1. The Traffic Monitor System-TM utilized on the Project shall be the Diamond Electronics System manufactured by Honeywell, or approved equal utilizing the Sony HD-6 camera.

2. The traffic monitor system shall include camera in dome, dome, dome mounting bracket and hardware, camera controller, cabling from the camera controller to dome electronics, and all accessories and hardware necessary for a complete operational unit.

The enclosure end of the cable will be provided with a termination installed by the manufacturer. The video monitor system shall include all required lightening protection for the electronics control, power, and coax video outputs.

3. The traffic monitor dome shall include a fan and heater system with automatic thermostat control.

4. The dome shall be connected to the controller cabinet by the use of a factory pre-fabricated connector and cable, maximum length of 125 feet, dome to camera controller unit. Locations where the camera dome to traffic controller cabinet distance exceeds the maximum 125 feet, a small pole mounted cabinet shall be installed with terminations of the cabling from the dome on the pole holding the camera and the wiring from the traffic controller

cabinet. Discrete wiring shall be provided by the contractor to provide power, coax for video and twisted pair communications from the controller cabinet to the small cabinet. The installation of this small controller cabinet and the additional in-controller terminations shall be considered incidental the furnishing and installing the camera monitoring unit. The small cabinet shall house the normal monitor dome control circuits for power, heater, blower, etc. required by the camera installation.

5. The dome electronics shall provide a full 360-degree horizontal rotation and a 180-degree vertical rotation from the horizon (+ 2 degrees) to ground and back up to horizon (+ 2 degrees) at the opposite direction under pan, tilt, and zoom (P/T/Z) control.

6. The dome electronics shall provide a minimum of 64 preset views to be programmed plus a minimum of nine preprogrammed pattern sequences of preset views. All views shall be selectable by the central office or a remote control device.

7. The traffic monitor camera shall be environmentally hardened and provide a clear focus video view of objects to a maximum range of 8,000 feet. The camera shall have a minimum mechanical zoom of 16X with digital zoom of 6X. The camera shall be color with automatic conversion to B/W during low light levels such as nighttime operation. The camera with controller shall provide auto-iris control and shall auto focus.

8. The camera shall mount in the 9-inch dome assembly utilizing a quick disconnect.

9. The traffic monitor system shall be tested under the supervision of the city traffic personnel and certified as fully functional. The camera shall be removed from the dome and be provided to city traffic operations personnel on site for programming the camera address. The Cornet encoder and Cornet decoder shall be provided to the Fiber Optic Coordinator for programming the IP addresses prior to field installation.

10. Positioning of the camera dome on the pole shall be as directed by the Engineer.

11. The traffic monitor system shall be provided with the ability to control the camera, PTZ, and see video from the traffic signal control cabinet at the intersection at which the system is located.

12. The video from the camera shall be connected to a Cornet encoder device to provide video over Ethernet using MPEG-4 video compression and shall be connected at Traffic Operations Center to a Cornet video decoder device to decode the video into NTSC full frame, 30 frames per second. The decoder shall be a blade device and be installed in a contractor furnished 19" rack

assembly. The contractor shall install all necessary rack support devices required to provide NTSC video to a video server/switcher and provide P/T/Z control of the camera monitoring system. The contractor shall provide on screen IP viewing software, IP based for viewing all video from any and all field monitor sites in the traffic monitor system.

13. The traffic monitor dome shall include a fan and heater system with automatic thermostat control.

14. Positioning of the camera dome on the pole shall be as directed by the Engineer and shown on the plans.

15. The Traffic Monitor System shall include all necessary hardware and software to view live video at 30 fps in the central office computer center.

16. Basis of Payment: Payment shall be per each Traffic Monitoring Assembly including camera in dome, mount, factory lead-in cable, monitor controller, encoder and decoder, central office rack assembly as required for blade decoders, external joystick, programmed and installed with all components as described in this section. Each Traffic Monitor System shall include the mounting hardware. Payment shall be made for each Traffic Monitor System provided, programmed, mounted, installed, and fully operational to the satisfaction of the Engineer.

9505.0 4.9 GHz Outdoor Wireless Base Station

1. Description: The Outdoor Wireless Base Station shall be a Wireless Grid Outdoor Bridge/Base Station Unit. The Wireless Radio System shall enable high-speed long-range outdoor communications links and shall be suited for installations subject to plenum rating and harsh environments.

2. The wireless outdoor bridge radio system shall include the wireless radio, power supply, power over Ethernet injector (POE), low loss cable, drop cables and connectors, and a lightning surge protector.

3. The wireless outdoor bridge shall meet the following minimum specifications:

a. 4.940 – 4.990 GHz Public Safety Band (FCC Part 70, licensed Intl.) Non-overlapping Channels: 8x5 MHz, 4x10 MHz, 2x20 MHz.

b. Orthogonal Frequency Division Multiplexing (OFDM)

c. 802.3, 802.11i, 802.11a hardware with proprietary bridging extensions

d. Radio output power Max: 20 dBm (Set to local regulatory requirements to comply with transmit, conducted EIRP power limits)

e. Data Rate - 54 to 1 Mbps

f. Receiver Sensitivity (dBm) -73 to -91

g. Modulation: 64QAM, 16QAM QPSK, BPSK

h. Mode: Point to Multipoint, Backhaul, Repeater and Hotspot

i. Power System: Remote power to IP67 rated outdoor unit.

j. Input: 100-240 AC, 50-60Hz

k. Output: 48V, 0.4A

4. Security: Secure RF architecture - Proprietary channelization and bridge protocol, link authentications AES-I28/WEP 152-bit data encryption optional VPN support for Ethernet tagged frames (802.1q, 802.1p)

Configuration and Management

a. Configuration Utility: Built-in web server. Telnet

b. Software Upgrades: FTP download

c. Antenna Alignment Tool: Real-time RSSI (Signal Strength) monitor, link optimization and throughput maximization utility

d. Indoor LED Status Indicator: Indoor remote power indicator

e. Real-time Link Monitoring: Secure Management Interface – Real-time signal strength indicator, authentication data, system uptime, data rate, and channel selection.

f. Dimensions: 1 0 x 8 x 6 in

5. Environmental

a. Radio Operating Temperature: -20° C to 55° C. Outdoor units shall be weather protected

b. Radio Operating Humidity: Max. 95%, non-condensing.

c. Outdoor Antenna: -40° C to 70° C

6. Compliance and Certification

a. EMC: FCC Part 15, Industry Canada RSS-210, Mexico, ETSI

b. Safety: UL - Canada, USA: CE

c. Radio: Public Safety (Part 70), FCC 15.407 (UNII, ISM), Industry Canada RSS-21O, ETSI (w/TPC & DFS), MII SRRC

7. The contractor shall be responsible for providing a complete, functional system including all necessary cables and connectors in accordance to the specifications and as specified on the plans. All miscellaneous patch and interconnect cables shall meet the proposed equipment specification requirements and shall meet EIA/TIA telecommunications standards.

The contractor shall be responsible to acquire state furnished database parameters necessary and shall program the radio(s) for final deployment operation utilizing factory personnel or factory designated representatives. On site support shall be provided by the contractor and shall include qualified personnel to complete final on-site deployment of the radio system.

8. The radio shall be manufactured by ENCOM to be consistent with the existing network security structure developed by MoDOT and provided compatible encryption techniques with security interlocks previously approved for roadside wireless network deployment.

9. Measurement: Measurement will be made for furnishing, installation, programming and testing of each wireless bridge base station unit, complete and accepted by the Engineer.

