CITY OF EDMOND

STANDARD SPECIFICATIONS FOR CONSTRUCTION

1992 Edition

PURPOSE, INTENT AND INTERPRETATION OF SPECIFICATIONS

The purpose of these Specifications is to establish, where applicable, minimum acceptable standards or a range for acceptable results. It is the intent of these Specifications that the Contractor be fully and exclusively responsible for producing an acceptable end product.

In producing this end product, the Contractor shall exercise control of the project. The city of Edmond personnel, except where specifically provided for herein, will make inspections to document that an acceptable product is being produced.

Interpretation of these specifications will be done in such a manner as to allow the Contractor to control his project to the greatest degree possible in producing an end result product that is in all respects acceptable. These Specifications should not, however, be interpreted in any manner that allows a Contractor to produce an unacceptable product or endanger the public. An acceptable end result product is the essence of the Contract. Only projects in substantial conformance with the Plans and Specifications will be accepted by the City of Edmond.

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ORDINANCE NO. 1985

AN ORDINANCE AMENDING CHAPTER 14.04 OF THE EDMOND MUNICIPAL CODE PROVIDING FOR UNIFORM STANDARDS AND SPECIFICATIONS FOR CONSTRUCTION OF STREETS, SIDEWALKS, DRAINAGE FACILITIES, WATER AND SANITARY SEWER LINES AND OTHER PUBLIC WORKS FACILITIES, PROVIDING FOR DISBURSEMENT OF STANDARDS AND SPECIFICATIONS, ADDING SUBSECTION 14.04.030 PROVIDING PENALTY FOR VIOLATION, AND PROVIDING FOR REPEALER AND SEVERABILITY.

BE IT ORDAINED BY THE MAYOR AND COUNCIL OF THE CITY OF EDMOND, OKLAHOMA:

Section 1: Section 14.04.010 of the Edmond Municipal Code is hereby repealed and amended as follows:

14.04.010. The City of Edmond Standard Specifications for Construction as prepared by the Engineering Department, consisting of one bound set of specifications on file with the City Clerk, and the City of Edmond Construction Standards as prepared by the Engineering Department, consisting of one bound set of standard drawings on file with the City Clerk are adopted. All construction and laying of streets, sidewalks, drainage facilities, water and sanitary sewer lines and other public works facilities shall be in accordance with said specifications and standards.

Section 2: Section 14.04.020 of the Edmond Municipal Code is hereby repealed and amended as follows:

14.04.020. Any person, firm or corporation who intends to design, construct, reconstruct, build or rehabilitate any City owned public improvement shall possess one bound set of Standard Specifications and one bound set of Construction Standards. Any person, firm or corporation may obtain the Standard Specifications and Construction Standards by submitting their name, address and telephone number along with funds in an amount of twenty ($20.00) dollars to the Engineering Department located at the Edmond City Hall.

Section 3: Section 14.04.030 of the Edmond Municipal Code is hereby added as follows:

14.04.030. Penalty for violation. Any person, firm or corporation who violates any provision hereof, or any legal order or regulation made in accordance with said Standard Specifications or with said Construction Standards, is guilty of a violation, and upon conviction shall be fined an amount not to exceed one-hundred dollars, including costs. Each separate violation and each day's continuation of any violation is a separate offense.

Section 4 REPEALER. All ordinances or parts of ordinances in conflict herewith are hereby repealed to the extent of any such conflict.

Section 5. SEVERABILITY. If any section, sub-section, sentence, clause, phrase, or portion of this Ordinance is, for any reason, held invalid or unconstitutional by any Court of competent jurisdiction, such portion shall be deemed a separate, distinct and independent provision and such holding shall not affect the validity of the remaining portion of this Ordinance.

PASSED AND APPROVED the 24 day of February, 1992.

Mayor

ATTEST:

CITY CLERK

APPROVED as to form and legality this 24th day of February, 1992.

CITY ATTORNEY

SECTION 100 - GENERAL PROVISIONS

101.00 Definitions and Terms. Whenever in these Specifications and Contracts, or in any documents or instruments pertaining to construction where these Specifications govern, the following terms or pronouns are used, the intent and meaning shall be interpreted as follows:

101.01 Abbreviations. Wherever the following abbreviations are used in Contracts, Proposals, these Specifications or on Plans, they are to be construed the same as the respective expressions represented:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AGC	Associated General Contractors of America
AIA	American Institute of Architects
ARA	American Railway Association
AREA	American Railway Engineering Association
ANSI	American National Standards Institute (United States of America Standards Institute)
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society of Testing and Materials
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
AWS	American Welding Society
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards (General Services Administration)
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
ITE	Institute of Traffic Engineers
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
ODOT	Oklahoma Department of Transportation
SAE	Society of Automotive Engineers
UL	Underwriters Laboratory

101.02 Adverse Weather Conditions. Weather conditions, which warrant special considerations by the Contractor to protect his work from damage due to wind, rain, dust or other conditions generally not under his control. It will also be considered adverse weather when the mean daily temperature falls below 40° F for more than two (2) consecutive days.

101.03 Advertisement. The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

101.04 Alteration. The City of Edmond authorized addition, deletion or revision of the work.

101.05 Award. The acceptance by the City of Edmond of a bid.

101.06 Base Course. The layer or layers of selected material of a designated thickness placed on a sub-base or a sub-grade or to support a surface course.

101.07 Bidder. An individual, partnership, joint venture, firm, or corporation submitting a bid for the advertised work.

101.08 Bid Opening. The time appointed for the opening of the Proposals submitted by Bidders.

101.09 Bonds.

Statutory (Payment) Bond. A bond, issued by a Surety as defined in Subsection 101.77, to the City of Edmond in a sum not less than the total amount of the Contract guarantying that the Contractor shall pay all reasonable indebtedness incurred by such Contractor or its subcontractors, in the performance of the Contract, and as required by the Statutes of Oklahoma.

Performance Bond. A bond, issued by a Surety as defined in Subsection 101.77, to the City of Edmond in a sum not less than the total Contract price, which shall insure the proper and prompt completion of the work in accordance with the provisions of the Contract.

Maintenance Bond. A bond, issued by a Surety as defined in Subsection 101.77, to the City of Edmond in a sum equal to one-hundred percent of the Contract amount for a period of one year after City acceptance of the project. The remaining years shall be bonded at fifteen percent of the Contract price. The maintenance bond shall be furnished by the Contractor and to the City of Edmond on a form acceptable to the City. The following indicates time and bonding percentages:

Type of Contract	Number of Years Bonded	% of Contract First Year	% for Bond Remaining Years
Sanitary Sewer	2	100	15
Storm Sewer	2	100	15
Paving	5	100	15
Resurfacing	1	100	15
Water Lines	2	100	15

Bid Bond. A bond, issued by a Surety as defined in Subsection 101.77, as a Proposal guaranty as defined in Subsection 101.53.

101.10 Bridge. A structure, including supports, erected over a depression or obstruction, such as water, a highway, or a railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines or arches or extreme ends of openings for multiple boxes; may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge Length. The length of a bridge structure is the overall length measured along the line of survey stationing back to the back of backwalls of abutments, if present; otherwise, end to end of the bridge floor but in no case less than the total clear opening of the structure.

***Bridge Roadway Length*.** The clear width of the structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

101.11 Calendar Day (Date). Any day shown on the calendar beginning and ending at midnight.

101.12 Change Order. A written order authorized by the City of Edmond covering changes within the scope of the Contract and establishing the basis of payment and time adjustments for the work affected by the changes. The Change Order is the document authorizing the use of a Change in Plan.

101.13 City. City Council, Edmond Public Works Authority. The Council of the City of Edmond or the Edmond Public Works Authority as constituted by the City Charter and which is charged with the duty to administer the affairs of the City of Edmond.

City Attorney. The Chief Legal Counsel of the City of Edmond providing primary legal representation to the Mayor and City Council, the Edmond Public Works Authority, and through the City Manager, to the various City departments.

***City Engineer*.** The Chief Engineer of the City of Edmond providing primary Engineering Services to the Mayor and City Council, the Edmond Public Works Authority, and to the various City departments.

***City Manager*.** The Executive Officer duly appointed and authorized by the City Council to direct and control the Departments and Personnel of the City of Edmond.

City of Edmond (The City). The public body and/or Authority with whom the Contractor has entered into the Contract and for whom the work is to be provided. The City of Edmond, the Edmond Public Works Authority, (The City), shall also be defined as all public Trusts, Boards, and Commissions created by the Charter of the City of Edmond and by the Municipal Codes through applicable Oklahoma State Statutes.

101.14 Contract. The written agreement between The City and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

The Contract includes the Solicitation for Bids, Instruction to Bidders, Bid Proposal, Contract Form, All Contract Affidavits, Bonds, Specifications, Supplemental Specifications, Special Provisions, all Plans, and the Work Order; also, any Change Orders and Supplemental Agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions.

101.15 Completion Date. The date on which the Contract work is completed.

101.16 Contract Item (Pay Item). A specifically described unit of work for which a price is provided in the Contract.

101.17 Contract Time. The number of work days or calendar days allowed for completion of the Contract, including authorized time extensions.

When a Calendar Date of completion is shown in a Proposal, the Contract time shall be the number of days between the effective date of the Work Order and the specified Completion Date.

101.18 Contractor. The individual, partnership, joint venture, firm or corporation contracting with the City of Edmond for performance of prescribed work.

101.19 Control Of Access. The condition where the right of owners or occupants of abutting land or other persons to access, light, air, or view in connection with a highway is fully or partially controlled by public authority.

Full control of access means that the authority to control access is exercised to give preference to through traffic by providing access connections with selected public roads only and prohibiting crossings at grade or direct private driveway connections.

Partial control of access means that the authority to control access is exercised to give preference to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossings at grade and some private driveway connections.

101.20 County. The duly elected Board of County Commissioners acting for Oklahoma County.

101.21 County Engineer. The duly appointed County Engineer of Oklahoma County or the Consulting Engineer employed by the County.

101.22 Culvert. Any structure under the roadway with a clear opening of twenty (20) ft. or less measured along the center of the roadway.

101.23 Drainage Ditch. An open excavation or ditch constructed for the purpose of carrying off surface water.

101.24 Easement. A grant of the right of use of property of an owner for a certain purpose at the will of the grantee.

101.25 Engineer. Those persons employed by the City of Edmond and/or designated as Assistants or Representatives of the City Engineer, acting within the scope of the particular duties entrusted unto them.

101.26 Equipment. All machinery, tools and apparatus necessary for the proper construction and acceptable completion of work.

101.27 Experimental Construction. Experimental Construction is construction in which one or more experimental features have been incorporated or utilized, regardless of whether the incorporation or utilization of the experimental feature is a primary or secondary consideration in undertaking the project.

101.28 Experimental Feature. An Experimental Feature may be a material, process, method, equipment item, traffic operational device or other feature that has not been sufficiently tested under actual service conditions to merit acceptance without reservation in normal highway construction.

101.29 Extra Work. Any work identified by the City for which no prices are provided in the Proposal or Contract and which is not considered as incidental to another item of work.

101.30 Financial And Experience Questionnaire. The approved form of the City upon which the prospective Bidder shall furnish the information as to his financial condition, his experience, the equipment to be used and to indicate his ability to finance and perform the work.

101.31 Final Acceptance Date. The date upon which the completed work is accepted by the City without exception or reservation.

101.32 Freeway. An expressway with full control of access.

101.33 Grade Separation. Any structure carrying highway traffic over or under another highway or street, or over or under the tracks of any railway.

101.34 Highway, Street Or Road. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.35 Holidays. Any day proclaimed a Holiday by the City of Edmond.

101.36 Laboratory. The official testing laboratory of the City or any other testing laboratory which may be designated by the Engineer.

101.37 Letter Of Credit. An irrevocable Letter of Credit for the benefit of the City of Edmond issued by a financial institution insured by the Federal Deposit Insurance Corporation or the Federal Savings & Loan Insurance Corporation. A letter of credit shall be in the form as prescribed by the City of Edmond.

101.38 Lot. A lot is an isolated quantity as defined in the Contract.

101.39 Materials. Any substances used in the construction of the Project and its appurtenances.

101.40 Median. The portion of a divided street separating the traveled ways for traffic.

101.41 OHD-L (Oklahoma Highway Department-Laboratory). The testing procedure and/or the material specifications of a particular product or service. Copies of the particular OHD-L test/specifications may be obtained from:

1) City Engineer or
   P. O. Box 2970
   Edmond, OK 73083

2) Materials Engineer
   Oklahoma Department of Transportation
   200 N. E. 21st Street
   Oklahoma City, OK 73105

101.42 Parkway. An arterial highway for non-commercial traffic, with full or partial control of access, and usually located within a part or a ribbon of park-like development.

101.43 Pavement Structure. The combined sub-base, base and surface courses placed on the sub-grade to support the traffic load and distribute it to the roadbed.

101.44 Plans. The approved plans, profiles, typical sections, cross-sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be done.

101.45 Prequalification. The process of qualifying a prospective Bidder prior to the issuance of bidding documents in conformance with the rules, regulations, policies and procedures of the City of Edmond.

101.46 Profile Grade. The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

101.47 Project Inspector. An authorized Representative of the Engineer assigned to make detailed inspections of Contract performance.

101.48 Project. The specific section of an improvement or proposed improvement or other facilities together with all appurtenances and construction to be performed under the Contract.

101.49 Proposal. The written offer of the Bidder, submitted on the prescribed form, to perform the work described in the Plans and Specifications, and to furnish the labor and materials at the prices quoted by the Bidder.

101.50 Proposal Form. The approved form on which the City requires bids to be prepared and submitted for the work.

101.51 Proposal Guaranty. The security furnished with a bid to assure that the Bidder will enter into the Contract if his offer is accepted. This Proposal Guaranty shall be in the form of a Bid Bond, certified check or cashier's check as authorized by law. The Proposal Guaranty is for the purpose of repaying the City of Edmond the cost of republication of notice to Bidders, all actual and reasonable expenses incurred by reason of the Bidder's default and the difference between the low bid of the defaulting Bidder and the amount of the bid of the Bidder to whom the Contract is subsequently awarded, but not to exceed the amount of said bid bond or check, in the event the apparently successful Bidder fails to execute the Contract or fails to provide the required Bonds and insurance to the City.

101.52 Questionnaire. The specified forms on which the Contractor shall furnish required information as to his ability to perform and finance the work.

101.53 Ramp. A connecting roadway between two intersecting highways at a highway separation, or a road connecting the highway with other roads or entrances.

101.54 Right-of-Way. A general term denoting land, property, or an interest therein, acquired for public purposes.

101.55 Roadbed. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

101.56 Roadside. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.57 Roadside Development. Those items, which provide for the preservation of landscape materials and features, necessary to the complete project.

101.58 Roadway. That portion of the Right-of-Way between the outer edges of the shoulder.

101.59 Shoulder. The portion of the roadway contiguous with the traveled way designed for emergency use and for lateral support of base and surface courses.

101.60 Sidewalk. That portion of the Right-of-Way constructed for the use of pedestrians.

101.61 Solicitation for Bids. The advertisement for Proposals for all work or materials on which bids are required. Such advertisement will indicate with reasonable accuracy the quantity and location of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of Proposals.

101.62 Special Provisions. Additions and revisions to be the Standard and Supplemental Specifications.

101.63 Specifications. The compilation of provisions and requirements for the performance of prescribed work.

101.64 Standard Specifications. The book of Specifications approved for general application and repetitive use by the City of Edmond.

101.65 Supplemental Specifications. The book of approved additions and revisions to the Standard Specifications.

101.66 Specified Completion Date. The date on which the work required under the Contract is specified to be completed.

101.67 Speed Change Lane. An auxiliary lane, including tapered areas, primarily for the acceleration or deceleration of vehicles entering or leaving the roadway. Speed Change Lanes are described as Acceleration Lanes, Deceleration Lanes or Median Lanes.

101.68 State. The State of Oklahoma.

101.69 Structure. Bridge, culvert, catch basin, drop inlet, retaining wall, cribbing, manhole, endwall, headwall, building, sewer, service pipe, underdrain, and foundation drain and other features which may be encountered in the work and not otherwise classified.

101.70 Subcontractor. An individual, partnership, joint venture, firm or corporation, being a separate and independent entity, to whom the Contractor contracts part of the work under Contract.

101.71 Sub-Base. The layer or layers of selected material of a designed thickness placed on a sub-grade to support a base course.

101.72 Sub-Grade. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

101.73 Substructure. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls, wingwalls and wing protection railings.

101.74 Superintendent. The representative of the Contractor present at all times during progress of the work, capable of supervising the work effectively and authorized to make binding decisions for the Contractor.

101.75 Superstructure. The entire structure except the substructure.

101.76 Supplemental Agreement. A written agreement made and entered into by and between the Contractor and the City of Edmond, covering work not otherwise provided for in the Contract which is necessary for the proper completion of the project.

101.77 Surety. The insurance company or other body, authorized under the laws of Oklahoma to insure the Contractor's faithful performance of the Contract, the payment of all indebtedness incurred in the performance of the Contract by the Contractor, and where applicable, the liability for any defects resulting from defective workmanship and/or materials furnished by the Contractor.

101.78 Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called the "A" Wearing Course.

101.79 Titles (Or Headings). The titles or headings of the Sections and Subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

101.80 Traveled Way. The portion of the roadway for the movement of vehicles, exclusive of shoulders.

101.81 Work. Work shall mean the furnishing of all labor, materials, equipment, and other incidentals necessary to the successful completion of the project and the carrying out of all the duties and obligations imposed by the Contract.

101.82 Working Day. Every day shown on the calendar, exclusive of Saturdays, Sundays and holidays as set forth in 101.37, on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for a minimum of six hours with normal working forces engaged in

performing the controlling item or items of work. Saturdays, Sundays and holidays on which the Contractor's forces engage in regular work, requiring the presence of an inspector, will be considered as working days, and require 48-hour advance notice of intent to work Saturdays, Sundays or holidays.

101.83 WORKING DRAWINGS. Stress sheets, shop drawings, erection plans, false-work plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

101.84 Work Order. Written notice to the Contractor to proceed with the Contract work not later than the date specified.

101.85 In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected or condemned," it shall be understood as if the expression were followed by the words "by the Engineer or to the Engineer".

102.00 BIDDING REQUIREMENTS AND CONDITIONS

102.01 Notice to Contractors. After the date is set for the receipt of Proposals, the City will give notice of bid opening to prospective Bidders. The notice will contain a description of the proposed work, together with information regarding access to Proposal forms, Plans and Specifications, the amount of Proposal guaranty, approximate quantities, and the minimum wage rate required per hour for skilled, intermediate and unskilled labor. This Notice to Contractors will also be published as an advertisement giving notice of the request for bids, as required by State Law. The Notice to Contractors will become part of the Contract documents.

102.02 Prequalification of Bidders. Prequalification shall be a prerequisite for bidding on all projects unless prohibited by law or waived by the City of Edmond. Prequalification of Bidders shall be accomplished in conformance with the Rules, Regulations, Policies and Procedures of the City of Edmond.

102.03 Contents of Proposal Forms. The City will furnish prospective Bidders with Proposal forms which will state the location and description of the contemplated construction and show the approximate quantities of the various items of work to be performed, materials to be furnished, and a schedule of items for which unit bid prices shall be submitted. The Proposal form will state the working time, the amount of the "Proposal Guaranty," and the date, time and place of the bid opening. The form will also include any Special Provisions, Supplemental Specifications or requirements which vary from or are not contained in the Standard Specifications. All papers bound with or attached to the Proposal forms are necessary parts thereof and must not be detached. The Plans, Specifications and other documents designated in the Proposal form will be considered a part of the Proposal whether attached or not.

102.04 Issuance Of Proposals. The City reserves the right to refuse to issue a Proposal to a prospective Bidder for any of the following reasons:

A. Lack of competency and/or inadequate equipment as revealed by the financial statement and experience questionnaires required under Subsection 102.02.

B. Uncompleted work which, in the judgment of the City, might hinder or prevent the prompt completion of additional work if awarded.

C. Failure to pay, or satisfactorily settle, all bills due on completed Contracts.

D. Failure to comply with prequalification regulations of the City of Edmond.

E. Default under previous Contracts.

F. The prospective Bidder is debarred or ruled unacceptable by the City of Edmond, a federal agency or other governmental agencies.

G. Unsatisfactory performance on previous work.

102.05 Interpretation Of Estimates. The Engineer's estimate of quantities of work to be done and materials to be furnished which are listed in the Proposal form are to be considered as approximately only, and are not to be used as a basis for the comparison of bids for the Award of the Contract. The City does not expressly, or by implication represent that the final quantities will correspond exactly with the estimates of quantities, nor shall the Bidder plead misunderstanding or deception because of such estimates of quantities, or the character, location or other conditions, pertaining to the work. Payment to the Contractor will be made only for the actual quantities of work performed, and materials furnished, in accordance with the Plans and Specifications. It is understood that the quantities of work to be performed and the materials to be furnished may each be increased, decreased, or omitted as hereinafter provided without in any way invalidating the unit prices bid.

102.06 Examination Of Plans, Specifications, Special Provisions And The Work Site. The prospective Bidder is required to examine carefully the work site, the Proposal, Plans, Specifications, Special Provisions, and Contract forms, and to satisfy himself as to the character, quality and quantities of work to be performed, and materials to be furnished, and to satisfy himself as to the requirements of these Specifications, Supplemental Specifications, Special Provisions and Contract. The submission of a Proposal shall be deemed conclusive evidence that the Bidder has made such an examination.

The prospective Bidder shall take no advantage of any apparent error or omission in the Plans or Contract. In the event the prospective Bidder discovers an error or omission, he shall immediately notify the City. The City will then make such corrections necessary to fulfill the intent of the Plans and Contract.

Boring logs and other records of subsurface investigations may be made available for inspection by prospective Bidders. It is specifically understood and agreed that such information was obtained by and is intended for design and estimating purposes only. The City makes no warranty, either express or implied as to the accuracy of the information, nor that the information is generally representative of the work site conditions. The information is made available to prospective Bidders in order that they may have access to the identical information available to the City. The information is not intended as, nor should it be used as a substitute for personal investigation, interpretation, or judgment of the prospective Bidder.

102.07 Preparation Of Proposal. The Bidder shall submit his Proposal upon forms furnished by the City. The Bidder shall specify a unit price in figures for each pay item for which a quantity is given, and shall show the product of the respective unit prices and quantities written in figures in the column provided for that purpose, and shall show the total amount of the Proposal by adding the amounts of the several items. All the figures shall be in ink or typed. In case of a discrepancy between the unit price and the unit product of the unit price, the unit price shall govern.

Any change in the unit price, the product of the unit price, or the total amount of the Proposal shall be acknowledged by the initials of the person signing the bid adjacent to each such change or alteration.

The Proposal must be signed in black or blue ink by the individual, by one or more members of the partnership, by a duly authorized officer of a corporation, or by an agent of the Bidder legally qualified to bid for the Bidder. If the Proposal is made by an individual, his name and post office address must be shown; if by a partnership, the name and post office address of the general partner signing the Proposal must be shown; if by a joint venture, the name and post office address of an authorized officer, general partner or the individual representing each member of the joint venture; if by a corporation, the name of the corporation and its business address must be shown.

102.08 Rejection Of Proposals. Proposals containing any omission, alterations of form, additions, conditions not called for, conditional or alternate bids unless called for, a clause in which the Bidder reserves the right to accept or reject a Contract awarded to him, incomplete bids, non-responsive bids or Proposals otherwise regular which are not accompanied by a Proposal Guaranty will be considered irregular and will be rejected. The City of Edmond reserves the right to waive minor technicalities as to changes or alterations and recommend the Award in the best interest of the City.

102.09 Proposal Guaranty. Each separate Proposal shall be accompanied by a Proposal Guaranty in an amount equal to or greater than 5 percent of the Contractor's bid, and made payable to, or subject to forfeiture to the City of Edmond. This Proposal Guaranty shall be defined in Subsection 101.53.

102.10 Delivery Of Proposal. Proposals will be received as set forth in the *Solicitation for Bids* contained in the Proposal. Proposals received after the designated closing times will be returned unopened.

102.11 Withdrawal Of Proposals. Any Bidder upon his, or his authorized representative's notarized written request, may withdraw his Proposal not later than the time set for opening thereof. If a request to withdraw a Proposal has been received, then at the time of reading the Proposals, when such Proposal is reached, it will be returned to the Bidder unread.

102.12 Combination Bids. If the City so elects, Proposals may be issued for projects in combination and/or separately so that bids may be submitted either on the combination or on separate projects of the combination.

The City reserves the right to recommend Awards on combination bids or separate bids to the best advantage of the City. No combination of bids, other than those specifically authorized by the City in the Proposals, will be considered.

102.13 Public Opening Of Proposals. Proposals will be publicly opened and read on the date and at the hour and place set forth in the advertisement and *Solicitation for Bids* in the presence of the City Council.

102.14 Rejection Of Bids. Any of the following reasons may be considered just cause for the rejection of a bid or bids.

A. More than one Proposal for the same work from an individual, firm, partnership, joint venture or corporation whether under the same or different names.

B. The prospective Bidder is debarred or ruled unacceptable by the City of Edmond, a federal agency or other governmental agency.

C. Unbalanced bids in which the price for any item is artificially high or low, or where front end loading is apparent.

D. Failure to submit a unit price, submission of a zero unit price, or a no charge statement for any item of work.

E. Lack of competency and/or inadequate equipment, as revealed by the financial statement and experience questionnaires required under Subsection 102.02.

F. Unsatisfactory performance on previous work.

G. Uncompleted work which, in the judgment of the City, might hinder or prevent the prompt completion of additional work if awarded.

H. Default under previous Contracts.

I. Errors in preparation of the Proposal.

103.00 AWARD AND EXECUTION OF CONTRACT

103.01 Consideration Of Proposals. Following the public opening and reading of the Proposals, the City will check and verify the product (extended amount) for each bid item and the Proposal amount for each Proposal received. The Proposal amount for each acceptable Proposal submitted will then be compared and the results made public. The City reserves the right to reject any or all Proposals, to waive minor technicalities, to advertise for new Proposals, or proceed to do the work otherwise when the best interest of the City of Edmond will be promoted thereby.

103.02 Award Of Contract. Award of the Contract will be made by the City, upon the recommendation of the City Council, to the lowest responsible Bidder submitting a responsive bid and meeting the requirements of the City. The Award, if made, will be within the time allowed by law after the opening of Proposals.

103.03 Cancellation Of Award. The City reserves the right to cancel the Award of any Contract at any time before the execution of said Contract without liability against the City Council or the City of Edmond.

In projects which are proposed to be funded in whole or in part by Federal or State Funds, it is expressly agreed and understood that the receipt of such funds is essential to the Contract and the receipt of such funds requires the concurrence of the funding agency. If the funding agency neglects, fails, or refuses to concur in the Award of the Contract, the City of Edmond reserves the right to unilaterally rescind the Award of the Contract despite the full and complete execution of the Contract by all parties.

In the event the City elects to exercise its right of unilateral rescission, the Contract's Proposal Guaranty shall be returned to the Contractor and both parties shall thereafter be released from any and all obligations and liabilities which otherwise would exit by reason of the Contract.

103.04 Return Of Proposal Guaranties. When the lowest responsible Bidder submitting a responsive bid has been determined, the Proposal Guaranties which accompanied those Proposals of the unsuccessful Bidders will be returned. The bidding security of the successful Bidder will be retained by the City until the Contract and Bonds have been executed and approved after which the Proposal Guaranty will be returned to the successful Bidder.

103.05 Bonding Requirements. The Bidder to whom the Contract is awarded shall, at the time of the execution of the Contract, deposit with the City a Performance Bond, Statutory (Payment) Bond and where applicable a Maintenance Bond as required by law. The Surety Company shall be acceptable to the City and, shall be in conformance with the rules, regulations, policies and procedures of the City. The terms of the Bonds shall be provided by the City, be executed by the Surety Company, and accompanied by a valid and acceptable Powers of Attorney.

103.06 Execution Of Contract. The individual, partnership, joint venture or corporation to whom the Contract has been awarded shall sign, and attest, where applicable, the necessary agreements for entering into a Contract with the City and return the executed Contract to the City Engineer within the time limit specified in the Proposal.

103.07 Approval Of Contract. The Contract shall not be binding upon the City of Edmond until it has been executed by the City, approved as to form and legality by the City Attorney or his authorized designee and delivered to the Contractor.

103.08 Failure To Execute Contract. Failure to comply with any of the requirements of these Specifications, to execute the Contract, or to furnish the bonds required by law shall nullify the Award. In the event of such annulment of the Award, the amount of the Proposal Guaranty shall be subject to forfeiture to the City of Edmond.

104.00 SCOPE OF WORK.

104.01 Purpose of Contract. The purpose of the Contract is to provide for the construction and completion in every detail of the work described in the Proposal. The Contractor shall furnish all labor, materials, equipment and incidentals required to complete the work in a workmanlike manner and in accordance with the Plans, Specifications and terms of the Contract.

104.02 Special Work. Whenever deemed necessary by the City, the City may prepare Special Provisions for any work included in the Proposal. Special Provisions shall be attached to the Proposal Form and shall be considered part of the Specifications. Should any Special Provisions or requirements conflict with these Specifications or supplements thereto, the Special Provisions will govern.

104.03 Alterations Of Plans Or Character Of Work And Changed Condition. It is mutually understood and agreed that it is inherent in the nature of construction that some changes in the Plans may be necessary during the course of construction to adjust the Plans to actual field conditions. It is the essence of the Contract to recognize a normal and expected margin of change within the meaning of this Subsection.

It is also mutually understood and agreed that the City reserves the exclusive ability and right to approve alterations or changes to the Plans or character of work and that no increase in pay or change in scope shall be considered approved without the written approval of the City Council or the Edmond Public Works Authority.

A. Changes in Pay Item Quantity. The City reserves the right to make increases or decreases in the Pay Item quantities within the general scope of the Contract, and as may be found necessary to the proper completion of the Project. Increases or decreases of Pay Item quantities shall not invalidate the Contract nor release the Surety Company from its obligations, and the Contractor agrees to accept the work and the changed Pay Item quantities as set forth in the original Contract. No claim shall be made by the Contractor for any loss of anticipated profits by reason of any variations between the approximate quantities and the actual quantity of Pay Item work done.

Increases or decreases of Pay Item quantities shall be paid for at the unit price bid for the item. If the increase or decrease is on a major item, and is a change of more than twenty percent (20%), and materially alters the character of the work and the unit cost, an adjustment in price may be requested by either party. When an adjustment agreement is made, it shall be in writing and be incorporated into the Contract prior to any work. This shall constitute a Supplemental Agreement. No Alterations based upon increase or decrease in Pay Item quantities may be entered into which increase the length or extent of a project in excess of twenty-five percent (25%).

B. Supplemental Agreement. When the character of the work is materially changed by alterations in the Plans or changes in the Pay Item quantities or the Contract does not contain bid items for the work to be performed, an equitable adjustment shall be made and the Contract shall be modified in writing by Supplemental Agreement.

Entering into a Supplemental Agreement shall not invalidate the Contract nor release the Surety from its obligations under the Bonds, and the Contractor agrees to accept the work as altered, the same as if it had been part of the original Contract.

C. Changed Conditions. Should the Contractor encounter or the City discover during the progress of the work, subsurface or latent physical conditions at the site differing materially from those indicated in the Contract, or unknown physical conditions at the site of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract, the Engineer shall be promptly notified in writing of such conditions before they are disturbed, or when discovered by the City, the Contractor shall be notified in writing of such conditions. The Engineer and the Contractor will thereupon promptly investigate the conditions and if they find the conditions do so materially differ and cause an increase or decrease in the cost of, or the time required for performance of the Contract, an equitable adjustment will be made and the Contract modified in writing in accordance with the Subsections 104.03 A. and 104.03 B.

D. Disputed Alterations. Any written order or oral order not designated as an Alteration which in effect is an Alteration shall be treated as such under this Subsection, provided that the Contractor gives the City written notice within twenty (20) days (exclusive of weekends and holidays) from receipt of the communication stating the date, circumstances, and source of the order, and that the Contractor regards the order as an Alteration or Change Order.