10. Basis of Payment: Basis of Payment: Payment shall be per each 4.9 GHz Outdoor Wireless Base Station programmed and installed with all components as described in this section. Each 4.9 GHz Outdoor Wireless Base Station shall include the mounting hardware. Payment shall be made for each 4.9 GHz Outdoor Wireless Base Station provided, programmed, mounted, installed, and fully operational to the satisfaction of the Engineer

9506.0 4.9 GHz WIRELESS BRIDGE

1. Description: The Wireless Bridge with Built-in Sector Antenna shall be a Wireless Grid Outdoor Bridge/subscriber Unit with a 23 dBi integrated antenna. The Wireless Radio System shall enable high-speed long-range outdoor communications links and shall be suited for installations subject to plenum rating and harsh environments.

2. The wireless outdoor bridge radio system shall include the wireless radio, power supply, power over Ethernet injector (POE), low loss cable, drop cables and connectors, and a lightning surge protector.

3. The wireless outdoor bridge shall meet the following minimum Radio specifications:

a. 4.940 – 4.990 GHz Public Safety Band (FCC Part 70, licensed Intl.) Non-overlapping Channels: 8x5 MHz, 4x10 MHz, 2x20 MHz.

b. Orthogonal Frequency Division Multiplexing (OFDM)

c. 802.3, 802.11i, 802.11a hardware with proprietary bridging extensions

d. Radio output power Max: 20 dBm (Set to local regulatory requirements to comply with transmit, conducted EIRP power limits)

e. Data Rate - 54 to 1 Mbps

f. Receiver Sensitivity (dBm) -73 to -91

g. Modulation: 64QAM, 16QAM QPSK, BPSK

h. Mode: Point to Multipoint, Backhaul, Repeater and Hotspot

i. Power System: Remote power to IP67 rated outdoor unit.

j. Input: 100-240 AC, 50-60Hz

k. Output: 48V, 0.4 Amps.

l. Security: Secure RF architecture - Proprietary channelization and bridge protocol, link authentications AES-I28/WEP 152-bit data encryption optional VPN support for Ethernet tagged frames (802.1q, 802.1p)

4. Configuration and Management

a. Configuration Utility: Built-in web server. Telnet

b. Software Upgrades: FTP download

c. Antenna Alignment Tool: Real-time RSSI (Signal Strength) monitor, link optimization and throughput maximization utility

d. Indoor LED Status Indicator: Indoor remote power indicator

e. Real-time Link Monitoring: Secure Management Interface – Real-time signal strength indicator, authentication data, system uptime, data rate, and channel selection.

f. Dimensions: 11 x 11 x 7 in

5. Environmental

a. Radio Operating Temperature: -20° C to 55° C. Outdoor units shall be weather protected

b. Radio Operating Humidity: Max. 95%, non-condensing.

c. Outdoor Antenna: -40° C to 70° C

6. Compliance and Certification

a. EMC: FCC Part 15, Industry Canada RSS-210, Mexico, ETSI

b. Safety: UL - Canada, USA: CE

c. Radio: Public Safety (Part 70), FCC 15.407 (UNII, ISM), Industry Canada RSS-21O, ETSI (w/TPC & DFS), MII SRRC

7. The contractor shall be responsible for providing a complete, functional system including all necessary cables and connectors in accordance to the specifications and as specified on the plans. All miscellaneous patch and interconnect cables shall meet the proposed equipment specification requirements and shall meet EIA/TIA telecommunications standards. The contractor shall be responsible to acquire state furnished database parameters necessary and shall program the radio(s) for final deployment operation utilizing factory personnel or factory designated representatives. On site support shall be provided by the contractor and shall include qualified personnel to complete final on-site deployment of the radio system.

8. The radio shall be manufactured by ENCOM to be consistent with the existing network security structure developed by MoDOT and provided compatible encryption techniques with security interlocks previously approved for roadside wireless network deployment.

9. Measurement: Measurement will be made for furnishing, installation, programming and testing of each wireless bridge subscriber unit, with integrated antenna complete and accepted by the Engineer.

10. Basis of Payment: Basis of Payment: Payment shall be per each 4.9 GHz Outdoor Wireless Bridge with Built-in Sector Antenna programmed and installed with all components as described in this section. Each 4.9 GHz Outdoor Wireless Bridge shall include the mounting hardware. Payment shall be made for each 4.9 GHz Outdoor Wireless Bridge with built-in integrated antenna provided, programmed, mounted, installed, and fully operational to the satisfaction of the Engineer

9600.0 FIBER OPTIC COMMUNICATIONS SYSTEM

9601.0 Fiber Optic Hub

9601.1 Fiber Optic Hub Cabinet – Outdoor

1. The fiber optic hub cabinet shall be a Caltrans 332. All hub cabinets, complete with all electronics specified, shall be provided by the traffic controller system manufacturer or their designated representative and shall be complete with all enclosures and electronics as specified herein. All cabinets shall be provided with a ground lug for external grounding. Power shall be provided in all Hub Cabinets.

2. The cabinet shall be aluminum with a natural aluminum finish.

3. Fiber Optic Hub Cabinets shall be provided with power as defined hereinafter, unless specifically excluded by the Plans.

a. Two circuit breakers, 30 amps for general circuits use and 10 amps for highly filtered circuits shall be provided. The cabinet fans and heater will be wired with the general circuit breaker. The cabinet shall include noise filter and surge protection, EDCO SHA-1210, that has the main circuit plus the 10 amp high filter protection.

b. Two cabinet fans – A standard cabinet fan, thermostat controlled, to bring in outside air and a second fan to blow air, circulation, inside the cabinet.

c. A cabinet heater with a minimum 150-watt capacity shall be provided. The heater shall be on a thermostat with a 32-degree or

lower setting to turn on the heater to reduce condensation. If the heater activates, the second fan inside the cabinet will turn on to circulate air in the cabinet.

d. A minimum of two C-MIC-024, Combination Splice/Termination Enclosure, units with a minimum of three each splice trays and 24 each termination hubs, complete with 24 hub mounts, per enclosure and one each CCH-04U, Termination Enclosure, unit with a minimum of 72 coupler hub mounts.

e. Two gooseneck mini-cylinder lights meeting traffic signal cabinet specifications. One flex light shall be mounted in front and one flex light shall be mounted in back. Two shelves shall be provided and installed such that one shelf is in the upper section of the cabinet and the second shelf is installed in the middle of the cabinet, unless directed otherwise by the Engineer.

f. A circuit breaker protected power strip with three sets of six outlet power plugs, 3 prong design, GFI protected. The power strip shall be mounted for plugging in devices from the back of the hub cabinet.

4. The Contractor shall install all hardware as shown in the Plans and in accordance with the wiring diagrams. All combination splice/termination enclosures, termination enclosures, and splice enclosures shall be mounted from the front of the cabinet. All non-rack mounted devices shall be mounted using wing panels to the side railing or be shelf mounted. Extension cables, nominal 10 to 12 inches, shall be used where the electrical connection utilizes a large AC to DC converter. This will eliminate the necessity to add additional power strips to plug in devices. Devices mounted in the hub may be installed utilizing the rear of the cabinet so long as the position does not, in the sole opinion of the Engineer, block access to the wiring and fiber entry/exit from enclosures. Terminations and/or splices in hubs shall be by the Contractor or their designated representative and shall be consistent with the design or final revised drawings provided.

5. Basis of Payment: Payment shall be per each Fiber Optic Hub Cabinet - Outdoor with all components as described in this section. Items covered under this pay item include all items, components, and modules housed in the Hub cabinet other than field wiring. The following list is not all inclusive but provided for illustration. The following items are included under this pay item: Fiber Optic Hub Cabinet - Outdoor, Local Ethernet Switch, Backbone Ethernet Switch, Copper Base Ethernet Switch, C-MIC-024, CCH-04U, CSH-03U, Wall Mount, terminal blocks, shelving, Traffic Monitor Controllers, and fiber optic terminations/splices, etc.

9601.2 Fiber Optic Hub Cabinet – Indoor

1. HUB sites, where specified, shall be provided with floor mounted or wall mounted racks as shown on the Plans or Wiring Diagrams. Racks shall be EIA Standard nominal 19 inch rack mount assemblies, compliant with UL 1863, constructed of high-grade 6061-T6 aluminum or pre-approved equal, self-squaring and self-supporting. All racks shall be pre-threaded 12/24 EIA holes for quick assembly and be provided with a minimum of 24 cross-recessed black panel mounting screws, 12/24 X ½" long. Each floor mounted rack shall be provided with shelves that support a minimum of 120 pounds, be nominal 19" wide, 10.6" deep or 17.4" deep and be double-sided, vented construction. Three shelves per rack assembly shall be provided to house equipment. Shelve positions shall be as specified by the Engineer for each rack. The floor-mounted racks shall be a minimum of 84" high, 15" floor base plate deep, and be provided with one cable manager installed.

2. Wall mounted racks shall be designed for tight spaces, designed to hold up to 150 pounds, be constructed of 12 gauge steel, allow a swing open front design, be a minimum of 24.5" deep and 38" (19U) high. Racks shall be pre-drilled and threaded for 12/24 mounting holes and be provided with a minimum of 12 each 12/24 X ½" screws. Cable managers are not required on wall rack assemblies. Shelving shall be provided as required.

3. All racks shall be drilled with a 5/8", 5/8", ½" universal hole pattern.

4. Basis of Payment: Payment shall be per each Fiber Optic Hub Cabinet - Indoor with all components as described in this section. Items covered under this pay item include all items, components, and modules housed in the Hub cabinet other than field wiring. The following list is not all inclusive but provided for illustration. The following items are included under this pay item: Fiber Optic Hub Cabinet - Indoor, Local Ethernet Switch, Backbone Ethernet Switch, Copper Base Ethernet Switch, C-MIC-024, CCH-04U, CSH-03U, Wall Mount, terminal blocks, shelving, Traffic Monitor Controllers, and fiber optic terminations/splices, etc.

9601.3 Fiber Optic Double Hub Cabinet

1. The fiber optic hub cabinet shall be a double wide Caltrans 332 with two doors, front and rear. A left side panel and a right side panel shall be installed on each inner rack assembly. All double wide hub cabinets, complete with all electronics specified, shall be provided by the traffic controller system manufacturer or their designated representative and shall be complete with all enclosures and electronics as specified herein. All cabinets shall be provided with a ground lug for external grounding. Power shall be provided in all Double Wide Hub Cabinets. The cabinet shall be nominally 66" high, 48" wide and 30" deep. The primary front and rear doors shall be provided with ¾" stainless steel handle with three point latching and padlock hasp, right front

and left rear doors. The cabinet shall be provided with two each lifting eyes. All welds shall be continuous. The cabinet shall be provided with two equipment rack frames and each rack frame shall be equipped with two shelves. All door hinges shall be 14 gauge, stainless steel mounted internal to the door housing. The cabinet shall be provided with four each 1" by 2" mounting slots. The contractor shall be responsible for verifying the bolt pattern of the hub concrete pad and the four mounting slots provided in the hub cabinet internal mount flange. The cabinet roof shall be provided with vent slots on both sides. A fan plate shall be provided on one or both sides. Each fan plate shall be provided with a vent fan, minimum of 100 CFM capacity, minimum of 200 CFM capacity per cabinet for cabinet ventilation.

2. The cabinet shall be aluminum with a natural aluminum finish.

3. The cabinet shall contain the following items (Fiber Optic Hub Cabinets shall be provided with power as defined hereinafter, unless specifically excluded by the Plans:

a. Two sets of the following devices shall be provided where one set is installed in the left side and the second set is installed in the right side of the enclosure. Two circuit breakers, 30 amps for general circuits use and 10 amps for highly filtered circuits shall be provided. The cabinet fans and heater will be wired with the general circuit breaker. The cabinet shall include noise filter and surge protection, EDCO SHA-1210, that has the main circuit plus the 10 amp high filter protection

b. Four cabinet fans – A standard cabinet fan, thermostat controlled, vent fan and a second fan to blow air, circulation, inside each side of the cabinet. Where cabinet design utilizes a single vent fan plate, a single fan, minimum of 200 CFM capacity, may be used instead of two separate fans.

c. Two cabinet heaters with a minimum 150-watt capacity shall be provided. The heaters shall be on a single thermostat with a 32-degree or lower setting to turn on the heater to reduce condensation. If the heater activates, the second fan on each side of the inside of the cabinet will turn on to circulate air in the cabinet. A relay shall be installed if the amperage of the heaters and fans exceed the switch rating of the thermostat.

d. Each side of the enclosure shall be provided with 19" rack railings secured to the enclosure. A removable inner panel shall separate the two sides and be mounted by supports to the hub enclosure or two inner panels shall be provided where each panel shall be mounted to the 19" racks.

e. A minimum of four C-MIC-024, Combination Splice/Termination Enclosure, units with a minimum of three each splice trays and 24 each termination hubs, complete with 24 hub mounts, per enclosure and two each CCH-04U, Termination Enclosure, unit with a minimum of 72 coupler hub mounts.

f. Four gooseneck mini-cylinder lights meeting traffic signal cabinet specifications. Two flex light shall be mounted in front and two flex light shall be mounted in back. Two shelves shall be provided and installed per inner section of the hub cabinet such that one shelf is in the upper section of the cabinet and the second shelf is installed in the middle of the cabinet (each side), unless directed otherwise by the Engineer.

g. Two circuit breaker protected power strips with three sets of six outlet power plugs, 3 prong design, GFI protected. The power strips shall be mounted for plugging in devices from the back of the hub cabinet.

4. The Contractor shall install all hardware as shown in the Plans and in accordance with the wiring diagrams. All combination splice/termination enclosures, termination enclosures, and splice enclosures shall be mounted from the front of the cabinet. All non-rack mounted devices shall be mounted using wing panels to the side railing or be shelf mounted. Extension cables, nominal 10 to 12 inches, shall be used where the electrical connection utilizes a large AC to DC converter. This will eliminate the necessity to add additional power strips to plug in devices. Devices mounted in the hub may be installed utilizing the rear of the cabinet so long as the position does not, in the sole opinion of the Engineer, block access to the wiring and fiber entry/exit from enclosures. Terminations and/or splices in hubs shall be by the Contractor or their designated representative and shall be consistent with the design or final revised drawings provided.

5. Basis of Payment: Payment shall be per each Fiber Optic Double Hub Cabinet with all components as described in this section. Items covered under this pay item include all items, components, and modules housed in the Hub cabinet other than field wiring. The following list is not all inclusive but provided for illustration. The following items are included under this pay item: Fiber Optic Double Hub Cabinet, Local Ethernet Switch, Backbone Ethernet Switch, Copper Base Ethernet Switch, C-MIC-024, CCH-04U, CSH-03U, Wall Mount, terminal blocks, shelving, Traffic Monitor Controllers, and fiber optic terminations/splices, etc.