Except as herein provided, no order, statement, or conduct of the Engineer shall be treated as an Alteration under this Subsection or entitle the Contractor to an equitable adjustment hereunder.

No extra compensation for Alterations shall be allowed for any costs incurred more than twenty (20) days before the Contractor gives written notice that the order is regarded as a Change Order.

Should the Contractor desire an adjustment in price, he must within twenty (20) days after the receipt of the order or the furnishing of written notice that an order is regarded as a Change Order, submit to the Engineer a written statement setting forth the general nature and monetary extent of such adjustment, unless this period is extended by the City.

No request by the Contractor for an equitable adjustment will be allowed if presented after the final estimate is signed by the Contractor and approved by the City.

E. Equipment Cost Rates. Equipment rates to be utilized in preparing any supplemental agreement or change in plan, or for any request for additional compensation or claim, shall be the Hourly Combined Ownership & Repair Expense found in the Contractor's Equipment Cost Guide as published by Dataquest Incorporated, in effect on September 1, 1988 as modified by special provision.

104.05 Maintenance Of Traffic. When shown on the Plans, the road adjacent to a project shall be kept open to all traffic by the Contractor. Where so provided on the Plans, traffic will be detoured over an approved route. The Contractor shall keep that portion of the project being used by public traffic, whether it is through or local traffic, in such a condition that traffic will be safely and adequately accommodated. The Contractor shall also provide and maintain in a safe condition temporary approaches or crossings and intersections with roads, streets, businesses, parking lots, residences, garages and field entrances. Snow or ice removal will not be required of the Contractor. The Contractor shall bear all expense of maintaining traffic over the section of road adjacent to a project and of constructing and maintaining such approaches, crossings, intersections, and other features as may be necessary, without direct compensation, except as provided in A. and B. below.

A. Special Detours. When the Contract contains an item for "Maintenance Detours" or "Removing Existing Structures and Maintaining Traffic", or as otherwise indicated on the Plans, then the payment for such item shall cover all cost of constructing and maintaining such detour or detours, including the construction and maintaining of any and all temporary bridges and accessory features, the removal of the same, and obliteration of the detour road. Right-of-way for temporary highways or bridges called for under this paragraph will be furnished by the City.

B. Maintenance of Traffic During Suspension of Work. During any suspension, the Contractor shall make safe and open to traffic such portions of the project as may be agreed upon between the Contractor and the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Signs, barricades and other traffic control devices will be paid for by the City at Contract prices or considered an Alteration of Plan as provided for by Subsection 104.03. Until resumption of construction operations, maintenance of the road will be by and at the expense of the Contractor. When work is resumed, the Contractor shall replace or renew any work or materials lost or damaged because of such temporary use of the project; shall remove any work or materials used in the temporary maintenance thereof and shall complete the project in every respect as though its prosecution had been continuous and without

suspension. All additional work caused by suspensions for reasons beyond the control of the Contractor, except seasonal suspensions, will be paid for by the City at Contract prices or considered an Alteration of Plans as provided by Subsection 104.03.

C. Maintenance Directed by the Engineer. If the Engineer directs special maintenance for the benefit of the traveling public, then the Contractor will be paid on the basis of unit prices or under Subsection 104.03 A. and 104.03 B.

D. Signing to Protect Traffic from Activities or Obstructions in the Work Zone. Whenever construction activities or stockpiled materials interface with or may affect the public, the Contractor shall take all required precautions to protect the public, and as a minimum, signing shall conform to the Manual of Uniform Traffic Control Devices and the Plans.

104.06 Removal and Disposal of Salvage Materials, Structures and Obstructions. Unless otherwise shown on the Plans or in the Proposal, all salvaged materials not incorporated in the work shall become the property of the City.

104.07 Rights in and Use of Materials Found on the Work. The Contractor, with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material determined suitable, as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding Contract unit price and for the pay item for which the excavated material is used. The Contractor shall replace at his own expense, with other acceptable material, all of that portion of the excavated material so removed and used which was needed for use in the embankments, backfills, approaches or otherwise. No charge for the materials so used will be made against the Contractor. The Contractor shall not excavate or remove any material from within the right-of-way which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

Unless otherwise provided, the material from any structure to be removed may be used temporarily by the Contractor in the erection of the new structure. Such material shall not be cut or otherwise damaged except with the approval of the Engineer.

104.08 Final Cleaning Up. Upon completion of the work and before acceptance and final payment will be made, the Contractor shall remove from the right-of-way all of his machinery, equipment, surplus and discarded materials, rubbish and temporary structures. The Contractor shall remove stumps or portions of trees, shall cut all brush and weeds within the limits of the right-of-way and shall leave the project and his borrow pits in a neat workmanlike condition. Material cleared from the right-of-way and deposited on

property adjacent to the right-of-way will not be considered as having been disposed of satisfactorily.

The Contractor shall leave any areas or slopes, where he performs any work, in a neat and workmanlike condition. The Contractor shall repair at his own expense, any areas, slopes or turfs that have been damaged by his operations.

105.00 CONTROL OF WORK

105.01 Authority of the City Engineer. The City Engineer will decide all questions concerning the quality and acceptability of materials furnished, work performed, rate of progress of the work, interpretation of the Plans and Specifications and the acceptable fulfillment of the Contract on the part of the Contractor.

The City Engineer will have the authority to suspend the work wholly, or in part, due to the failure of the Contractor to correct conditions unsafe for the workmen or the general public; for failure to carry out provisions of the Contract; for such periods as he may deem necessary due to unsuitable weather; or for any other condition or reason deemed to be in the public interest.

The City Engineer does not have the authority to increase pay and/or materially change the scope of work. Except as herein provided, no order, statement, or conduct of the Engineer shall be treated as an approval of an increase in pay or of a change in the scope of work.

105.02 Plans and Working Drawings. Plans will show details of all structure, lines, grades, typical sections and a summary of pay items appearing on the Proposal. The Contractor shall keep one set of Plans available on the work site at all times.

The Plans will be supplemented by such working drawings as are necessary to adequately control the work. Working drawings for structures shall be furnished by the Contractor and shall consist of such detailed plans as may be required to adequately control the work and which are not included in the Plans furnished by the City. Working drawings shall include stress sheets, shop drawings, erection plans, false work plans, cofferdam plans, bending diagrams for reinforcing steel or any other supplementary plans or similar data required. All working drawings must be approved by the Engineer; however, such approval shall not be construed nor operate to relieve the Contractor of his responsibility under the Contract for the successful completion of the work.

The Contract price will include the cost of furnishing all working drawings.

105.03 Conformity with Plans and Contracts. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions and material requirements, and within the tolerances shown on the Plans or included in the Contract.

When tolerances are given, it is the intent that every effort be made to remain well within the tolerances and the maximum or minimum values approached or equaled only occasionally.

In the event the Engineer finds the materials or the finished product in which the materials are used is not in conformity with the Plans and the Contract, but that acceptable work has been produced and may remain in place, the Engineer will document the basis of acceptance by Contract modification which will provide for an appropriate adjustment in the Contract price for such work or materials. In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed is not in conformity with the Plans or the Contract and has resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by, and at the expense of the Contractor.

105.04 Coordination of Plans Specifications, Supplemental Specifications, and Special Provisions. These Specifications, the Supplemental Specifications, the Plans, Special Provisions, and all supplementary documents are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for complete work. In case of a discrepancy, calculated dimensions will govern over scaled dimensions; Plans will govern over Standard Specifications and Supplemental Specifications; Supplemental Specifications will govern over Standard Specifications; Special Provisions will govern over Standard Specifications, Supplemental Specifications and Plans.

The Contractor shall take no advantage of any apparent error or omission in the Plans or Contract. In the event the Contractor discovers an error or omission, he shall immediately notify the Engineer. The Engineer will then make such corrections necessary to fulfill the intent of the Plans and Contract.

105.05 Cooperation by Contractor. The Contractor will be supplied with a minimum of two sets of Plans and one copy of the Contract. One set of Plans, Specifications and Special Provisions shall be available on the work site at all times.

The Contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall fully cooperate with the Engineer, his inspectors, and other Contractors.

The Contractor shall have on the work site at all time, as his agent, a competent superintendent capable of reading and thoroughly understanding the Plans and Contract and who is thoroughly experienced in the type of work being performed. The Superintendent shall have full authority to communicate with the Engineer and make binding decisions for the Contractor. He shall also have the authority to promptly supply such materials, equipment, tools, labor and incidentals as may be required. The Superintendent shall be on the project from the beginning of work through completion irrespective of the amount of work sublet.

105.06 Cooperation with Utilities. The City will notify all utility companies, all pipe line owners, or other parties affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipe lines, and other appurtenances within or adjacent to the limits of construction made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, except as otherwise provided for in the Contract or as noted on the Plans.

It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated positions as shown on the Plans and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them except as provided in Subsection 107.16.

In general, the Contract will indicate various utility items, certain of which are to be relocated or adjusted by the utility owner and others which are to be relocated or adjusted by the Contractor.

105.07 Cooperation Between Contractors. The City reserves the right at any time to contract for and have performed other work within or near the project limits covered by the Contract. When separate Contracts are let within limits of any one project, each Contractor shall conduct his work so as to minimize interference with the progress or completion of the work being performed by other Contractors. Contractors working on the same Project shall cooperate with each other and coordinate their operations in such a manner as to facilitate prompt and expeditious completion of all Contracts pertaining to a Project. Contractors failing to cooperate with other Contractors may be declared in default on their Contract.

The Contractor shall arrange his work and shall place and dispose of the materials being used so as to minimize interference with the operations of the other Contractors within the limits of the same Project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that the other Contractors.

At all grade separations and/or bridge structures where the Plans indicate fills at abutments are to be made by the Grading Contractor, the Grading Contractor shall begin grading operations at these locations immediately upon beginning work on the Project and shall complete the fills adjacent to abutments without undue delay. No rock shall be placed in fills within 30 ft. of abutment locations.

At all grade separation structures where the Plans indicate that roadway excavation through the structure location is to be made by the Grading Contractor, the Grading Contractor shall begin grading operations at these locations immediately upon beginning work on the Project and shall complete this work without undue delay. Excavation at these locations shall not extend beyond the width of excavation shown on the underpass plans.

The Bridge Contractor shall complete the bridge boxes and the backfills around the bridge boxes to the top of the box or to the natural ground line, whichever is the lower, as soon as possible after the Contract is effective, so that the Grading Contractor may make the roadway fills over these bridge boxes.

If the Grading Contractor has completed his project, except for fills at bridge boxes to be constructed by the Bridge Contractor prior to completion of these boxes, the Bridge Contractor shall make the roadway fills to the typical section and sub-grade line as shown on the Plans.

Each Contractor involved in the Project shall assume all liability in connection with his Contract, and shall save and hold harmless the City of Edmond, its officers, agents and employees from any and all damages or claims that may arise because of inconvenience, delay, or other loss experienced by him because of the presence and operations of the other Contractors working within the limits of the same project.

105.08 Construction Stakes, Lines and Grades. Except when Section 642 "Contractor Construction Staking" is included in the Contract, the Engineer, without charge, will set construction stakes establishing lines, slopes and continuous profile-grade, together with necessary reference stakes and benchmarks. The Engineer will set sufficient right-of-way stakes to define right-of-way limits. The Engineer will set stakes to mark center line and establish benchmarks for bridges and special structures as necessary. The Engineer will provide stakes determining the centerline of piers and pedestals, the face of abutments, angles of wings and retaining walls, or other detailed measurements. The City will be responsible for the accuracy of this engineering work.

Should work be performed in accordance with inaccurate initial stakeout made by the Engineer and not discovered by the Contractor, payment for such work and any correction thereof will be made at applicable prices of the Contract unless such work differs substantially from that described on the Plans or in the Contract, in which case the provisions of Subsection 104.03 shall apply.

The Contractor shall be solely responsible for the preservation of all stakes and marks. If any construction stakes or marks are destroyed or disturbed by the Contractor, the cost of replacing them and correction of any errors in the work will be charged against him and will be deducted from the payment for the work.

Construction staking by the Contractor will be required when specified in the Contract.

105.09 Authority and Duties of the Engineer. As the direct representative of the City, the Engineer has immediate charge of the engineering details of each construction Project. He is responsible for the inspection and documentation of the Contractor's efforts towards the satisfactory completion of the Project. He is delegated authority commensurable with his responsibilities. His authority includes, but is not limited to, the designation of subordinates to represent him, the authority to reject defective materials, and to suspend any work not in conformance with the Plans and Contract.

105.10 Duties of the Project Inspectors. Project inspectors will be authorized to inspect all work done and materials furnished. Inspection may extend to all or any part of the work and to the preparation, fabrication or manufacturing of the materials to be used. The inspector is not authorized to alter or waive the provisions of the Plans or the Contract. He is specifically prohibited from acting as foreman for the Contractor.

105.11 Inspection of Work. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection and to document the Contractor's efforts towards satisfactory completion of the project.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the Plans and Contract. If the work thus exposed or examined proves acceptable, the uncovering or removing, and the replacing of the covering or making good of the parts removed will be paid for in accordance with Subsection 104.03. Should the work so exposed or examined prove unacceptable, the uncovering or removing, and the replacing of the covering or making good of the parts removed, will be at the Contractor's expense.

Any work done or materials used without inspection by an authorized City representative may be ordered removed and replaced at the Contractor's expense unless the City representative failed to inspect after having been given reasonable notice that the work was to be performed.

When any unit of government or political subdivision or any railroad corporation is to pay a portion of the cost of the work covered by this Contract, its respective representatives shall also have the right to inspect the work. Such inspection does not make any unit of government, political subdivision, or any railroad corporation a party to this Contract.

105.12 Removal of Unacceptable and Unauthorized Work. All work which does not conform to the requirements of the Plans and Contract will be considered as unacceptable, unless determined acceptable under the provisions in Subsection 105.03.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause, found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in accordance with the Plans and Contract.

No work shall be done without lines and grades having been set. Work performed not in accordance with the Plans and Contract, work done beyond the lines shown on the Plans, or as given, except as herein specified, or any other unauthorized work performed will not be paid for by the City. Such work may be ordered removed or replaced at the Contractor's expense.

105.13 Load Restrictions. The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the project. A special permit will not relieve the Contractor of liability for damage which may result from the moving of equipment.

The operation of equipment of such weight or height or so loaded as to cause damage to structures or the roadway or to any other type of construction will not be permitted.

The hauling of materials within the project limits will be done in such a manner that it will not cause damage to the base or surface course. Loads in excess of the legal load limitations will not be permitted on any bridge structure within the limits of the project without written permission of the Engineer. Loads will not be permitted on concrete pavement, base, or structure before the expiration of the curing period. The Contractor shall assume all risks of damage and be financially responsible for all damage done by his hauling equipment.

105.14 Maintenance During Construction. The Contractor shall maintain the work during construction and until the Project is accepted. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the improvements are kept in satisfactory condition at all times.

In the case of a Contract for the placing of a course upon a course or sub-grade previously constructed, the Contractor shall maintain the previous course or sub-grade during all construction operations.

All cost of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various pay items and the Contractor will not be paid an additional amount for such work.

105.15 Failure to Maintain Roadway or Structure. If the Contractor, at any time, fails to comply with the provisions of Subsection 105.14, the Engineer will immediately notify the Contractor of such non-compliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the Project, and the entire cost of this maintenance will be deducted from monies due or to become due the Contractor on his Contract.

105.16 COMPLETION AND ACCEPTANCE.

A. Semi-Completion. If at any time during the prosecution of the Project, the Contractor completes a unit or portion of the Project, in accordance with the Contract, such as a structure, an interchange, or a section of road or pavement, he may request the Engineer to make a final inspection of that unit. If the Engineer finds upon inspection that the unit has been completed in compliance with the Contract, a completion date for that unit may be established and the Contractor may be relieved of further responsibility for that unit. Such semi-completion shall in no way void or alter any terms of the Contract.

B. Completion. Upon notification from the Contractor that he has performed the work required in the Contract, the Engineer will make an inspection. If all construction is found to have been completed in accordance with the Contract, that inspection will be the Final Inspection. The Engineer will declare the project complete and the Contractor relieved of all construction site responsibilities. If, however, the inspection discloses any work, in whole or in part, not in accordance with the Contract, the Engineer shall give written notice to the Contractor of the exceptions found in the inspection. Upon completion of these exceptions, the Engineer will declare the Project complete and relieve the Contractor of all construction site responsibilities.