9601.4 Auxiliary Hub – Pole Mount Powered

1. The Auxiliary Hub pole mounted cabinet, powered shall be completely fabricated from a 0.125 inch thick type 5052-H32 vinyl-coated, mill-finished aluminum with continuous welded seams. The front door shall be attached with a heavy gauge stainless steel continuous hinge utilizing a non-removable 3/16 inch diameter hinge pin. The front door shall be provided with a three point locking mechanism with duplex nylon rollers on the top and bottom and a ¾ inch diameter stainless steel outward turning handle with padlock capability. The door opening shall be single flanged in the sides and bottom and double flanged on the top to prevent water entry into the cabinet when the door is open. The door shall have a louvered air vent with stainless steel mesh filter mounted on the lower front section with a retaining mechanism to hold the filter to the door. The cabinet shall have vent with a perforated air passage section, air exhaust outlet, on the bottom of the front roof line of the cabinet. The door and cabinet assembly shall have an adjustable 3/8 inch diameter stainless steel door stop that can be latched in several positions to allow the door to open partially to full open. The door lock shall utilize a traffic industry standard pin tumbler lock with two each #2 keys. The door shall be sealed with the use of closed-cell neoprene door seal gasket.

2. The cabinet shall be provided with power mounted on a separate panel mounted on the side railing, lower right side. This panel shall include two circuit breakers, 20 amps for general circuits use and 10 amps for highly filtered circuits shall be provided. The cabinet fans and heater will be wired with the general circuit breaker. The cabinet shall include noise filter and surge protection, EDCO SHA-1210, that has the main circuit plus the 10 amp high filter protection. Two cabinet fans shall be provided, including a standard cabinet fan, thermostat controlled, to bring in outside air and a second fan to blow air, circulation, inside the cabinet. A cabinet heater with 150-watt capacity shall be provided. The heater shall be on a thermostat with a 32-degree or lower setting to turn on the heater. If the heater activates, the second fan inside the cabinet will turn on to circulate air in the cabinet.

3. The cabinet shall be provided with rails to hold shelving inside of the cabinet. The shelving shall be offset from the rear of the cabinet wall to allow cabling rear access to the cabinet fiber enclosures. The cabinet shall be provided with two shelves. Combination Splice/Termination Enclosure, C-MIC-024, units shall be fastened to the shelf for mounting in the cabinet in the quantity as defined in the wiring diagrams and Plans. Where more than two Combination Enclosures are specified, one enclosure shall be installed on top of the shelf and the second shelf installed on the bottom of the shelf, maximum of four Combination Enclosures per cabinet. Combination Enclosure mounting hardware shall include wing nuts with compression washers to allow easy removal of the enclosures for rewiring or modification.

4. The cabinet width shall be 24 inches overall with a minimum of a 22 inch door opening. The cabinet shall be 18 inches in depth including the front roof overhang. The overall height shall be a minimum of 45 inches to a maximum of 52 inches high. The door clearance opening for inserting hardware inside the cabinet shall not be less than 26 inches. The cabinet shall be provided with two pole mounting brackets complete with everything necessary to mount on the pole as shown on the plans.

5. Basis of Payment: Payment shall be per each Auxiliary Hub – Pole Mounted Powered with all components as described in this section. Items covered under this pay item include all items, components, and modules housed in the Hub cabinet other than field wiring. The following list is not all inclusive but provided for illustration. The following items are included under this pay item: Auxiliary Hub – Pole Mounted Powered, Local Ethernet Switch, Backbone Ethernet Switch, Copper Base Ethernet Switch, C-MIC-024, CCH-04U, CSH-03U, Wall Mount, terminal blocks, shelving, Traffic Monitor Controllers, and fiber optic terminations/splices,
etc.

9602.0 Fiber Optic Cable & Installation

9602.1 Fiber Optic Communications

1. This specification contains the minimum design and operating requirements for a Fiber Optic Communications network installation consisting of fiber optic cable, cable installation, termination enclosures, splice enclosures, combination termination/splice enclosures, splices, terminations, construction tools and test equipment.

2. This work shall consist of furnishing and installing a fiber optic cable of the type, size and number of fibers specified.

3. Materials and Equipment: Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. The fiber optic cable shall be OFS AllWave or Corning conforming to the following specifications. The fiber optic shall be manufactured utilizing Corning glass fiber conforming to the following specifications. All materials and equipment furnished shall be completely free from defects and poor workmanship. All fibers shall be glass and be manufactured by Corning or pre-approved equal. The cable shall be rated for gigabyte data bandwidth. All fiber shall be loose tube construction for both indoor and outdoor installation. Indoor cabling shall use plenum rated conduit to within less than 50 foot of point of termination eliminating the requirement to convert to indoor cable.

4. Contractor Qualifications: Trained and experienced personnel shall supervise the fiber optic cable installation. Qualified technicians shall make the cable terminations and splices. The Contractor upon request of the

Engineer shall provide documentation of qualifications and experience for fiber optic equipment installations. The Engineer shall determine if the Contractor is qualified to perform this work. The Contractor shall have attended a certified fiber optic training class mandated by these specifications prior to starting work.

5. Codes Requirements: The fiber optic cable installation shall be in accordance with or exceed all minimal requirements of State codes, National codes, and manufacturer codes as applicable.

6. Miscellaneous Equipment: The Contractor shall furnish and install all necessary miscellaneous connectors and equipment to make a complete and operating installation in accordance with the plans, standard sheets, standard specifications, special provisions, and accepted good practice of the industry.

7. General Considerations: The cable shall meet all requirements stated within this specification. The cable shall be new, unused, and of current design and manufacture.

8. Fiber Characteristics: All fibers in the cable must be usable fibers and meet required specifications. All outdoor fiber installation shall be 72 strand single mode fibers in a single cable unless specified otherwise in the project specifications.

a. Multimode Fiber
Core diameter: 62.5 +3.0um
Cladding diameter: 125.0 +2.0um
Core-to-cladding offset: <3.0um
Coating diameter 250 +/-15um
Graded Index

Attenuation uniformity: No point discontinuity shall be greater than 0.25 dB, except terminations or patch cords, at either 850nm or 1300nm. The coating shall be a layered UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically removable without damaging the fiber.

Factory cable rating shall be 3.5 dB/KM at 850 nM and 1.0 dB/KM at 1300 nM, or less. Installed tolerance shall be less than 3.85 dB/KM at 850 nM and less than 1.1 dB/KM at 1300 nM, testing tolerance.

b. Single-Mode Fiber
Typical core diameter: 8.3um
Cladding diameter: 125 +1.0um by fiber end measurement.
Core-to-cladding offset: <1.0um
Coating diameter: 250 +15um

Attenuation uniformity: No point discontinuity shall be greater than 0.1 dB, except terminations or patch cords, at either 1310nm or 1550nm. The coating shall be a layered UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically removable without damaging the fiber.

Factory cable rating shall be 0.35 dB/KM at 1310 nM and 0.30 dB/KM at 1550 nM. Installed tolerance shall be less than 0.44 dB/KM at 1310 nM and less than 0.33 dB/KM at 1550 nM, testing tolerance

9. All fibers in the cable shall meet the requirements of this specification. The testing tolerance attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable when installed.

10. The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.20 dB/km at 1550 nm, with 80 percent of the measured values no greater than 0.10 dB/km at 1550 nm.

11. Optical fibers shall be placed inside a loose buffer tube, minimum twelve (12) fibers per tube unless otherwise specified in the project specification.

12. Multimode only – each buffer tube shall contain 12 fibers.

13. Single-mode only – each buffer tube shall contain 12 fibers.

14. The buffer tubes will meet EIA/TIA-598, "Color coding of fiber optic cables."

15. All fiber cables shall be Gigabyte rated, i.e. multimode shall be 200/500 Meter for 850 and 1300 nM respectively, single mode shall be 5000 Meter for 1310 and 13,300 meters for 1550 nM utilizing an industry standard 10 dB rated budget. All single mode fiber shall be ALL WAVE rated supporting all four light frequencies being transmitted concurrently.

16. Single-mode fibers shall be placed in the first buffer tubes. Multimode fibers, when specified for Indoor Plant designs, shall be in the remaining buffer tubes. Fiber count, tubes of fiber, shall be as specified on the plans.

17. Fillers shall be included in the cable core to lend symmetry to the cable cross-section where needed.

18. The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

19. The cable shall use a completely dry cable design without the use of gels and filling compounds. Dry water blocking material shall be used around the buffer tubes as well as internal to the tubes. Water blocking gels shall not be acceptable on this project.

20. Buffer tubes shall be stranded around a central member. Acceptable techniques include the use of the reverse oscillation, or "SZ", stranding process.

21. All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. Cable jacketing shall utilize the newer designs to provide maximum flexibility without loss or appreciable dB attenuation. Cable diameter shall not exceed 0.50 inch.

22. The jacket or sheath shall be marked with the manufacturer's name, the words "optical cable", the year of manufacture, number of fibers, type of fiber (SM or MM) and sequential feet or meter marks. The markings shall be repeated every one-meter or three feet. The actual length of the cable shall be within –0/+1% of the length marking. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm. A copy of the manufacturer fiber definition and shipping sheet identifying all tests, results and fiber indexes shall be provided to the Engineer on delivery of cable to the City or shall be included with a contractor's listing of place(s) of installation when installed by a Contractor.

23. The maximum pulling tension shall be 600 pounds (2700 N) during installation.

24. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.

25. All optical fibers shall be 100% attenuation tested at the manufacturer. The attenuation of each fiber shall be provided with each cable reel. The measured attenuation shall be for both 850 and 1300 frequency for multimode and 1310 or 1550 frequency for single mode. This documentation shall be provided with each spool. The Contractor shall designate on the Plans and on this (See 28.2.11) documentation the location where each spool has been installed and provide this data to the Engineer.

26. Where ever possible, six (6) buffer tubes with twelve (12) fibers each, or subsets specified, shall be provided and designated as follows:

Buffer Tube/Fiber	Tube/Fiber Color
#1, 1st tube or fiber	blue
#2, 2nd tube or fiber	orange
#3, 3rd tube or fiber	green
#4, 4th tube or fiber	brown
#5, 5th tube or fiber	slate
#6, 6th tube or fiber	white
#7, 7th tube or fiber	red
#8, 8th tube or fiber	black
#9, 9th tube or fiber	yellow
#10, 10th tube or fiber	violet
#11, 11th tube or fiber	rose
#12, 12th tube or fiber	aqua

27. Cable Installed in Ducts and Conduits: A suitable cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct off the reel. It shall be carefully inspected for jacket defects. If defects are noticed, the pulling operation shall be stopped immediately and the Engineer notified. Precautions shall be taken during installation to prevent the cable from being “kinked” or “crushed”.

28. A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. A pulling swivel shall be used to eliminate twisting of the cable. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Dynamometers or breakaway pulling swing shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer.

29. The mechanical stress placed on a cable during installation shall not be such that the cable is twisted or stretched. The pulling of cable shall be hand assisted at each controller cabinet. The cable shall not be crushed kinked or forced around a sharp corner. If a lubricant is used it shall be of water based type and approved by the cable manufacturer.

30. Sufficient slack shall be left at each end of the cable to allow proper cable termination, MINIMUM OF 30 FEET. This slack shall be in addition to installation slack as hereinafter specified. Additional slack cable shall be left in each hub cabinet, handhole, and at the top of each conduit riser. Excess slack at hub cabinets shall be re-pulled into the nearest handhole to provide a neat and orderly installation.

31. The minimum slack amounts, in addition to the minimum cable lengths required for termination or splicing shall be as follows:

Hub cabinet – 50 feet
Controller cabinet – 50 feet
Type 1Handhole – 20 feet
Type 2 Handhole – 100 feet

32. Storage of minimum slack cable in controller cabinets and additional slack at pull boxes shall be coiled. The slack coils shall be bound at a minimum of 3 points around the coil parameter and supported in their static storage positions. The binding material and installation shall not bind or kink the cable. Storage of additional slack cable adjacent to conduit risers and support poles shall be as visibly marked/tagged as "CAUTION – FIBER OPTIC CABLE". Maximum length of cable pulling tensions shall not exceed the cable manufacturer's recommendations.

33. Along with the fiber optic cable, one (1) #10 AWG THHN, 600 volt single conductor cable (identifier conductor), orange in color, shall be pulled with ten feet (10') slack in each pull box, except where rigid metallic conduit or other metallic conductors are installed.

34. All fiber cables shall be marked with a metallic, or pre-approved, identifier in the handhole adjacent to the traffic signal cabinet or hub cabinet and on the cable in the traffic signal cabinet or hub cabinet at the point of termination.

35. The identifier, both in the cabinet and in the handhole, shall indicate the direction the cable is going, cable contents [SM or SM/MM], and the abbreviated location for the other end destination. Fiber cabling between traffic controllers and adjacent hub locations shall be outdoor rated, loose tube fiber, when not linked by a direct, continuous conduit installation.

36. Minimum Bend Radius: For static storage, the cable shall not be bent at any location to less than ten times the diameter of the cable outside diameter or as recommended by the manufacturer. During installation, the cable shall not be bent at any location to less than twenty times the diameter of the cable outside diameter or as recommended by the manufacturer.

37. After the Fiber Optic Cable Installation: Each section of the cable shall be tested for continuity and attenuation as a minimum. If the attenuation is found not to be within the acceptable nominal values, the Contractor shall use an optical time domain reflectometer (OTDR) to locate points of localized loss caused by bends or kinks. If this is not successful the Contractor shall replace the damaged section of cable with no additional payment.

38. Splices will not be allowed to repair the damaged section. After all fiber cable is installed between traffic controller cabinets and fiber links between fiber distribution points (FDP – Fiber Hub Cabinets) complete links, all fibers, whether terminated or non-terminated, shall be tested with an OTDR. All fibers terminated shall be tested with a power meter.

39. The Contractor may jumper termination points at controller cabinets to minimize the number of tests and run a single OTDR test between several controller cabinets, subject to the range of the OTDR. Links between FDP's shall be tested separately. Each OTDR trace, for documented test result submittal, shall be displayed individually and not be combined with other fiber traces as overlays.

40. Multimode fiber, when installed, shall be tested using 1300 nm; and, single mode fiber shall be tested at 1310 nM. The results of the OTDR test shall be provided on an electronic media (disk) and paper printout.

41. The OTDR wave, pictorial diagram of dB loss over the length of fiber tested, shall be provided along with the measured data values. The printout shall contain the manufacturer's fiber optic Index of Refraction to the third decimal point for the fiber provided. The Contractor shall provide the Engineer with a written report showing all the values measured compared to the calculated values for length and coupler/connector losses at the completion of these tests. Outdoor patch cords between FDP and controller units less than 151 feet do not need be OTDR tested.

42. Documentation provided to the Engineer shall include a written indication of every splice, termination, patch cord, etc. for cable being measured. Power meter measurement recordings shall indicate the exact measured distance [OTDR or field measurement with cross reference for oscillation multiplier] on the sheet showing the power meter readings. Any deviations between fiber readings in the same tube shall be notated for OTDR graphs as well as deviations greater than 5% on power meter readings. Rated values for acceptable installation shall be based on the following parameters:

Patch cords/Pigtails.60 MM & .15 SM dB each
UniCam Terminations1.0 dB set of 2 [In and Out]
Splices0.08 each
1 KM = 0.3077 KF where KF is 1000 feet

43. Data documentation shall include for each test between cabinets or between FDP sites, the length of fiber as measured by OTDR, frequency used in test on OTDR by each fiber type, distance to each splice, termination or patch cord jumper, dB loss rating by manufacture from spool documentation, index of refraction by type of fiber in section, and the dB loss of each section as measured in the final test for each fiber.