C. Final Acceptance. The Engineer will issue a statement of final acceptance as of the date when the Contractor has furnished all of the required reports, certifications and other documentation. The date of final acceptance by the City will govern, in accordance with statutes and regulations, for payment of any interest on money due the Contractor.

105.17 CONTRACTOR CLAIMS.

A. Notice of Intent to File Claim. If the Contractor deems that additional time or compensation is due him for work or material not covered in the Contract or a change-in-plan, the Contractor shall, in writing, notify the Engineer of his intention to make a claim before he begins the work on which he intends to base the claim. The written notice shall set out the general nature of the proposed claim. If such notification is not given, the Contractor waives any claim for additional time or compensation.

B. Submission of Request for Additional Compensation or Time. The Contractor shall state in detail, for each item of additional compensation or extension of time requested, the reason for the request, references to applicable provisions of the Contract, the nature of each element of the request, each period of time involved, and all other factual data attributable to the request. If requested in writing, the Contractor shall give the City access to any record relating to the compensation request, and when so requested shall furnish copies thereof. A request for records access and/or copies thereof shall extend the time permitted for the review by the City, as hereinafter set forth, by the time necessary for the Contractor to make the additional records available to the City.

Failure to submit such information and details will be sufficient cause for denying the request for additional compensation or time.

C. Review of Request for Additional Compensation or Time. The City shall make a written response to the Contractor's request for additional compensation or time after a review of the request.

Nothing in this Subsection shall be construed as establishing any claim contrary to the terms of Subsections 104.03 or 108.11.

106.00 CONTROL OF MATERIALS

106.01 Source of Supply and Quality Requirements. The materials used on the Project shall meet all quality requirements of the Plans and the Contract. In order to expedite the inspection and testing of materials, the Contractor shall notify the Engineer of his proposed sources of materials, including fabrication, prior to the beginning of work. At the option of the Engineer, materials may be approved at the source of supply before delivery. If it is found that the sources of supply for previously approved materials do not perform as specified in the Plans and the Contract, the Contractor shall furnish materials from other sources.

When the Contractor has an option of using one of two or more materials or products as covered by a bid item of work in the Proposal, the successful Bidder shall advise the City in writing of the specific materials or product that he will use on the project.

106.02 Local Material Sources.

A. Suggested Sources. Possible sources of local materials may be suggested on the Plans and described in the Plans and the Contract. The quality of material in such deposits will be acceptable in general. However, the Contractor must determine for himself the amount of equipment and work necessary to produce a material meeting the requirements of the Plans and the Contract. It is specifically agreed and understood that the City does not determine the limits or quality of the entire deposit. The City does not warrant, either expressly or by implication, the quantity or quality of the materials contained in the suggested source. The Engineer may approve material from any portion of a deposit and may reject other portions of the deposit not meeting the requirements of the Plans and the Contract.

The City may require and make available to the Contractor the right to take materials from the sources suggested in the Plans and the Contract together with the right to use such property for plant site, stockpiles and hauling roads. It shall be the Contractor's responsibility to determine if he will utilize the suggested sources of materials, if the material is of adequate quality, and if sufficient quantities of material are present and submit his bid accordingly. No adjustment in price will be made on the basis of inadequacy of a suggested source.

B. Contractor Furnished Sources. If the Contractor desires to use material from sources other than those suggested, he shall acquire the necessary rights and shall pay all costs related thereto. All costs of exploring and developing such sources shall be borne by the Contractor. The use of material from other than suggested sources will not be permitted until approved in writing by the Engineer.

When material deposits are not suggested in the Plans or the Contractor, the Contractor shall provide sources of material meeting the requirements of the Plans and the Contract.

Unless otherwise permitted, pits and quarries shall be so excavated that water will not collect and stand therein. Sites from which material has been removed shall, upon completion of the work, be left in a neat and presentable condition. Where practicable, borrow pits, gravel pits, and quarry sites shall be located so that they will not be visible from the roadway, and in any case not closer than five hundred (500) feet to the near right-of-way, except by written permission of the Engineer.

106.03 Samples, Tests, Cited Specifications. All materials will be inspected, tested and accepted by the Engineer as being in conformance with the Plans and the Contract before being incorporated in the work. Any work in which untested, unaccepted or where mislabeled materials are used without prior written approval of the Engineer shall be performed at the Contractor's risk and may be considered unacceptable. Unless otherwise designated, acceptance tests in accordance with the most recent standard methods of AASHTO or ASTM, including AASHTO interim Specifications or ASTM tentative Specifications, which are current on the date of advertisement for bids, will be made by and at the expense of the Contractor.

Standard density as used in these Specifications shall be the maximum density as determined by AASHTO T 99, Method C or D, unless otherwise stipulated by the Plans and the Contract or designated by the Engineer. In-place density shall be determined AASHTO T 238 (Nuclear) or other approved test method for in-place density determination.

Samples for acceptance testing will be taken by a qualified testing firm. All materials being used are subject to inspection, testing or rejection at any time. Copies of all tests will be furnished to the City.

Quality control during the progress of construction shall be the responsibility of the Contractor.

106.03 Plant Inspection. The Engineer may undertake the inspection of materials at the source.

In the event plan inspection is undertaken, the following conditions shall be met:

A. The Engineer shall have the cooperation and assistance of the Contractor and the supplier with whom the Contractor has contracted for materials.

B. The Engineer shall have full right of entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.

C. If required by the Contract, the Contractor shall arrange for an approved building for the use of the inspector, such building to be located conveniently near the plant, independent of any building used by the material supplier.

D. Adequate safety measures shall be provided and maintained by the Contractor.

106.05 Field Office Laboratory. The Contractor shall furnish and maintain, for each Field Office or Laboratory required, an approved weatherproof building or trailer.

106.06 Storage of Materials. Materials shall be stored in such a manner as to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may be inspected prior to and during their use in the work. Approved portions of the right-of-way may be used for storage purposes and the placing of the Contractor's plant and equipment, but any additional space required therefore must be provided by the Contractor at his expense. If portions of the right-of-way are used for the storage of materials, equipment, or the location of a plant, the Contractor shall take all precautions necessary to insure the safety of the public. Private property shall not be used for storage purposes without written permission of the owner or lessee. If requested by the Engineer, copies of such written permission shall be furnished by the Contractor. All storage sites shall be restored to their original condition by the Contractor at his expense.

106.07 Delivering and Stockpiling Aggregates. All aggregates shall be handled in such a manner as to preserve their quality, gradation and fitness for the work. The provisions for transporting aggregates shall be such to assure a continuous supply of material to the work.

Aggregate stockpiles shall be built up in such a manner that acceptable materials will be delivered to the plant or the project. Aggregates from different sources and different gradations shall not be stockpiled together.

The gradation requirements, for the individual stockpiles and proportioning from the stockpiles, shall be the responsibility of the Contractor. Aggregates that have become segregated, or mixed with earth or other foreign material shall be considered unacceptable.

106.08 Handling Materials. All materials shall be handled in such manner as to preserve their quality, gradation and fitness for the work. Aggregates shall be transported from the storage site to the work in such a manner as to prevent loss or segregation of materials.

The handling, loading, hauling, transferring, pumping, or similar operations connected with the movement of bituminous materials to the project site or

mixing plant, and the storage of such material shall be in compliance with the requirements of the Oklahoma Department of Transportation Materials Division.

106.09 Unacceptable Materials. All materials not conforming to the requirements of the Plans and the Contract at the time they are used shall be considered as unacceptable, will be rejected, and shall be removed immediately from the site of the work.

106.10 City-Furnished Material. The Contractor shall furnish all materials required to complete the work, except those specified on the Plans and in the Proposal as being furnished by the City.

Material furnished by the City will be delivered or made available to the Contractor at the points specified on the Plans or in the Proposal.

The cost of handling and placing all materials after they are made available to the Contractor shall be considered as included in the Contract price for the bid item in connection with which they are used.

The Contractor will be held responsible for the storage, handling, and security of all material made available to him, and deductions will be made from any monies due him for any shortages or deficiencies, from any cause, for any damage which may occur after delivery and for any demurrage charges.

106.11 Guarantees And Warranties. The Contractor shall obtain and assign to the City all manufacturer's or producer's warranties or guarantees on all items, materials, electrical or mechanical equipment consistent with those provided as customary trade practice.

The Contractor shall supply manuals for all pieces of equipment included in the Project. Such manuals shall include operational procedures, complete nomenclature, wiring diagrams, schematics showing testing voltages or procedural methods, a functional description of circuits, parts lists, cross reference to standard part numbers, flow diagrams, and, where appropriate, testing procedures and other pertinent data.

The provisions of this section shall not be construed to be in lieu of the requirements of the Maintenance Bond but shall be cumulative thereto.

106.12 MATERIALS CERTIFICATIONS.

A. Description. This Subsection covers the requirements and procedures for the issuance and distribution of certifications of various types when designated as a part of the Plans and Contract for various materials and procedures.

B. General Requirements.

1. The Contractor shall be responsible for obtaining all certifications and arranging for their delivery to the proper destinations as required by this Specification.

2. Certifications shall be signed by a responsible representative of the company which issues the certification. The official company title of the signer must be clearly shown immediately beneath his signature.

3. All certifications shall be furnished in duplicate and each copy shall show the following information:

Project Name
Name of Contractor
Type of Test
Location of Test
Identification Markings on Shipment
Quantity of Material Represented by the Certification
(See Note)

4. Sampling and testing of materials and procedures called for by the Plans and/or Specifications shall require a Type D Certification and shall be submitted under the guidelines listed above and within these Specifications.

When no certification type is expressly called for on the Plans and/or Specifications, a Type D Certification shall be supplied.

C. Types of Certifications. Unless otherwise specified, a certification shall be one of the following types:

1. *Type A Certification* shall be prepared by the manufacturer and shall consist of a certified copy of a report covering tests conducted by an approved laboratory. Such tests shall have been conducted on samples obtained from the lot or lots of material in the shipment.

2. *Type B Certification* shall consist of a certification prepared by the manufacturer and shall show the limits of test values as determined by an approved manufacturer's laboratory, a qualified commercial laboratory or other approved laboratory.

3. *Type C Certification* shall be prepared by the manufacturer and shall certify that the material in the shipment conforms to the same formula and/or is essentially the same as the material previously approved by the City.

4. *Type D Certification* shall be prepared by a testing firm, a laboratory or by the manufacturer and shall state that the materials, samples and tests meet the applicable Specifications. These Specifications shall be listed by number, Section reference or other appropriate identification acceptable to the Engineer.

5. *Type E Certification* shall be prepared by the Fabricator to cover a composite item incorporating two or more materials which have been previously approved on an individual basis, but which lose their identity when they are incorporated into the composite item. All materials used in the fabrications shall be listed and identified. Composite items would include signs, overhead sign structures, etc. The Certification shall state that all materials used in the fabrication of the item in question were previously approved for use. The fabricator shall keep test reports and/or other pertinent identifying records of the individual items incorporated into the composite item until the item has been approved and accepted by the Engineer.

D. Distribution of Certifications. Certifications shall be mailed in duplicate to:

City Engineer
P. O. Box 2970
Edmond, OK 73083-2970

These certifications will be checked for conformance with the applicable Specifications, and approved copies forwarded to the Contractor.

E. Basis of Acceptance. Whenever a certification is required as part of a Specification, such material may be accepted on the basis of certification provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of the material to be satisfactory.

All material furnished under certification shall be tagged, stenciled, stamped, or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification. Material accepted on certification shall not be incorporated in the work until the certificates have been approved by the City.

107.00 LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01 Laws to Be Observed. The Contractor shall be responsible to stay informed of all Federal and state laws, all local laws, ordinances, regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affects those engaged or employed on the work, or which in any way affects the conduct of the work. The Contractor shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; protect, indemnify, save and hold harmless the City of Edmond, its officers, agents, and employees against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor, his employees, his sub-contractors, or others performing work on the project under his authorization.

All new construction, remodeling, modifications and alterations will meet or exceed the Federal Code of Regulations, 1900 to 1910; and will meet all requirements as specified in the Americans With Disabilities Act (Uniform Federal Accessibility Standards).

107.02 Permits and Licenses. In the prosecution of construction Contracts awarded by the City, the Contractor shall be required to obtain work permits or licenses for operations.

107.03 Patented Devices, Materials and Processes. If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the Surety shall protect, indemnify, save and hold harmless the City, its officers, agents, and employees, any affected third party or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the City of Edmond for any costs, expenses, and damages which it may be obliged to pay by reason of any infringement, at any time during the prosecution of or after the completion of the work.

107.04 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service within the project or to grant permits for same, at any time, is hereby expressly reserved by the City. The Contractor shall not be entitled to any damages from the City except as provided for in Subsection 108.11 for delay or damage due to utility service construction or reconstruction by a third party or parties.

Any individual, firm, or corporation wishing to make an opening in any easement or right-of-way must secure a Permit from the City. The Contractor shall allow parties bearing such Permits, and only those parties, to make openings. The Contractor shall make, in an acceptable manner, all necessary repairs due to such openings and such necessary work will be paid for as provided for in

Subsection 104.03, or as otherwise provided, and will be subject to the same conditions as original work performed.

107.05 Federal and State Aid Provisions. When the United States Government and/or the State of Oklahoma pays all or any portion of the cost of a project, the Federal and State laws, and the rules and regulations made pursuant to such laws must be observed by the Contractor, and the work shall be subject to the inspection of the appropriate Federal or State agency.

Such inspection shall in no instance make the Federal or State Government a party to this Contract and will in no way interfere with the rights of either party hereinunder.

107.06 Sanitary, Health and Safe Provisions. The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements of the State and the City Boards of Health, or of other bodies or tribunals having jurisdiction.

Attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. The Contractor shall not require any worker to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his health or safety.

Precaution shall be exercised at all times by the Contractor for the protection of all persons, including employees, the public and property. The Contractor shall be expected to comply with all laws, Federal Regulations, Ordinances and the City of Edmond Risk Management/Safety Manual related to safety and health, and shall make special effort to detect hazardous conditions and shall take prompt action where loss control/safety measures should be reasonably expected.

The Engineer may order work to be stopped if conditions exist that present immediate danger to persons or property.

107.07 Public Convenience and Safety. The Contractor shall comply with all applicable Federal, State and City laws governing safety, health and sanitation. The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions, on his own responsibility or as requested by the Engineer, to protect property in connection with the performance of the work covered by the Contract.

Whenever construction activities or stockpiled materials interface with or affect the public, the Contractor shall take all required precautions to protect the public and as a minimum, signing shall conform to the MUTCD and the Plans. No public road shall be closed except by express permission of the Engineer.

Where the Contractor constructs a temporary shoo-fly detour, temporary crossings for streams, or temporary culverts or bridges, his responsibility shall include the roadway approaches as well as the structures of such crossings.

The Contractor shall conduct his work so as to impose minimum interference to the public.

The Contractor shall maintain traffic as provided in Subsection 104.05.

If the above requirements are not complied with, the Engineer may issue a shut down order and may do such work as required for the safety of the traveling public and deduct the cost from any monies due the Contractor for work performed on the project.

107.08 Reserved.

107.09 Construction Traffic Control Devices. The Contractor shall provide, erect, and maintain all required barricades, suitable sufficient lights, signals, signs, and other traffic control devices, and shall take all required precautions for the protection of the work and safety of the public. Roadways and streets closed to traffic shall be protected by advance warning signs and effective barricades to prohibit unauthorized entry into the project. All obstructions to the normal flow of traffic shall be properly delineated during hours of reduced visibility. Warning signs and other protective devices which are as a minimum in compliance with the Plans and Contract and the MUTCD shall be provided to safely and properly control and direct traffic through the project.

The Contractor shall erect suitable warning signs where operations may interfere with the free flow of traffic and at all intermediate points where the project crosses or coincides with an existing road.

All barricades, warning signs, lights, temporary signals, and other protective devices must as a minimum conform to the MUTCD for Streets and Highways. The Contractor shall provide any and all additional construction zone traffic control devices required on the project for the safety of the public.