A special test shall be made on all continuous spliced fiber from start to end that includes the total dB loss measured and the OTDR plot on electronic disk. Splice points shall be identified on the trace.

44. The contractor shall contract with the traffic controller manufacture representative for a Fiber Optic Coordinator, approved by the City for reviewing the installation and test results before approval and acceptance by the City. The Fiber Optic Coordinator shall coordinate all installation and testing reviews directly with the City for their review.

45. Cable Termination: Terminations shall be made using the method recommended by the connector manufacturer. All fibers shall utilize a fan-out kit of the size and type recommended by the manufacturer and of the number of fibers provided in each fiber tube. All fibers terminated shall utilize a ceramic ferrule (outdoor connections), ST, mechanical termination equal to Siecor UniCam connectors, or be a wide temperature (-40 to +170 degrees Fahrenheit) epoxy. Heat cured or epoxy type connections meeting the full temperature ratings are acceptable, including factory manufactured pigtails designed for outdoor application. All contractor terminated fibers with contractor polished ST connectors shall be fine polished without blemish or scratches as viewed with a 400X zoom cable scope. The Contractor shall be required to provide proof of purchase of sufficient quantities of ceramic terminations for outdoor terminations to verify ceramic connector usage or temperature ratings on epoxy or heat cured processes prior to terminating any fibers. Contractor's utilizing Heat cured or epoxy connections shall provide an industry smooth and unblemished polished mating surface as inspected by the Engineer's view utilizing a 400 X fiber microscope. Any pitting, browning, scratches, etc. on the mating surface shall be cause for rejection of the ST Connector Termination.

46. The Contractor may terminate fibers by splicing factory pigtails to the fiber ends and then connecting the pigtail to the fiber coupler in the fiber tray. When splicing pigtails to terminate, all splices shall be provided with the metal reinforced shrink tube protector. The contractor may terminate fibers by the use of UniCam mechanical termination connectors. Splices to fibers shall be fusion spliced. Mechanical splices, such as Siecor CamLite, shall only be used where specifically authorized by the Engineer, such as for testing or connecting launch cables for OTDR applications.

47. All termination ST couplers shall be rated for single mode fiber application, MM and SM, or shall be permanently identified specifically as to the mode of fiber the coupler is rated when multimode fiber is specified in the project special provisions.

48. Breakout Kits: The breakout kits or termination boxes used to terminate each fiber cable in the cabinet shall provide for the separation and protection of the individual fibers with the buffer tubing and jacketing materials. The termination housing shall be installed within a wall or shelf mountable interconnect housing which shall provide for storing fibers, ample room for feed through cable, strain relief for multiple cables within unit, and accommodate ST compatible connectors.

49. All fiber pigtails shall be terminated through ST connectors on the wall or shelf mounted interconnect panel. All terminations shall be ST type, ceramic core (outdoor connections), and plug into the provided controller unit internal fiber optic modem or the Ethernet switch.

50. Acceptable enclosures for combination termination/splice points shall be MIC-024 <rack or shelf> or WDC-024 <Wall Mount> enclosures or pre-approved equal.

51. Splices to pigtail fiber, where used, shall utilize fan out kit protection to the fiber, heat shrink tubing with metal bar reinforcement and 900 micron rated pigtail insulation. Splices to factory pigtails shall use pigtails that are rated for a minimum temperature range of zero degrees to +150 degrees Fahrenheit. In the absence of pigtails meeting this temperature rating, fibers shall utilize loose tube fiber in fan out kit tubes and UniCam mechanical ST termination connectors. These splices, fiber cable to pigtails, may be external to splice trays mounted internally to the enclosure, when shown on the wiring diagrams. All other splices, not specified to be installed external to the fiber splice tray, shall be fusion spliced and installed in splice trays and be supported with heat shrink tubing. Acceptable splice trays include MIC-024-048 or 067 series or pre-approved equal.

52. Connectors: Connectors shall be mechanical ST (ceramic ferrule-outdoor connections) compatible, field installable, and self-aligning and centering or factory fabricated pigtails. Connections to the special devices used for Ethernet network connections shall utilize a factory converter cable of SC to ST or manufacturer specified converter patch cord to ST termination connector. Fiber optic equipment, used for terminating fibers, shall be rated for the type of connectors used. Connectors shall be Siecor CamLite, UniCam, or NEMA temperature rated epoxy type, or Engineer approved equal.

53. Splices: The fiber cable shall be installed in continuous runs between cabinets. No splices shall be allowed, unless shown on the plans or for testing. Only mechanical splices, Siecor CamLite or approved equal will be allowed, when specified, such as testing of non-terminated fibers, and these splices shall not be acceptable for any permanent connection. Splices, where specified, shall be by fusion splice and shall be installed using an automatic fusion splicer. Splices between two fibers leaving the cabinet shall be supported in splice trays installed in splice enclosures. All splices shall be protected by heat

shrink tubing designed for fiber optic splicing applications. Fibers being terminated in two separate termination or splice enclosures shall be supported between enclosures by the use of buffer tubing or approved equal support material or shall be pigtail patch cords. Combination Splice/Termination Enclosures shall be separated by less than 12 inches unless a conduit is installed between enclosures. All splices shall be performed by an automated splicer device that verifies the final splice termination quality. All splices shall be nominally .03 to .05 dB loss, but shall be less than a 0.08 dB loss.

54. Launch Reference Attenuator <Testing>: The launch attenuator, two each for single fiber testing, shall be utilized for all OTDR tests such that one launch cable shall be at the beginning of the fiber being tested and the second launch cable shall be on the end of the fiber being tested past the final connector. Only one launch cable shall be required when testing non-terminated fiber. The launch attenuator(s) shall be of the same fiber core size and type as the fiber under test. The attenuator shall emulate 300 hundred foot fiber length, minimum, for multimode and 900 feet length, minimum, for single mode fiber or as specified by the OTDR manufacturer for stabilization of the pulse generation. Launch cables shall be of identical length for incoming and outgoing light during tests. ST connectors shall be utilized with each attenuator to connect the device to the test device, OTDR. One launce cable shall be installed on the start of the fiber being tested and one launch cable shall be installed on the end of each terminated to view the dB loss of the final connector.

55. The OTDR shall have the Threshold Loss set at a value to show each splice or termination junction of a single fiber in each tube without showing the extraneous noise caused by handhole coils or turns into the cabinets. This level is normally a value [Threshold Loss] between 0.3 and 0.8 on the OTDR. This trace shall be provided for one fiber in each tube tested and each “event” shall be marked as to splice, jumper or patch cord. The Threshold Loss shall then be set to a value of 0.25 for multimode fiber tests and to a value of 0.10 for single mode fiber tests. The test of each fiber installed shall be conducted and any recorded events above this threshold shall be identified, such as jumper or patch cord. Events that are in excess the provided values shall be corrected prior to documentation submittal, such as terminations in excess of the rated value or bends in the fiber at the point of a splice entering of leaving the splice tray (See Fiber Optic Cable Testing). For measured values recorded in excess of the above (0.25 MM and 0.10 SM) listed values, refer to the specification above. The Engineer reserves the right to spot test fiber terminations, splices, or re-testing of all fibers in a section to insure proper quality assurance both during and after installation and testing. Deviations from Engineer testing and report documentation shall be reviewed and the Contractor shall be able to retest any or all challenged measurements to verify a valid test. Inconsistent test results, in the sole opinion of the Engineer, shall be cause for the Contractor to retest the entire fiber installation.

56. Basis of Payment. The furnishing and installing of Fiber Optic Cable and the tracer cable to include cable markings and Fiber Optic Cable Testing shall be paid for on a Per Unit Linear Foot for "Fiber Optic Cable, Complete". The furnishing of the ST connector, miscellaneous supplies, labor and clean-up, etc. shall be paid for a Per Unit Termination for "Fiber Optic Termination, Complete". The furnishing of the hardware, miscellaneous supplies, labor and clean-up, etc. for a Per Unit Splice for "Fiber Optic Splice, Complete". Testing of the fiber optic cable complete with termination, splices, launch cables, testing equipment, fan out kits, etc., shall be considered incidental to the furnishing and installing of Fiber Optic Cable, Complete and no separate funds will be paid.

57. Visible Light Source Kit: When specified, the Contractor shall provide one each 650 nM visible light source, Model VF13 or approved equal, complete with all attachments for viewing individual fibers of multimode and single mode for spot inspection of installed and terminated fibers. This test kit shall include one each 400X power zoom scope for observing fiber ends for smoothness and fractures. The kit shall include a cable cutting knife for slicing the outer jacket of the fiber cable and cutting the split cable outer jacket from the cable. The kit shall include a cleaver, lab or bench level accuracy. The kit shall include twelve (12) single mode ST connectors, Corning UniCam mechanical connectors with ceramic ferrules complete with crimper device, twenty-four (24) couplers rated for SM ST connections for field links, twelve (12) Corning CamLite mechanical splicing devices complete with splice locking mechanism and three boxes of fiber wrap disposable cloths, cleaning solvent and six (6) cans of compressed air for cleaning couplers and device ports.

58. Launch Reference Attenuator: When specified, two each launch attenuators, for single mode fiber verification, shall be provided by the contractor. Each launch attenuator shall be of the same fiber core size and type as the fiber under test. The attenuator shall emulate 900 hundred foot fiber length, minimum, for single mode fiber for stabilization of the pulse generation. Launch cables shall be of identical length for incoming and outgoing light during tests. ST connectors shall be utilized with each attenuator to connect the device to the verification device, normally an OTDR. One launce cable shall be installed on the start of the fiber and one launch cable shall be installed on the end of each terminated to view the dB loss of the final connector.

59. Light Source: When specified, the contractor shall furnish one each Light Source or the same brand and model sequence as the Power Meter. The LED light source shall be provided with a wavelength that is the system wavelength, 850 and 1300 nm for multimode and 1310 and 1550 nm for single mode, shall be used. The LED shall be stable within 0.1 dB in intensity over a time period sufficiently long to perform the measurement. The output of the LED shall overfill the input end of the launch fiber/cable in both numerical

apertures (NA) and core diameter. The accuracy of the combined light source and power meter shall be less than .05 dB and be temperature compensated stabilized to 0.01 dB over the operating range of the meter(s). AC power adapters shall be provided with all light sources as well as battery operation.

60. Power Meter: When specified, the contractor shall furnish one each Power Meter or the same brand and model sequence as the Light Source. The detector in the power meter shall have an effective numerical aperture and active region that is larger than the receive reference cable and/or the fiber under test. The power meter shall have a minimum range from +3 DBMS to –40 DBMS. The power meter shall have an accuracy of +/-0.5 dB through the operating temperature and minimum resolution of 0.1 dB.

The Power meter shall be operational on both multimode and single mode fiber for the frequencies specified under the Light Source. AC power adapters shall be provided with all power meters as well as battery operation.

61. C-MIC-024 Combination Splice/Termination Enclosure: Where specified, all fiber entering a controller cabinet or Hub shall be installed in a separate C-MIC-024 combination splice/termination enclosure, or as shown on the wiring diagrams. Excluding endpoint locations and side panel [wall] mounts defined elsewhere in the specifications, all traffic controller cabinets shall be provided with two C-MIC-024 enclosures, unless specified otherwise. Each C-MIC-024 enclosure shall be provided with three (3) splice trays and 24 termination points unless specified otherwise in the wiring diagrams. As specified on the Plans or wiring diagrams, the Contractor shall terminate, splice or tie and bundle single mode fibers from each fiber cable entering the cabinet and shall terminate, splice or tie and bundle single mode fibers exiting each cabinet. All cabling that is not specified to be terminated or spliced shall be neatly tied and bundled in one of the enclosures and properly labeled as to the direction [N, E, S, or W] of entry. The combination splice/termination enclosure shall be a rugged aluminum construction and shall have knock-out holes for the fiber cable to enter and/or exit on the left and right side as well as cable entry/exit in the rear of the enclosure. A cable tie point shall be provided to latch the center member of the fiber cable holding the cable in place. The enclosure shall have a hinged tray that shall swing out for viewing and connections for the fibers. The tray shall have a full bottom such that all fibers are contained within the inside of the tray and the fibers are terminated of spliced in the tray area. The tray shall contain oblong guides to form the fiber tubes for termination or for splicing. The tray shall have mount positions for terminating six fibers per removable panel and the panel shall have couplers, set of six each, designed and tested for single mode ST connectors. Behind the removable panels shall be room for splice trays. Sufficient depth shall be provided to accommodate four splice trays each capable of holding twelve splices in non-metallic grooves. The enclosure shall be provided with two point, minimum, wings to mount the enclosure on a shelf, under the shelf or in a 19" rack mount rail. The wings shall be field adjustable to accommodate the above referenced mount

positions. All Combination Splice/Termination Enclosures shall be marked with the designation provided in the wiring diagram, Plans for each location.

62. CCH-04U Termination Enclosure – 72 Position: Where specified, all fiber entering a Hub cabinet shall be installed in a separate C-MIC-024 combination splice/termination enclosure, CCH-04U Termination Enclosure, CSH-03U Splice Enclosure, Wall Mount Enclosure or as shown on the wiring diagrams. All locations where termination enclosures are specified, the Termination Enclosure shall be a 19" rack mounted enclosure with the ability to terminate 72 fibers per enclosure. Each CCH-04U enclosure shall be provided with twelve (12) panels each containing six (6) each couplers designed and tested for single mode fiber installation. Unless otherwise specified on the Plans or wiring diagrams, the Contractor shall terminate all single mode fibers from each fiber cable entering or exiting the cabinet. All cabling that is not specified to be terminated shall be neatly tied and bundled in one of the enclosures and properly labeled as to the direction [N, E, S, or W] of entry.

The termination enclosure shall be a rugged aluminum construction and shall have knock-out holes for the fiber cable to enter and/or exit on the left and right sides as well as cable entry/exit in the rear of the enclosure. All patch cord connections shall be made from the front of the enclosure. A cable tie point shall be provided to latch the center member of the fiber cable holding the cable in place. The enclosure shall have mount positions for terminating six fibers per removable panel and the panel shall have couplers, set of six each, designed and tested for single mode ST connectors. The enclosure shall be provided with wings on the left and right to mount the enclosure on the 19" rack mount rails. The wings shall be field adjustable to accommodate the above referenced mount positions for the depth necessary to close the Hub door with fiber patch cords connected. All Termination Enclosures shall be marked with the designation provided in the wiring diagram, Plans for each location.

63. CSH-03U Splice Enclosure – 3U Height: Where specified, all fiber entering a Hub cabinet shall be installed in a separate C-MIC-024 combination splice/termination enclosure, CCH-04U Termination Enclosure, CSH-03U Splice Enclosure or as shown on the wiring diagrams. All locations where termination enclosures are specified, the Splice Enclosure shall be a 19" rack mounted enclosure with the capacity to splice 72 fibers, per direction per enclosure. Each CSH-03U enclosure shall be provided with six (6) Splice Trays each containing twelve (12) non-metallic holders designed and tested for single mode fiber installation. Unless otherwise specified on the Plans or wiring diagrams, the Contractor shall splice all single mode fibers from each fiber cable entering to the fibers exiting the cabinet. All cabling that is not specified to be spliced shall be neatly tied and bundled in one of the enclosures external to the splice trays and properly labeled as to the direction [N, E, S, or W] of entry.