107.10 Use of Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care to protect life, property, and completed work. When using explosives, the Contractor shall comply with any and all laws and ordinances governing such use, in particular a Blasting Permit issued by the Edmond Fire Department. The Contractor shall assume all risks and shall be solely responsible for any and all damages resulting from the use or storage of the explosives on the project. The Contractor shall use an expert certified in the use of any proposed explosives.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked "Dangerous

Explosives". As a minimum, storage shall be provided in accordance with Occupational Safety and Health Act (OSHA) regulations as defined in the Federal Register, but not closer than one thousand (1,000) feet from any building, camping area or place of human occupancy.

The Contractor shall notify the Fire Marshall, the Engineer, property owners, public utilities and railroads having facilities near the site of the work of his intentions to use explosives and the location, date, time, and approximate duration of the blasting. The notice shall be given sufficiently in advance to enable the owners and companies to take any steps as they may deem necessary to protect their property from damage or injury.

The Contractor shall erect suitable warning signs on all roads alerting the public in the immediate vicinity of blasting operations. The signs shall also include a warning that all portable radio transmitters should be turned off while in the vicinity. If required, the Contractor shall control traffic by use of flagmen and guards in the danger zone of blasting.

107.11 Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation of all public and private property and shall protect all land monuments and property marks until the City has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall be solely responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in his manner or method of executing the work, or at any time due to defective work or materials.

If 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 by the Contractor, he shall restore, at his 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 or he shall make good such damage or injury.

107.12 Forest, Park, and Public Land Protection. In carrying out work within or adjacent to State or National Forests, Parks, or Public Lands, the Contractor shall comply with all regulations of the State Fire Marshal, Conservation Commission, Forestry Department, or other authority having jurisdiction. He shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures in accordance with the requirements of the duly authorized official.

The Contractor shall take all reasonable precautions to prevent and suppress forest fires and shall require his employees and subcontractors, both independently and at the request of the Authority having jurisdiction, to do all reasonably within their power to prevent and suppress and to assist in preventing and suppressing forest fires and to make every possible effort to notify a Forest official at the earliest possible moment of the location and extent of any fires seen by them.

107.13 Insurance Responsibility for Damage Claims. The Contractor shall protect, indemnify, save and hold harmless the City of Edmond, their officers, agents, and employees from all suits, actions or claims of any kind or character brought because of bodily injuries, sickness, disease or personal injury, or damages received or sustained by an person, persons, or property on account of any operations of the Contractor, his agents, employees, his sub-contractors or any others authorized by the Contractor to perform work on the project.

Third Party Beneficiary Clause. It is specifically agreed by and between the parties executing this Contract, that it is not intended by any of the provisions of any part of the Contract to create in the public or any member thereof any third party beneficiary provisions or to authorize anyone not a party to this Contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this Contract.

The Contractor shall carry insurance of the following kinds and amounts on all City Contracts:

A. Contractor's Public Liability, Auto Liability and Property Damage Liability Insurance. The Contractor shall provide regular Contractor's Public Liability Insurance for a combined amount of one million ($1,000,000) dollars of coverage for all damages arising out of bodily injury, death, and property damage for each occurrence with an aggregate limit of two million ($2,000,000) dollars.

The Contractor shall provide business auto liability coverage for an aggregate limit of one million ($1,000,000) dollars of coverage for bodily injury and property damage arising out of the operation or maintenance of any vehicle including owned, non-owned and hired vehicles, and employee non-ownership use.

B. Insurance for Subcontractor's and Contractor's Protective Public Liability and Property Damage Liability Insurance. In the event that any of the work to be performed by the Contractor on the project is sublet or assigned, or is otherwise to be performed by anyone other than the Contractor's own employees, then the insurance specified above shall extend to cover such work.

C. Workmen's Compensation Insurance and Employer's Liability Insurance. The Contractor shall furnish satisfactory evidence to the City that, with respect to the work to be performed by him on the project, he carries regular Workmen's Compensation and Employers Liability Insurance covering his liability under the "Workmen's Compensation Law of the State of Oklahoma". The Contractor shall maintain the aforementioned insurance in full force and effect for the duration of the Contract. Should the Contractor fail or neglect to maintain the aforementioned insurance, the City specifically reserves the right to withhold all funds due and owing the Contractor until such time as the required insurance is in effect.

In addition to the aforementioned insurance coverage, on any project in which the Contractor shall perform any Railway-Highway work, the Contractor shall also secure the following: "Railroads' Protective Liability and Property Damage Insurance".

D. Railroads' Protective Liability and Property Damage Insurance. In addition to the above, the Contractor shall furnish satisfactory evidence to the City that, with respect to the work to be performed by him under the Contract, he has provided for and on behalf of the Railway Company or Railway Companies involved, Protective Public Liability Insurance in an amount as may be required by the Railway Company, which amount shall be specified in the bid documents. Policies shall not include liability for negligence on the part of the Railway Company, its agents or employees, except as set out in Coverage A, B, or C of the form of policy, or amendments thereto, referred to under paragraph 6 below. This insurance applies to each and all Railway Companies involved in the work.

E. General. The insurance hereinbefore specified shall be carried in Insurance Companies approved by the City, and where applicable the Railway Company, during all times when work is being carried on under the terms of the Contract, until all work required to be performed under the Contract is satisfactorily completed as evidenced by the formal acceptance by the City.

F. Certificates of Insurance. Required insurance shall be documented by Certificates of Insurance which provide that the City of Edmond shall be notified at least sixty (60) days in advance of cancellation, non-renewal or adverse change. The Certificate of Insurance shall show the City of Edmond as the named insured.

For general liability, the Contractor shall provide an indication of the amounts of claims, payments or reserves chargeable to the aggregate amount of liability coverage.

G. Variances. A variance may be granted from the one million ($1,000,000) dollar insurance requirement only upon a finding by the City Engineer, City Purchasing director and City Manager that:

1. The application of the insurance requirement in a particular project would create an unnecessary hardship;

2. The variance, if granted, would not cause substantial detriment to the public good, or impair the purposes and intent of the insurance requirement;

3. The variance, if granted, would be the minimum necessary to alleviate the unnecessary hardship;

4. The nature and type of the project does not necessarily justify the insurance requirement.

107.14 Opening Sections of Project. Opening sections of the work prior to completion of the entire Contract may be desirable from a service standpoint, or may be necessary due to conditions inherent in the work, or by changes in the Contractor's work schedule, and may be necessary due to conditions or events unforeseen at the time of the Contract. Such openings as may be necessary due to any of the foregoing conditions shall be made when so ordered by the Engineer. Under no condition shall such openings constitute acceptance of the work or a part thereof, or a waiver of any provisions of the Contract, except as provided in writing in accordance with Subsection 105.16 A.

Special Provisions shall state, in so far as possible, which sections shall be opened prior to completion of the Contract. On any section opened by order of the Engineer, whether covered in the Special Provisions or not, the Contractor shall not be required to assume any expense entailed in maintaining the opened section of the work. On such portions of the project which are ordered by the Engineer to be opened, compensation for additional expense, if any, to the Contractor and allowance of additional time, if any, for completion of any other items of work on the portions of the project ordered by the Engineer to be opened, shall be as set forth in a change order mutually agreed to by the Engineer and the Contractor.

If the Contractor is dilatory in completing features of the work, the Engineer may so notify him in writing and establish therein a reasonable period of time in which the work should be completed. If the Contractor fails to make a reasonable effort toward completion in this period of time, the Engineer may open all or a portion of the project. On such sections, the Contractor shall conduct the remainder of his construction operations so as to cause the least obstruction and shall not receive any added compensation due to the added cost of the work by reason of opening such section.

On any section opened under any of the above conditions, whether stated in the Special Provisions or opened by necessity of the Contractor's operations, or unforeseen necessity, any damage which might occur on such sections shall be repaired by the Contractor at his expense.

107.15 Contractor's Responsibility for Work. Until completion of the project in accordance with Subsection 105.16 B., the Contractor shall have the charge and care thereof and shall take every required precaution against injury or damage to any part thereof by the action of the elements or from any other cause. The Contractor shall also take all required precautions for the protection of the public prior to completion of the work required in the Contract. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before completion of the work and shall bear the expense thereof, except damage to the work due to unforeseeable causes beyond the control of, and without the fault or negligence of the Contractor, including but not restricted to acts of God, acts of the public enemy or governmental authorities.

Unless otherwise provided, when the work is suspended for any cause whatever, the Contractor shall be responsible for the project and shall take required precautions that may be necessary to prevent damage to the project, provide for drainage, protect the public, and shall erect any necessary temporary structures, signs, or other facilities in accordance with the Contract. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under his Contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

107.16 Contractor's Responsibility for Utility Property and Services. At points where the Contractor's operations are adjacent to properties of railroad, telephone, power companies, other utilities or facilities rightfully located within the limits of the project, damage to which might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements that are required for the protection thereof have been made.

The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner and that duplication of rearrangement work may be reduced to a minimum and that services rendered by those parties will not be unnecessarily interrupted.

Reference is made to the Underground Facilities Damage Prevention Act (63 O.S. Section 142.1 et. seq.), including amendments, which is made part of the Contract.

In the event of interruption to water or utility services as a result of accidental breakage, or as a result of being exposed or unsupported, the Contractor shall

immediately notify the proper authority. He shall cooperate with the said authority in the prompt restoration of service. In no case shall interruption to water service be allowed to exist outside of working hours. Fire hydrants shall be kept accessible to the Fire Department at all times and no materials shall be kept or stockpiled within fifteen (15) feet of any fire hydrant.

The Contractor shall check the location of all water services, water mains, sanitary sewers and other utilities and shall be solely responsible for damages to these facilities resulting from his operation.

107.17 Furnishing Right-Of-Way. The City will be responsible for securing all necessary rights-of-way, as shown on the Plans, in advance of construction. Any exceptions will be indicated in the Contract.

107.18 Reserved.

107.19 No Waiver of Legal Rights. The City shall not be precluded or estopped by any measurement, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefore, from showing the true amount and character of the work performed and materials furnished by the Contractor, nor from showing that any such measurement, estimate or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the Contract. The City shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate and payment in accordance therewith, from recovering from the Contractor or his Sureties, or both, such damage as it may sustain by reason of his failure to comply with the terms of the Contract. Neither the acceptance by the City, or any representative of the City, nor any payment for, or acceptance of, the whole or any part of the work, nor any extension of time, nor any possession taken by the City, shall operate as a waiver of any portion of the Contract, or of any power herein reserved, or of any right to damages. Acceptance shall be final and conclusive except as otherwise provided in the Specifications, or as regards latent defects, or frauds, or such gross mistakes as may amount to fraud, or as regards to the City's rights under any warranty or guaranty. A waiver of any breach of the Contract shall not be held to be a waiver of any other or subsequent breach. Nothing contained in this section shall operate as a waiver or extension of any applicable statute of limitations with respect to the time within which an action may be brought for the breach of Contract.

107.20 Reserved.

107.21 Reserved.

108.00 PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the Contract or Contracts or any portion thereof, or any of his rights, title, or any interests therein, without written consent of the City or its authorized representative.

Requests for permission to sublet, or otherwise dispose of any portion of the Contract work shall be in writing and accompanied by a statement showing that the organization which will perform the work is particularly experienced and equipped for such work. No Subcontracts, or transfer of Contract, shall in any case release the Contractor of his liability under the Contract and bonds.

Should the Contractor assign any of his right title or interest in the Contract said assignment shall be made only with the full knowledge and written consent of the Surety. It is specifically understood that a violation of the Subsection will constitute an act of default on the part of the Contractor.

108.02 Work Order. The Work Order will stipulate the date on which it is expected the Contractor will begin the construction. In no case shall work, other than mobilization, start prior to issuance of the work order.

108.03 Prosecution and Progress. The Contractor shall furnish, if required, the Engineer with a "Progress Schedule". The Progress Schedule will be used as the basis for establishing major construction operations and as a control on the progress of the work.

The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the Plans and the Contract. Should the prosecution of the work for any reason be discontinued, the Contractor shall notify the Engineer at least twenty-four (24) hours in advance of resuming operations, and submit a revised Progress Schedule.

108.04 Limitation of Operations. The Contractor shall conduct the work at all times in such a manner and in such sequence as will assure the least interference with the public. He shall not open up new work to the prejudice or detriment of work already started. The Contractor may be required to finish a section before work is started on additional sections, if opening of such sections is essential to the public safety and convenience.

108.05 Character of Workers. The Contractor shall at all times employ sufficient labor for prosecuting the several classes of work to full completion in the manner and time required by the Plans and the Contract.

All workers shall have sufficient skill and experience to perform properly the work assigned to them.

Any person employed by the Contractor or by any Subcontractor who does not perform his work in a proper and skillful manner, whose conduct is disruptive, abusive, or impedes the progress of the work shall, at the written request of the Engineer, be removed forthwith by the Contractor or Subcontractor, and such person shall not return to the project without the approval of the Engineer.

Should the Contractor fail to remove such person or persons or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice, but time to complete the project as set forth in the Contract shall not be suspended or extended.

In the performance of this Contract, the Contractor shall comply with all Federal and State requirements for nondiscrimination and equal employment opportunity. On all projects, Special Provisions, which set forth minimum wage rates and required reports, shall be included in the Contract.

108.06 Methods and Equipment. It is the intent of the Plans and the Contract that, except where specifically provided, methods and equipment used shall be those generally accepted by the industry and which produce the quality of work specified.

If the Contractor desires to use an unusual or experimental method or type of equipment, he shall notify the Engineer in writing. The notice shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to use that method or equipment before he begins work. If the Engineer concurs, it is specifically agreed and understood that the Contractor will be fully responsible for producing construction work in conformity with Contract requirements.

If after use the proposed methods or equipment fails to produce work meeting the requirements of the Plans and the Contract, the Contractor shall discontinue the use of that method or equipment and complete the remaining work with conventional methods and equipment in a manner acceptable to the Engineer. The Contractor shall remove the deficient work and replace it with work meeting the requirements of the Plans and Contract. No change will be made in the basis of payment for the construction items involved or in the Contract time as a result of a change in methods or equipment under these provisions.

The Engineer shall have the final authority to reject any method which cannot produce the required results or equipment which cannot be properly calibrated or controlled. Rejected equipment shall be removed from the project and replaced with approved equipment.

108.07 Determination and Extension of Contract Time. The time allowed for the completion of the work will be stated in the Proposal and Contract, and will be known as the "Contract Time".

When the Contract Time is on a calendar day basis, it shall consist of the number of calendar days stated in the Contract counting from the effective date of the Work Order or from the date the Contractor begins work, whichever is earlier, including all Sundays, holidays and non-work days. All calendar days elapsing between effective dates of any orders of the Engineer to suspend work and to resume work for suspensions, not the fault of the Contractor, shall be excluded.

When the Contract completion time is a fixed calendar date, that date shall be the date on which all work on the project shall be satisfactorily completed.

The number of days for performance allowed in the Contract as awarded is based on the original quantities as defined in Subsection 102.05. If satisfactory fulfillment of the Contract requires performance of work in greater quantities than those set forth in the Proposal, the Contract time allowed for performance shall be increased on a basis commensurate with the amount and difficulty of the added work. Such changes or agreements will contain the additional time, if any, allowed for performance of the work.

If the Contractor finds it impossible, for reasons beyond his control, to complete the work within the Contract time as specified or as extended in accordance with the provisions of this Subsection, he may, at any time prior to the expiration of the Contract time as extended, make a written request to the Engineer for an extension of time setting forth therein the reasons which he believes will justify the granting of his request. The Contractor's plea that insufficient time was specified in the Proposal and the Contract or that previously unprotested time charges were incorrect shall not be grounds for an extension of time. If the Engineer finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, the Engineer may extend the time for completion in such amounts as the conditions justify. The extended time for completion shall then be in full force and effect the same as though it were the original time for completion. Daily time charges will cease when the project is completed in accordance with Subsection 105.16 B.

108.08 Failure to Complete on Time. If the Contractor fails to complete the work within the time specified in the Contract, the sum specified in the Contract will be deducted from any monies due the Contractor for each calendar day or work day beyond the specified time, not as a penalty but as liquidated damages. Rates for liquidated damages will be set forth in the Contract.