The splice enclosure shall be a rugged aluminum construction and shall have knock-out holes for the fiber cable to enter and/or exit on the left and right sides as well as cable entry/exit in the rear of the enclosure. A cable tie point shall be provided to latch the center member of the fiber cable holding the cable in place within the enclosure. The enclosure shall have mount positions for splicing twelve fibers per individual splice tray. The enclosure shall be provided with wings on the left and right to mount the enclosure on the 19" rack mount rails. The wings shall be field adjustable to accommodate the above referenced mount positions for the depth necessary to close the Hub door with the splice enclosure installed. All Splice Enclosures shall be marked with the designation provided in the wiring diagram, Plans for each location

64. Wall Mount Enclosure: Where specified, the Wall Mount Enclosure shall be a rugged metal enclosure with a removable front panel plate having twenty-four (24) pre-drilled holes with fiber optic ST couplers installed. The case shall have a screw mounted point where the central member of the fiber is latched and held in position with a stainless steel screw compression fastener. The internal section of the enclosure shall have a fiber routing mount to wrap the fiber around in a circular direction to relieve the stress on the fibers and to maintain an orderly fiber installation. Panel knockout holes shall be available to enter the assembly from either the top or the bottom. The enclosure shall be approximately 8" in depth, 8" in height and 4" in width and be mounted securely in either the controller cabinet on the side rails or in the hub cabinets on the racks via an aluminum plate. The enclosure shall be mounted with the removable front panel facing the cabinet or hub door with the removable or hinged side panel door, used to protect the fibers, opening to the free space area of the cabinet or hub.

9602.2 FIBER OPTIC CABLE TESTING

1. The Contractor shall provide all personnel, equipment, instrumentation and supplies necessary to perform all testing. All testing shall be performed in an accepted manner and in accordance with the testing equipment manufacturer's recommendations. All data shall be recorded and submitted to the Traffic Engineer and Fiber Optic Coordinator as hereinbefore specified. The Contractor shall provide one copy of operating software to read and view all OTDR traces to the Traffic Engineer and the Fiber Optic Coordinator.

2. Attenuation: The end-to-end attenuation shall be measured for each fiber for each link after installation and termination. A patch cord jumper cable shall be connected to both the light source and the receive cable to the power meter by the use of a connector (barrel). The two reference cables shall then be connected via a termination coupler and the power meter "zeroed" to eliminate the line loss. This process results in a reading of the actual line loss (dB) of the input connector, fiber cable, exiting connector and any other splices or jumpers installed in the measured test link. The calculated "loss" shall not include the input or departing cables in the loss calculation. The calculated

fiber loss measured shall list the number of terminations, including the input and departing connectors, the number of splices and the number of patch cords used to jumper the link(s) into the measured final link. The measured values for each terminated fiber in each tube shall include the Tube number, fiber number, number of feet in the link, the number of splices, the number of patch cords and the number of connectors, if any. The length of optical cable shall be as measured by the OTDR rather than the fiber cable jacket as the fiber is a reverse oscillation process resulting in a greater optical distance than the fiber cable jacket. The value for both the OTDR length and the cable jacket shall be provided in the recorded documentation for each link distance. All distances shall be recorded in feet rather than meters for both recorded lengths.

3. Fibers that are not continuous from beginning of the link to the end of the link shall be noted in the documentation; otherwise, all fibers in a single tube may be listed with a single data entry for all required data listed above for all fibers in the tube. The fiber documentation for each fiber shall identify the fiber being tested by either fiber number or fiber coating color and be recorded by complete tube, Tube 1 through Tube 6, fiber 1 through fiber 12. The direction of the test shall be recorded for information purposes only to resolve discrepancies in replicating the test during inspections of the final installation. The power meter reading recordings shall log total dB loss over the length of the fiber measured, equivalent to a dB loss budget.

4. The output power levels at the network hardware transmitters and receivers shall be measured and recorded for system documentation. The power meter shall be connected to the transmitter side of the equipment with a system jumper. The transmit power level shall then be read and recorded.

5. Each tube of a cable shall be in the same computer storage file divider where the tube cover OTDR page shows the overview of all splices, patch cords, terminations from start to end. The second section shall include all Power Meter readings and the mandated documentation to show the calculated line loss (losses). The third section shall contain all OTDR traces, one trace per screen. The fourth section shall include the spool sheet for the fiber installed on the test section. An "explanation" sheet may be included where required to clarify an unusual reading that is valid but difficult to be explained through traditional data presentation, such as a video feed fiber that is attached to a jumper to provide continuous feed from the start to end of the tube length where other fibers in the same tube are simply spliced. The above format shall be repeated for each tube of a cable. Traffic fiber measured in sections marked by traffic controller cabinets between Hub Sites may be sub-sectioned in an easy to understand format or may be jumpered using patch cords as a single OTDR Link with each section separated for power meter readings.

6. Continuity: Continuity tests shall be used to determine whether a test or system jumper does or does not pass light. A continuity test shall also be used to assure the fibers have not been crossed over in the jumper and that the transmit fiber goes to the receiver fiber. The visible light tester shall be utilized to illuminate faulty terminations or fibers with excessive bends failing to pass light.

7. To perform continuity test, a high-intensity red light (Visible Fault Identifier) light source shall be aimed into the connector at one end, while an observer watches for a flicker of light at the other end. One each 650 nm red NFL light source shall be furnished to the Engineer by the Contractor on request during the testing of the fiber by the Contractor for spot testing. This device shall be made available during testing of continuity to the Engineer to assist in verifying fault locations and connector bleeding.

8. OTDR Testing: An Optical Time Domain Reflectometer (OTDR) shall be used to evaluate the quality and length of cable reels prior to their use on the project. A minimum of one fiber per tube per reel shall be tested if payment for stored goods is requested. The fiber loss in dB/km and the length of each reel shall be recorded in the documentation. The maximum attenuation of the cable shall be as hereinbefore specified. This test does not require an electronic document; but is provided to insure that the fiber has been received in useable quality without shipment damage. The test results of the Contractor OTDR tests of received spools shall be provided to the Engineer, in a minimum of hard copy print, prior to receiving payment for stored goods.

9. An Optical Time Domain Reflectometer (OTDR) shall be used to evaluate the quality and length of cable installed on the project. This test shall be conducted on all fibers, terminated and not terminated, and shall be conducted after all terminations on the fibers for a link have been completed. The fiber loss in dB/km and the length of each reel shall be recorded in the documentation. The index of refraction, minimum of three decimal points, provided by the manufacturer on the spool documentation shall be used for the test on the OTDR. The maximum attenuation of the cable shall be as hereinbefore specified. A hard copy of OTDR signature traces, electronically and in printed form, for all fiber links shall be made and provided in the documentation as specified. The data provided shall be in easy to understand format and of sufficient detail to verify the results. Fiber testing shall include only one fiber trace per graph. One copy of the operating system software to view the fiber graphs shall be provided with the final documentation.

10. Documentation: The result of all testing shall be recorded along with date of test, name of person performing test, brand name, model number, serial number of equipment used during test, and any other pertinent information and data. The Contractor shall be responsible to provide input to the Engineer reviewing the recorded data documentation to resolve all questions or data discrepancies. A copy of the evaluation calculation equations to be used may be obtained by the Contractor by request and by supplying a floppy disk. (The evaluation FO Calculator is an EXCEL program worksheet that calculates design dB Loss based on required inputs.) Documentation shall be considered incidental to bid item Fiber Optic Cable, Complete and no additional compensation shall be provided.

9700.0 STANDARD PLANS