When tied or combination bids are permitted, the manner of assessment of time will be shown in the Plans and the Contract.

Permitting the Contractor to continue and finish the work or any part of it after the time specified for its completion will in no way operate as a waiver on the part of the City of any of its rights under the Contract.

108.09 Default and Termination of Contract. If the Contractor fails to begin the work under the Contract within the time specified in the Work Order; fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work; fails to coordinate his work with other Contractors as provided in Subsection 105.07; performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable; discontinues the prosecution of the work; fails to resume work which has been discontinued within a reasonable time after notice to do so; becomes insolvent or is declared bankrupt; commits any act of bankruptcy or insolvency; allows any final judgment to stand against him unsatisfied for a period of ten (10) days; fails to carry on the work or comply with the Contract in an acceptable manner; the Engineer will give notice in writing to the Contractor and his Surety of such delay, neglect or default.

If the Contractor or Surety, within ten (10) days of such notice shall fail, refuse, or commit any other acts referenced as a default in these Specifications; neglect to correct the default, the City shall have full power and authority without breaching the Contract or violating the terms thereof to take the prosecution of the work from the control of the Contractor and so notify the surety Company who shall assume full responsibility for the work. The City shall take all reasonable steps to protect the work after the Contractor has been removed from the Contract, and may have the Contract completed in a manner consistent with State Law. Should the Surety Company fail, refuse or neglect to take action to correct the default, the City may at its option refuse to accept further bonds from that company

All costs and charges incurred by the City, together with the cost of completing the work under Contract, will be deducted from any monies due or which may become due said contractor or Surety. If such expense exceeds the sum which would have been payable under the Contract, then the Contractor and the Surety shall be liable and shall pay to the City the amount of such excess. The Surety Company in correcting the default shall either provide such necessary assistance to the Contractor in order to allow him to correct the default and complete the Contract or the Surety Company shall enter into an agreement with another Contractor acceptable to the City for the completion of the work. In no event shall the Surety Company tender to the City a substitute Contractor for the City to enter into a Contract with for the completion of the work.

108.10 Termination of Contract before Completion without Fault of the Contractor. The City of Edmond specifically reserves the right to terminate any Contract at any stage of completion without fault of the Contractor, when in the event of a national emergency or for any other reason beyond the control of the City such termination becomes necessary in the best interest of the City. Written notice of such termination shall be given to the Contractor. Upon such termination, the Contractor shall be entitled to the full amount of the estimate for the work actually done by him under the terms and conditions of the

Contract up to the date of service of the notice of termination, including any retained percentage. In addition, the Contractor shall be reimbursed by the City of Edmond for any actual expenses incurred which are not otherwise compensated and which are required in preparing for, moving to and from the job, and for materials on hand; the intent being that an equitable settlement shall be made with the Contractor.

Termination of a Contract, or a portion thereof, shall not relieve the Contractor of his responsibilities for the completed work, nor shall it relieve his Surety of its obligation for and concerning any just claims arising out of the work performed.

Notice shall have been served upon the Contractor when delivered to the person in charge of any office used by the Contractor, the Contractor's superintendent, or any other authorized representative in charge of the job, or sent by registered mail to the Contractor at his last know place of business.

108.11 Hindrances and Delays. Should the Contractor be delayed in the commencement, prosecution, or completion of the work to be performed under the terms of the Contract by an act of the City, its officers, agents, or employees or by the act of any other Contractor, the Contractor shall, as his sole and exclusive remedy, be entitled to an extension of time on the Contract. The extension of time shall release and discharge the City, its officers, agents, and employees from all claims of any kind or character on account of the aforesaid delay. Extension of time occasioned by delay shall in no instance exceed the time actually lost to the Contractor by reason of the aforesaid delay. The Contractor shall notify the City within five (5) days of the beginning of the delay that the delay is occurring or has occurred, the cause for the delay, and that the Contractor desires additional time as compensation for the delay. No allowance of additional time shall be due to the Contractor if the Contractor fails to notify the City within the five (5) day period.

109.00 MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities.

A. ***General.*** All work completed under the Contract will be measured by the Engineer according to the United States standard measure.

Linear measure of portland Cement concrete pavements shall be along actual surface, not horizontally.

A station when used as a definition or term of measurement will be one-hundred (100) linear feet.

The methods of measurements and computations to be used in determination of quantities of material furnished and of work performed under the Contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the Plans or as modified by the Engineer.

Where the area unit for measurement and payment is on an acre basis, the measurements will be taken on the slope of the ground to compute the actual surface area in acres for payment.

Structures will be measured according to neat lines shown on the Plans or as altered to fit field conditions.

All items which are measured by the linear foot, such as pipe culverts, guardrail, underdrains, etc., will be measured as specified under the Method of Measurement for the item in the Specifications, unless otherwise shown on the Plans.

In computing volumes of excavation the average end area method, photogrammetry method, or other acceptable methods will be used.

The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate, pipe culvert and arches, and metal cribbing will be specified and measured in decimal fractions of inches. The measurement of wire will be Size Number in accordance with AASHTO M 32 unless otherwise specified.

The term "ton" will mean the short ton consisting of two-thousand (2,000) pounds avoirdupois. All materials which are measured or proportioned by

weight shall be weighed on accurate approved scales by competent, qualified personnel at locations designated by the Engineer. If material is shipped by rail, the car weight may be accepted, provided that only the actual weight of material will be paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the Engineer directs, and each truck shall bear a plainly, legible identification mark.

All scales for weighing truck loads of materials to be paid for by weight measurements shall be of adequate size and capacity to weigh the entire gross load at one weighing on a single set of scales.

Scales shall be inspected and certified at least every 6 months or more often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have on hand not less than ten fifty (50) pound weights for testing scales. Approved commercial scales may be used.

Instead of weighing truck loads of materials on single sets of scales measuring the gross load as provided above, the Contractor may use an approved automatic batch weight and printer system.

The approved automatic batch weight and printer system shall be electronically controlled and capable of determining the net batch weight of material being delivered to the transporting truck. Such weights shall be evidenced by a weigh ticket containing all the required identifying information for each load.

The printed batch weights may be used in lieu of truck scales in making this weight determination.

The automatic batch weight and printer system shall be subject to calibration, inspection, and certification requirements as provided above for scales.

Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their strike-off level or approved established capacity when materials are delivered to the project.

The Engineer may require leveling of the loads as deemed necessary to assure receiving at least the established capacity.

The capacity of all vehicles shall be established by the Engineer and plainly marked on said vehicle and the capacity or marking shall not be changed without permission of the Engineer.

When requested by the Contractor in writing, and approved by the Engineer, material specified to be measured by the cubic yard or ton may be converted to the other measure as appropriate. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of measurement of the pay quantity is used.

Bituminous materials will be measured by the gallon or ton.

Volumes will be measured at 60° F or will be corrected to the volume at 60° F using ASTM D 1250 for asphalt or ASTM D 633 for tars.

Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when bituminous material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the work.

Wherever in the Plans or the Contract, or in the Proposal, it is provided that liquid asphalt be measured by the gallon, and the liquid asphalt is delivered to the project with certified weight billing, the weight of the liquid asphalt used in the completed and accepted work shall be converted to gallons by the application of a conversion factor approved by the Engineer. Any portion of a load delivered to the work and not used shall be determined by measurement or weighing, in the vicinity of the project, and making the necessary deduction to arrive at the weight or volume of liquid asphalt used in the work.

Liquid asphalt, when measured by weight or converted to gallons as provided herein, shall be paid for by the gallon.

The Contractor shall provide all necessary means and assistance for measuring and calibrating distributors and tanks for determining the quantity of material in distributors and tanks at any time. The Engineer may require that the distributor be calibrated before its use on the work and any other time deemed necessary. The Contractor shall furnish a calibrated gauge (strapping stick) for each distributor so that the volume can be determined at any level of the contents. The Contractor shall place the distributor on a level area for these measurements.

Portland Cement will be measured by the pound, hundredweight (cwt), or ton.

Timber will be measured by the thousand feet board measure (M.F.B.M.) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses, and the extreme length of each piece.

The term "lump sum" when used as an item of payment will mean completed payment for the work described in the Contract.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited Specifications, manufacturing tolerances established by the industries involved will be accepted.

B. Plan Quantities. When the Contract specifies payment of an item or of a portion of an item on a plan quantity basis, the quantities for payment will be those shown on the Plans with deductions from or additions to such quantities resulting from authorized deviations from the Plans.

When disagreement develops between the Contractor and the Engineer as to the accuracy of the plan quantities, either party shall, before any work is started which would affect the measurement, have the right to request in writing that the quantities involved be measured. If the Plan Quantity is found to be in error, acceptance and payment will be made in accordance with the corrected Plan Quantity.

109.02 Scope of Payment. The Contractor shall accept the compensation, as herein provided in the Contract, in full payment for furnishing all materials, equipment, labor, tools and incidentals necessary to complete the work and for performing all work contemplated and embraced under the Contract; also for loss or damage arising from the nature of the work, or from the action of the elements, or from any unforeseen difficulties, except as provided in Subsection 107.15, which may be encountered during the prosecution of the work until the final acceptance by the Engineer, and for all risks of every description connected with the prosecution of the work, for all expenses incurred in consequence of the suspension or discontinuance of the work as herein specified, and for any infringement of patent, trademark, or copyright; and for completing the work according to the Plans and the Contract. Neither the payment of any estimate or of any retained percentage shall relieve the Contractor of any obligation to make good any defective work or material.

In the event the Surety on any statutory, performance or maintenance bond given by the Contractor becomes insolvent, is placed in the hands of a receiver,

is taken under supervision, or has its right to do business in this State revoked as provided by law, the City shall withhold payment of any estimate filed or approved by the Engineer until the Contractor shall give a good and sufficient security as provided by law in lieu of the bond so executed by such Surety.

109.03 Payment for Increased or Decreased Quantities. Payment for changes of quantities is to be paid for as set forth in Subsection 104.03.

Increase in quantities covered in Subsection 107.15, regardless of magnitude will be paid for at the Contract unit price bid for each item of work involved.

No adjustment of payments to the Contractor will be made for increases or decreases in cost.

109.04 Payment for Cancelled Items. Payment for cancelled items is to be paid for as set forth in Subsection 104.03 and as provided below.

Acceptable materials ordered by the Contractor or delivered on the work subsequent to the Award of the Contract and prior to the date of cancellation, alteration, or suspension of the work by order of the Engineer will be paid for at the actual cost to the Contractor and shall thereupon become the property of the City. The Contractor shall submit immediately certified statements covering all money expended in preparation for work on any cancelled item when such preparation has no value to the remaining items of the Contract for a proportionate amount based on the total Contract price over which such preparation would ordinarily be distributed when other items are included in such a preparation.

109.05 Reserved.

109.06 Partial Payments. The Engineer will make written estimates of the materials complete in place and amount of work performed in accordance with the Contract during the current period of time between estimates and the value thereof figured at the Contract unit prices. From the total of the estimate so ascertained an amount equal to 10% of the amount earned will be retained.

At any time the project is fifty percent or more complete, the rate of retainage will be one-half of the original retained amount, provided the percentage of time charged to the Contract does not exceed the percentage of the Contract amount earned by more than ten percent. At any time the percentage of time charged exceeds the percentage of the amount earned by more than ten percent, the retainage will be resumed at the rate in the above table. The percent of the project complete will be determined by dividing the amount earned to date by the dollar amount of the Contract as awarded. The percent of time charged will be determined by dividing the number of days charged by the number of days provided as Contract time. Projects with a specified completion date will be treated as calendar day projects for this purpose.

The dollar amount of retainage as computed above will be retained by the City until final payment is made. Upon approval of the Surety and the City, the retainage amount will be further reduced provided the project is complete as defined in Subsection 105.16 B., or the uncompleted work is restricted by the Specifications.

Estimates will be made monthly. No estimates except final estimates will be made for a sum less than five hundred dollars ($500). The estimates will be approximate only and all partial or monthly estimates and payments will be subject to correction in the estimate rendered following discovery of an error in any previous estimate.

Should any defective work or material be discovered, or should a reasonable doubt arise as to the integrity of any part of the work completed prior to the final acceptance and payment, there will be deducted from the first estimate rendered after the discovery of such work, an amount equal in value to the defective or questioned work, and this work will not be included in a subsequent estimate until the defects have been remedied or the cause for doubt removed.

109.07 Payment for Material on Hand. Payment to the Contractor may be made for materials conforming to the Plans and the Contract which are stockpiled at the project site or other approved or designated locations, or at a plant site required for his operations as approved by the City. This payment will be made in accordance with the City procedure on the following basis:

A. The quantity of each particular stockpiled material to be considered will be limited to that required for the project and the payment shall not exceed their prorata part of the Contract item or items in which such materials are to be incorporated in conformity to the Contract.

B. Payment for stockpiled materials shall be limited to bulky materials which are durable in nature. The applicable retainage will apply to payment for materials on hand. Payment for material on hand will be withheld until issuance of the work order, unless otherwise authorized.

C. Items having a gross value of less than one thousand dollars ($1,000.00) will not be entered for payment.

109.08 Final Payment. Upon the completion of any Contract a final inspection must be made by the Engineer to determine whether the work has been completed in accordance with the Plans and the Contract. All prior partial estimates and payments shall be subject to correction in the final estimate and payment. When the work has been completed and certified to the City Council, the final estimate shall be executed and submitted expeditiously.

Acceptance shall be final and conclusive except as otherwise provided in the Contract or as regards latent defects or frauds, or such gross mistakes as may amount to fraud, or as regards to the City's rights under any warranty or guaranty or bond.

200.00 EARTHWORK AND ROADSIDE DEVELOPMENT

201.00 CLEARING AND GRUBBING

201.01 DESCRIPTION. This work shall consist of clearing, grubbing, removing and disposing of all vegetation and debris which are within designated limits inside the limits of the right-of-way and easement areas, except such objects as are designated to remain or are to be removed in accordance with other Sections of these Specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

201.04 CONSTRUCTION METHODS.

A. ***Clearing****.* Trees outside the limits of construction shall be cut only within the areas shown on the Plans. Trees within the limits of construction, when designated by the Engineer, shall be left standing. All branches of trees overhanging a roadbed shall be removed to a clear height of 20 feet above the top of the surfacing. All trimming and pruning of trees left standing shall be done by experienced workmen and in accordance with the best horticultural practice. Trees left in place shall not be damaged during construction operations.

All merchantable timber in the clearing area which has not been removed from the right-of-way prior to the beginning of construction shall become the property of the Contractor, unless otherwise provided.

All other trees, logs, stumps, brush, and objectionable material shall be removed, burned, or otherwise disposed of in an approved manner. If perishable material is burned, it shall be burned under the constant care of competent watchmen at such times and in such manner that the surrounding vegetation, other adjacent property, or anything designated to remain on the right-of-way, will not be jeopardized. Burning shall be done in accordance with applicable laws and ordinances, in particular a burn permit issued by the City Fire Marshall.

When permitted by the Engineer, materials and debris which cannot be burned and perishable materials may be removed from the right-of-way and disposed of at locations off the project outside the limits of view from the project with the written permission of the property owner on whose property the materials and debris are placed. The Contractor shall make all necessary arrangements with property owners for obtaining suitable disposal locations and the cost involved shall be included in the unit price bid, or considered as incidental to excavation.

B. ***Grubbing.*** All stumps and roots within the right-of-way, including channel right-of-way except as defined in C. below, shall be blasted or grubbed out and satisfactorily disposed of.

C. ***Preservation of Areas Outside of Construction.*** Areas outside of construction slopes, except that area necessary for constructing fences, shall be preserved in their natural state. Unless specifically required on the Plans, clearing or grubbing will not be permitted in areas outside construction stakes except for the removal of debris, dead trees and stumps. Care shall be exercised not to disturb areas outside of construction stakes except as necessary to store reserved topsoil from storage areas within the right-of-way. Any areas within the right-of-way damaged by Contractor operations shall be restored to the satisfaction of the Engineer by the Contractor at his own expense.

D. ***Selective Clearing.*** Selective clearing shall include the trimming of selected trees and shrubs, the removal from the ground and disposal of logs, root pods, brush, refuse dumps and other undesirable debris, and the cutting, removal and disposal of all undergrowth, stumps, and standing trees, except those trees and shrubs designated to be preserved. The selective clearing areas will be shown on the Plans. This work shall be performed in a manner as to leave the designated areas in a park-like condition and susceptible to economical maintenance. Disposal of all material shall conform to the methods set out in the Clearing and Grubbing requirements. Trees will normally be selected which will give a spacing of 20 to 30 feet.

Movement and operation of equipment shall be so restricted that trunks, branches and roots of trees and shrubs selected for retention will not be scarred, broken, or otherwise damaged including compaction of soil around trees and shrubs, to the extent that the life of the plant is endangered.

201.05 METHOD OF MEASUREMENT. When shown on the Plans as a contract pay item, Clearing and Grubbing will be measured to the nearest 0.05 acre of the areas cleared within the designated limits, or by the lump sum for the project.

No deduction will be made for areas occupied by existing roads or other bare areas within the limits designated or marked by the Engineer to be cleared and grubbed.

Selective clearing will be measured by the acre or by the lump sum for the project.

201.06 BASIS OF PAYMENT. Clearing and grubbing or selective clearing, measured as provided above, will be paid for at the contract unit price per acre or by the lump sum and such payment shall be full compensation for all

equipment, tools, labor and incidentals necessary to complete the work as specified.

Clearing and Grubbing	AC. or Lump Sum
Selective Clearing	AC. or Lump Sum

All work performed in clearing and grubbing areas not so designated on the Plans shall not be paid for directly but shall be considered as incidental work necessary to the several classes of excavation.

202.00 EXCAVATION AND EMBANKMENT

202.01 DESCRIPTION. This work shall consist of excavation, disposal, or compaction of all material not being removed under some other item which is encountered within the limits of the work necessary for construction in accordance with these Specifications and in reasonably close conformity with the line, grades, thicknesses and typical cross-sections shown on the Plans or established by the Engineer. All excavation will be classified as common excavation, rock excavation, unclassified excavation, muck excavation, or borrow as hereafter described.

202.02 EXCAVATION-CLASSIFICATION.

A. Common Excavation. Common excavation shall consist of all excavation not included as rock excavation or excavation which is otherwise classified and paid for.

B. Rock Excavation. Rock excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without blasting or the use of rippers, and all boulders or other detached stones each having a volume of 0.5 cubic yard or more. Shales that can be graded or ripped will be considered as common excavation.

C. Unclassified Excavation. Unclassified excavation shall consist of the excavation and disposal of all materials of whatever character encountered in the work.

D. Muck Excavation. Muck excavation shall consist of the removal and disposal of saturated or unsaturated mixtures of soils and organic matter or other materials not suitable for foundation material regardless of moisture content or other characteristic.

E. Unclassified Borrow. Unclassified borrow shall be all borrow excavation not classified as Select Borrow.

F. Select Borrow. Select borrow shall be material meeting the requirements provided for in Subsection 705.01. The City may specify on the Plans specific soil groups or group characteristics.

202.04 CONSTRUCTION METHODS.

A. Roadway Excavation. The excavation and embankments shall be finished to reasonably smooth and uniform surfaces. The top of finished sub-grade shall be within the tolerances shown in Subsection 202.04 F. No materials shall be wasted without permission of the Engineer. Excavation operations shall be conducted so that the material outside of the limits of slopes will not be disturbed. Prior to beginning excavation, grading, and embankment

operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with Section 201, Clearing and Grubbing.

When Plans shown an item for salvaging topsoil, it shall be removed and stockpiled before roadway excavation begins and will be paid for as a separate item in accordance with Section 205.

Unless otherwise provided for on the Plans, rock or other solid unyielding material in the finished grade of roadbed cut sections shall be excavated to a depth of at least 12 inches below sub-grade and backfilled with approved material. Approved materials for backfilling shall meet the requirements of Select Borrow Subsections 705.01 A. or 705.01 B. Sandstone or as may be otherwise specified on the Plans in accordance with Subsection 202.04 D. 1. Materials. All approved material for use in this work shall pass a 3-inch sieve. Any material which during manipulation does not reduce to less than 3 inches shall be removed from the grading limits. Compacting in cuts shall meet the moisture and density requirements as designated in Subsection 202.04 C. Embankment, or as shown on the Plans. No excavation below sub-grade or backfill will be paid for unless measured by the Engineer before backfill is placed. Excavation more than 12 inches below sub-grade will not be measured for payment unless shown on the Plans, or authorized by the Engineer. No ridges of rock shall be left and all areas of the rock surface shall drain to the ditches. In blasting rock, a reasonably uniform face shall be left regardless of whether or not the excavation is carried beyond the specified slopes. All breakage and slides shall be removed by the Contractor and disposed of in a manner approved by the Engineer.

Obliteration of old roadways shall include all grading operations necessary to incorporate the old roadway into the new roadway and surroundings in order to provide a pleasing appearance from the new roadway.

When the Contractor's excavating operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archeological significance, the operations shall be temporarily discontinued. The Engineer will contact archeological authorities to determine the disposition thereof. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper authorities. Such excavation will be considered for payment under Subsection 104.03.

Where excavation to the finished graded section results in a sub-grade or slopes of unsuitable soil, the Engineer may require the Contractor to remove the unsuitable materials and backfill to the finished graded section with an approved material. The Contractor shall conduct his operations in such a way that the Engineer can take the necessary cross-sectional measurements before the backfill is placed. Suitable material for backfilling

shall be such materials that are equal to or better than approved materials in close proximity to or adjoining those materials removed, as determined by AASHTO M 145, Method of Classification. When shown on the Plans, backfill material shall meet the requirements of subsection 202.04 D. 1. Materials, as specified.

The Engineer may designate as unsuitable those soils that cannot be properly compacted in embankments. All unsuitable materials shall be disposed of by the Contractor as approved by the Engineer.

When the location of unstable soil is shown on the Plans, the removal and replacement shall be as shown.

Channel excavation will be made at locations shown on the Plans or as directed by the Engineer and will be paid for as unclassified excavation.

B. Borrow Excavation. Unless otherwise designated on the Plans or in the proposal, the Contractor shall make his own arrangements for obtaining borrow and shall pay all costs involved. When procurement of borrow from a designated area is mandatory, it will be so shown on the Plans and right-of-way for mandatory borrow areas will be furnished by the City or other Agency purchasing right-of-way for the project.

No excavation for borrow shall be made until it has been determined by the Engineer that the additional material will be needed.

If the Contractor places more borrow than is required without written approval of the Engineer and thereby causes a waste of excavation, the amount of such waste will be determined and deducted from the borrow volume as measured in the borrow area.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas, so that cross-section elevations and measurements of the ground surface, after clearing, may be taken and any necessary required tests may be made.

Widening of roadway cuts and special ditches shall be permitted only when shown on the Plans or authorized by the Engineer, and material moved from these areas will be measured as Unclassified Excavation.

Borrow shall not be excavated from pits closer than 500 feet to the near right-of-way, except by written approval of the Engineer.

The Contractor shall provide and maintain all necessary haul roads from the borrow pits to the work site at his own expense. Unless otherwise provided, clearing, grubbing, stripping and replacement of top soil of

borrow areas and material not used in the embankment will not be measured for payment.

All borrow pits shall be excavated with uniform slopes. Borrow pits shall be left in a neat and workmanlike condition and in full compliance with all applicable State and Federal laws. The Contractor shall shape the pit for cross-sectioning immediately upon completion of borrow excavation.

C. Embankment. General. Embankment construction shall consist of constructing various types and styles of embankments, including preparation of the areas upon which they are to be placed within the right-of-way and the placing and compacting of approved material within areas where unsuitable material has been removed. Only approved materials shall be used in the construction of embankments.

Embankments shall be started at the low point and placed in layers approximately parallel to the finished grade and sloped to provide drainage at all times.

No rock larger than 3 inches in any dimension shall be placed in the top 12 inches of compacted embankment.

Embankment of earth material, including backfill, shall be placed in horizontal layers not exceeding 8 inches (loose measurement). All embankment material and the top 6 inches below Plan grade in cuts or designated grade for backfilling shall be compacted to not less than 95 percent of Standard Density when tested in accordance with Subsection 106.03. The moisture content of the embankment material at the time of compaction shall be within 2 points of the optimum moisture content as determined by AASHTO T-99, unless otherwise specified on the Plan or approved by the Engineer in writing.

The Engineer may designate and adjust the moisture range for compaction of embankment as may be required for specific or unusual conditions encountered in the work.

The Contractor may request in writing a lower moisture range for compaction of A-4 or A-5 soil groups to within 3 or 4 points below optimum moisture. Upon demonstration to the Engineer's satisfaction that the lower moisture range is more practicable, the Contractor's request may be so approved, provided embankment compaction meets the 95 percent minimum requirement.

No embankment shall be constructed on frozen material nor shall frozen material be placed in embankments. Effective spreading and disking equipment shall be used on each lift to obtain an approximate uniform thickness prior to compacting. Construction equipment shall generally be

routed over the entire surface of each layer. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density and moisture. Water shall be added or removed, if necessary, in order to obtain the required density and moisture content.

When in the opinion of the engineer, the stability of the foundation area for embankments can be improved, the Contractor shall construct a blanket of material of sufficient depth over the area to support normal hauling equipment half loaded until such time as normal operations can be resumed.

The Contractor shall employ proper and adequate workmanship in the construction of embankments at all times to obtain the required section within reasonable limits.

Rocks, broken concrete, or other solid materials shall not be placed in embankment areas where piling is to be placed or driven.

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built ½ width at a time, the slopes that are steeper than 4:1 shall be continuously benched, as directed by the Engineer, over those areas where it is required as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be re-compacted along with the new embankment material at the Contractor's expense.

Where embankment is to be placed and compacted and end dumping is permitted, the slopes of the original ground or embankment shall be deeply plowed or cut into before starting end dumping. Where end dumping is permitted, the rock will be dumped near the end of the existing lift and pushed over the end.

Unless otherwise shown on the Plans or in the Special Provisions, where the height of an embankment is 4 feet or less to the finished elevation, all sod and vegetable matter shall be removed from the surface upon which the embankment is to be placed, and the cleared surface shall be completely broken up by plowing, scarifying or stepping to a minimum depth of 6 inches. This area shall then be re-compacted. Sod not required to be removed shall be thoroughly disked or scarified before construction of embankment.

In those areas where fills are to be placed which cannot be satisfactorily compacted to stable and durable conditions due to unstable materials such as sod, trash, organic substances and muck, the Engineer may designate

removal and backfilling with suitable material to the original ground line elevation. Suitable material for backfilling shall be such materials that are equal to or better than approved materials as determined by AASHTO M 145, Method of Classification. When shown on the Plans, backfill materials shall meet the requirements of Subsection 202.04 D. 1. Materials, as specified.

Wherever a compacted road surface containing granular materials lies within 3 feet of the sub-grade, such old road surface shall be scarified to a depth of at least 12 inches. This scarified material shall be compacted as specified for embankments.

When shown on the Plans or in the Special Provisions, the foundation areas upon which embankments are to be placed shall be constructed in accordance with prescribed methods. Where the removal of unsuitable material and backfilling is prescribed by the typical cross-sections, unsuitable materials shall be excavated to within plus or minus 0.2 feet of the designated foundation grade. Unsuitable materials to be removed may include unstable materials such as rock, shale and classified silty or highly plastic soils. Unless otherwise specified on the Plans, suitable materials for backfilling shall be such materials that are equal to or better than approved materials as determined by AASHTO M 145, Method of Classification. When shown on the Plans, backfill material shall meet the requirements of Subsection 202.04 D. 1. Materials, as specified.

If embankment is to be placed on one side only of abutments, wing walls, piers, retaining walls or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. When embankment is to be placed on both sides of a concrete wall, abutment, end bent or box type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure. No rocks or boulders larger than 6 inches in the largest dimension shall be placed in the embankment nearer than 5 feet to the structure.

All excess or unsuitable excavated material, including rock and boulders larger than 8 inches in the largest dimension, that cannot be used in embankments may be placed on the side slopes of the nearest fill in a satisfactory manner and shall be placed so as to maintain a distinct shoulder line by keeping all such waste material not less than 3 feet below the finished shoulder elevation, unless otherwise shown on the Plans or directed by the Engineer. In case it is impossible to dispose of all such material in the manner described, the remainder shall become the property of the Contractor and disposed of by him to the satisfaction of the Engineer.

Embankments constructed of material of which a large portion is rock of such a nature that, in the opinion of the Engineer, construction in 8-inch layers is not feasible shall be constructed in layers the depth of which shall not exceed the maximum size of the rock present in the material, and in no case shall the thickness of the layer exceed 24 inches. End dumping will be required. The rock shall be dumped near the end of the existing lift and pushed over the end. Compactive effort on the rock and rocky material shall consist of making multiple coverings of each layer with a tamping type roller or with a vibratory roller as approved by the Engineer. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. The top 12 inches of embankment shall be constructed with approved material, smoothed and placed in layers not exceeding 8 inches in loose thickness and compacted as specified for embankments. When specified on the Plans, approved materials will be classified for acceptance in accordance with Subsection 202.04 D. 1. Materials.

The surface layer of a roadbed shall not be wetted or compacted until final finish grade stakes have been set and all embankment material is in place. The surface layer of the entire embankment shall then be manipulated by scarifying and the moisture corrected as specified for embankments, after which the entire surface layer shall be compacted to not less than 95 percent of Standard Density when tested in accordance with Subsection 106.03.

All material shall be placed in layers and rolled except that which is inaccessible to the roller, such as adjacent to culverts or bridge abutments in which case the material shall be placed in layers not to exceed 6 inches in depth measured loose and compacted to the density and moisture content of the adjacent embankment with mechanical tampers of approved design. No additional compensation will be allowed for tamping.

D*. *Selective Sub-grade Topping. When designated on the Plans, the upper portion of the embankment or fill shall be constructed with selective sub-grade topping materials. The base of the selected sub-grade zone shall be constructed within plus or minus (0.2) foot of the required elevation shown on the Plans.

1. *Materials*. Selective sub-grade topping materials shall meet the requirements specified for the various classes of topping shown below; or as may be otherwise specified by classification or characteristics referenced in AASHTO M 145.

SELECTIVE SUB-GRADE TOPPING CLASS	SPECIFICATION REQUIREMENT
Class I Topping	AASHTO M 145 Granular Materials: A-1, A-2-4, A-2-5 or A-3 Groups
Class II Topping	Subsection 705.01(b)
Class III Topping	Subsection 705.01(a)
Class IV Topping	15 P.I. or less
Class V Topping (Restrictive)	AASHTO M 145 Silt-Clay Materials: 1/ A-7-5 and A-7-6 Groups with a Group Index over (16) A-4 and A-5 Groups with a Group Index over (10)

Note: 1/ These materials will be restricted from use in Class V Topping.

Selective sub-grade topping shall all pass a 3" sieve unless otherwise specified.

1.1 *Testing.* Selective sub-grade topping materials shall be tested in accordance with Subsection 705.01(c).

1.2 *Classification.* The classification of selective sub-grade materials for acceptance by group and sub-group classifications will be in accordance with AASHTO M 145 as shown in Tables 1 and 2 below. The determination of group index values (numbers) specified for acceptance of group and sub-group classifications shown in Tables 1 and 2 will be determined in accordance with the procedures prescribed in AASHTO M 145.

TABLE 1
CLASSIFICATION OF SOILS AND SOIL AGGREGATE MIXTURES

General Classification	Granular Materials (35% or less passing No. 200)			Silt-Clay Materials (More than 35% passing No. 200)			
Group Classification	A-1	A-3 a/	A-2	A-4	A-5	A-6	A-7
Sieve Analysis							
No. 10							
No. 40	50 Max.	51 Min.					
No. 200	25 Max.	10 Max.	35 Max.	36 Min.	36 Min.	36 Min.	36 Min.
Characteristics of fraction Passing No. 40		b/					
Liquid Limit	. . .	. . .		40 Max.	41 Min.	40 Max.	41 Min.
Plasticity Index	6 Max.	N. P.		10 Max.	10 Max.	11 Min.	11 Min.
General Rating as Sub-grade	Excellent to Good			Fair to Poor			

a/ The placing of A-3 before A-2 is necessary in the ^A^Aleft to right elimination process and does to indicate superiority of A-3 over A-2
b/ See Table 2 for values.

TABLE 2.
CLASSIFICATION OF SOILS AND SOIL AGGREGATE MIXTURES
(WITH SUGGESTED SUBGROUPS)

General Classification			Granular Materials (35% or less passing No. 200)					Silt-Clay Materials (More than 35% passing No. 200)			
	A-1		A-3	A-2				A-4	A-5	A-6	A-7 A-7-5
Group Classification	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-6
Sieve Analysis											
Percent passing:											
No. 10	50	. . .	. . .								
No. 40	Max.30	50 Max.	51 Min.								
No. 200	15 Max.	25 Max.	10 Max.	35 Max.	35 Max.	35 Max.	35 Max.	36 Min.	36 Min.	36 Min.	36 Min.
Characteristics of Fraction Passing No. 40											
Liquid Limit		. . .	. . .	40 Max.	41 Min.	40 Max.	41 Min.	40 Max.	41 Min.	40 Max.	41 Min.
Plasticity Index		60Max.	N.P.	10 Max.	10 Max.	11 Min.	11 Min.	10 Max.	10 Max.	11 Min.	11 Min.
Visual types of Significant Constituent Materials	Stone Fragments Gravel and Sand		Fine Sand	Silty or Clayey		Gravel and Sand		Silty Soil		Clayey Soils	
General Rating as Sub-grade			Excellent to Good					Fair to Poor			

a/ Plasticity Index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity Index of A-7-6 subgroup is greater than LL minus 30.

2. *Sources of Selective Sub-grade Topping Materials.*

   2.1 *Contractor's Option.* The Contractor shall develop a plan which demonstrates to the Engineer that an adequate quantity of material will be salvaged or reserved for selective sub-grade topping. During the movement of excavation, it will be the Contractor's responsibility to follow the approved grading plan to the extent that the available quantity of material needed for selective sub-grade topping will be reserved for use.

   2.2 *Mandatory Sources Designated on the Plans*. When selective sub-grade topping material sources are designated on the Plans as mandatory sources, the Contractor shall excavate such materials within the limits designated, haul and place the materials at the locations shown on the Plans.

3. *Plan Quantities*. Estimated quantities of selective sub-grade topping materials will be shown on the Plans. In the event the Contractor determines that Selective Sub-grade Topping Materials specified on the Plans or in the Proposal are not available in sufficient quantities or of the quality specified, the Engineer shall be so notified in writing in accordance with the provisions of Subsection 104.03.

E*. *Sloping, Shaping, Dressing and Finishing. The slopes of all cuts, ditches, and embankments shall be constructed and dressed in a neat and workmanlike manner, as indicated on the Plans or as directed by the Engineer. Shovel cuts will require the removal of the ridge which a shovel ordinarily leaves along the top of the bank, and such hand work shall be performed as may be necessary to maintain approximately the designated slope and produce a backslope free from humps and hollows. The top and bottom of slopes shall be rounded to the approximate typical cross-section shown on the Plans. When rock extending to the top of cuts makes rounding impractical, it will not be required. Old existing banks shall be sloped, shaped and rounded as specified for new work. Hand trimming of slopes and shoulders will not be required where a neat, uniform face is otherwise obtained. The slopes in all cuts and banks of borrow pits shall be trimmed from top to bottom in firm material.

Dressing shall include all the necessary clearing of the right-of-way of stumps, brush, weeds, and other rubbish, and disposing of same in accordance with Subsection 201.04.

F*. *Tolerances. The embankment shall be brought to a uniform cross-section with a maximum tolerance of + 0.1 foot from the cross-section as given.

202.05 METHOD OF MEASUREMENT.

A. Measured Quantities. When payment is specified on a volume basis, all accepted excavation and borrow shall be measured in its original position by cross-sectioning the area excavated, which measurements will include over breakage or slides in common excavation and unclassified excavation, not attributable to carelessness of the Contractor, and authorized excavation of rock, shale, muck or other unsuitable material. Volumes will be computed from the cross-section measurements by the average end area method. Volumes of structures and obstructions removed, measured and paid for under Section 619 will not be measured and paid for under this Section.

Authorized excavation of rock, shale, muck or unsuitable material below grade shall consist of that excavation necessary to provide the designed thickness of backfill. If the plan of the designated grade line falls within a layer of stratum of rock, the below-grade excavation to the bottom of the layer, not exceeding 12 inches below the designated bottom of excavation, will be considered as authorized and will be measured for payment. Rock excavation more than 12 inches below the designated grade line will not be paid for unless authorized by the Engineer. If the nature of the material, the thickness of the layers or strata and method of operations are such that it is practical to excavate only to the depth shown on the Plans, no measurement will be made of any material removed below the line designated. The measurements will include over-breakage in rock excavation from the backslopes to an amount not to exceed in any half station of 50 feet, 10 percent of the actual quantity required for that half station.

Measurements will be made for unsuitable materials actually excavated and removed to obtain proper compaction in cut sections and in foundations for fill sections.

Measurements will not be made of the suitable material temporarily removed and replaced to facilitate compaction of the material for the full depth shown on the Plans.

Where it is impractical to measure material by the cross-section method due to the erratic location of isolated deposits, acceptable methods involving three-dimensional measurements may be used.

B. Measurements on a Linear Basis. Linear grading shall consist of reshaping the entire existing surface to the typical section as shown on the Plans. When it is specified that an item of excavation is to be measured and paid for on a linear basis, the actual length will be measured along the centerline in the units specified in the Contract for linear grading.

C. Measurement of Excavation Items on a Weight or Truck Measurement Basis. An item of excavation may be specified to be measured and paid for on a weight or truck measurement basis. When a weight or truck measurement basis is specified, the material will be weighed or measured in accordance with Section 109.

D. Measurement of Embankments. When embankment is specified in the Contract for payment as a separate bid item, accepted quantities for payment will be measured in place by the average end area method. The volume so constructed will be computed in cubic yards by the Engineer from the dimensions of the embankment cross-sections and the depths below the completed grade to which this method of construction applies. It will be the Contractor's responsibility to furnish the number of cubic yards of material actually required to meet the Plan typical cross-sections. No allowances will be made for surplus material outside the limits of the typical cross-sections or for any materials or work required to correct settlement, shrinkage or swell of the embankments. No deductions for the volume of culverts, manholes and the like will be made.

Where the Contract does not specifically provide for payment for embankment, the work or embankment construction will not be paid for as such but will be considered incidental to the various classifications of excavation.

E. Pre-splitting of Rock. When specified in the Contract, pre-splitting of rock will be measured by the linear foot of drilling completed and approved.

202.06 BASIS OF PAYMENT. Accepted quantities of excavation and embankment, measured as provided above, will be paid for at the contract unit price for:

(A)	Common Excavation	Cu. Yd.
(B)	Rock Excavation	Cu. Yd.
(C)	Unclassified Excavation	Cu. Yd.
(D)	Muck Excavation	Cu. Yd.
(E)	Unclassified Borrow	Cu. Yd.
(F)	Select Borrow	Cu. Yd. or Ton
(G)	Embankments	Cu. Yd. or Ton
(H)	Linear Grading	Sta. or Mi.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

When water is not specified as a pay item in the contract, the water used will not be measured or paid for but will be incidental to the work.

203.00 TEST ROLLING

203.01 DESCRIPTION. This work shall consist of the test rolling with heavy pneumatic tired rollers when shown on the Plans or required by the Specifications.

203.02 MATERIALS. In the event test rolling discloses soft, yielding or otherwise unstable areas, such areas shall be corrected by removing all unsuitable material and replacing it with suitable material. The satisfactory correction of any area shall be demonstrated by test rolling of the corrected area.

203.03 EQUIPMENT. Heavy pneumatic tired rollers shall have a minimum of 4 wheels abreast equipped with pneumatic tires of such size and ply that tire pressures shall not be less than 50 + 5 psi for rolling operations. The roller wheels and axles shall be so designed that each wheel will carry an approximately equal load when the roller is operated over uneven ground. The centers of the wheels shall be spaced at not more than 1¾ times the rated tire width of a single tire. The roller shall have a loading platform suitable for loading with ballast sufficient to obtain a total roller weight of not less than twelve (12) tons. The Contractor shall furnish the Engineer with certified weights of the empty roller and weights of the ballast. There shall be a metal plate attached to the roller showing the tare weight and capacity of the load box.

The motivating equipment shall be capable of operation within the limits of the Specification and so constructed that it can be turned without damage to the work being tested. Rolling equipment shall be approved by the Engineer.

203.04 CONSTRUCTION METHODS. The area to be tested shall be rolled with not less than 6 passes or 3 complete coverages. The roller shall be operated at speeds between 2 and 10 miles per hour as directed by the Engineer.

In every case when test rolling is called for on embankment, the sub-grade in both cuts and fills shall be tested, and where the original ground which is to be the foundation of an embankment is accessible to the roller, as determined by the Engineer, this area shall also be tested.

203.05 METHOD OF MEASUREMENT. Test rolling will not be measured for payment. All equipment, labor, water and incidentals as may be required shall be included in the unit price bid on the items for which test rolling is designated.

205.00 SALVAGING TOPSOIL

205.01 DESCRIPTION. This work shall consist of salvaging available natural topsoil from areas of excavation and embankment, stockpiling and/or placing material on the completed areas as shown on the Plans or designated by the Engineer.

205.02 MATERIALS. The salvaged soil shall consist of the surface layer. In all cases, the top one inch of the soil surface shall be a part of the salvage material. The soil shall be salvaged from only those areas shown on the Plans or approved by the Engineer.

205.03 EQUIPMENT. The equipment for salvaging, stockpiling and spreading the soil shall be approved by the Engineer. The equipment for rolling shall conform to Subsection 230.03.

205.04 CONSTRUCTION METHODS. All areas from which soil is to be salvaged shall be cleared of brush, weeds, tall grasses, or other objectionable material such as rock or shale. The soil to be salvaged shall be excavated to a depth of approximately six inches for the full width of excavation and embankment areas unless otherwise determined by the Engineer.

Salvaged topsoil to be stockpiled shall be placed outside of the construction stakes in such a manner that the maximum amount of material may be recovered. The Contractor shall avoid excavating below the original ground surface when removing the stockpiled material.

Type A Salvaged Topsoil. The excavation and embankment areas shall be finished in reasonably close conformity to the lines and grades shown on the Plans or established by the Engineer. Slopes and disturbed areas to be covered with the salvaged soil as shown on the Plans shall be scarified on the contour with approved equipment, prior to placing the salvaged topsoil, and in a manner approved by the Engineer. Prior to placing the salvaged soil, the fertilizer specified shall be applied at the rate shown on the Plans. When satisfactory results can be obtained, disking for slope scarification and incorporation of fertilizer may be accomplished in one operation. The salvaged soil shall be spread approximately 5 inches thick unless otherwise directed by the Engineer. Immediately after spreading, the areas shall be rolled.

Type B Salvaged Topsoil. Type B Salvaged Topsoil shall be that material to be used in accordance with Method B Broadcast Sprigging Operations in Subsection 230.04 E. Prior to placing the Salvaged Topsoil, the fertilizer specified shall be applied at the rate shown on the Plans. The topsoil shall be stockpiled in a manner approved by the Engineer in those areas shown on the Plans or determined by the Engineer.

205.05 METHOD OF MEASUREMENT. Both Type A and Type B Salvaged Topsoil shall be measured by the cubic yard in accordance with Subsection 109.01 A.

Additional or second handling as defined in Subsection 202.04 A. will not be measured for payment. Type A Salvaged Topsoil will be measured as fifty percent complete when the material has been removed from areas of excavation and embankment.

205.06 BASIS OF PAYMENT. Accepted Salvaged Topsoil Type A or B, measured as provided above, will be paid for at the contract unit price for:

Type A Salvaged Topsoil	Cu. Yd.
Type B Salvaged Topsoil	Cu. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to salvage, stockpile and otherwise handle the materials as shown on the Plans and meet the requirements of these Specifications.

209.00 MACHINE GRADING

209.01 DESCRIPTION. This work shall consist of that class of grading in which the material to be excavated will approximately make the fills, and which can be completed principally by heavy machine blading supplemented with sufficient equipment to accomplish the necessary drifting or hauling, and borrowing.

209.04 CONSTRUCTION METHODS. Machine grading shall include all necessary drifting or hauling of excavated material, plowing, scarifying, blading, removal of stone and boulders, compacting, and shaping to bring the area to a uniform grade and the typical cross-section and approximate grade elevation shown on the Plans. All side slopes and ditches shall be graded and shaped to conform approximately with the typical cross-section designated on the Plans. Unless otherwise shown on the Plans, rock, hard sandstone, shale, or other solid unyielding material shall be excavated and backfilled with acceptable material in accordance with Subsection 202.04 A. Excavation and embankment shall be constructed in accordance with Subsections 202.04 A. and C. of these Specifications.

Unless otherwise noted on the Plans, all normal inlet and outlet channels shall be cleaned to right-of-way line and this work shall be included in the price bid for machine grading. Grading over and adjacent to culverts and bridges in place, or new structures, shall be done as a part of machine grading and must be performed with special care to prevent damage to the structures. Any damage to structures shall be repaired at the Contractor's expense, as directed by the Engineer.

As soon as any portion of the work is graded, it shall be bladed and shaped to secure a smooth surface of uniform cross-section approximately true to line and grade. Blading operations shall be continued thereafter at such times as directed by the Engineer to maintain a satisfactory condition until final acceptance.

All work performed under this item shall be done in a neat and workmanlike manner acceptable to the Engineer.

209.05 METHOD OF MEASUREMENT. Machine grading will be measured by 100 feet stations to the nearest 0.1 station along the centerline.

209.06 BASIS OF PAYMENT. Machine grading, measured as provided above, will be paid for at the contract price for:

Machine Grading Sta.

and such payment shall be full compensation for drifting, or hauling of excavated material, plowing, scarifying, blading, removal of stone and boulders, compacting, shaping, cleaning all normal inlet and outlet channels to right-of-way lines, and for all labor, tools, equipment and incidentals necessary to complete the work as specified.

210.00 OBLITERATING ABANDONED ROAD

210.01 DESCRIPTION. This work shall consist of obliterating designated sections of old road by removing and disposing of surfacing, structures and other items, in reasonably close conformity with the Plans and these Specifications.

210.04 CONSTRUCTION METHODS. This work shall be done after the sections of the old road to be obliterated are no longer needed for traffic.

Pavement and base courses shall be broken and removed in accordance with Section 619. Steel bridges, culvert pipe, guard rail, posts, bridge timber and other items with salvage value, shall be removed without damage and stockpiled or stored within the limits of the project as shown on the Plans. When salvage or use in the work is not shown on the Plans for any items, they shall become the property of the Contractor.

Concrete structures to be removed will be broken out to the ground level or to an elevation to be covered with earth. Broken concrete and debris may be spread out at locations designated by the Engineer and covered with earth to a depth of at least 12 inches, or shall be removed from the site of the work by the Contractor.

After the surfacing, structures and other items have been removed, the old roadbed shall be scarified or plowed and rounded and smoothed by blading or other suitable methods; the ends of embankments and the top of cuts within the existing right-of-way, except in rock shall be graded, sloped and rounded. Ditches shall be filled and the entire roadway graded.

210.05 METHOD OF MEASUREMENT. Obliterating abandoned road will be measured by the station of 100 feet or fraction thereof measured along the center line of the old roadway obliterated.

210.06 BASIS OF PAYMENT. Obliterating abandoned road, measured as provided above, will be paid for at the contract unit price for:

Obliterating Abandoned Road Sta.

and such payment shall be full compensation for removal, disposal and storing all materials with salvage value and for the satisfactory disposal and obliteration of other materials and debris, regarding and shaping the roadway; and for all equipment, tools, labor and incidentals necessary to complete the work as specified.

220.00 TEMPORARY EROSION AND SEDIMENT CONTROL

220.01 DESCRIPTION. This work shall consist of temporary measures and devices to control erosion and sediment within the project limits and to minimize the pollution of rivers, streams, impoundments and private properties. Such measures may include berms, dikes, slope drains, bale barriers, siltation screens, fabrics, sediment filters, sediment basins, fiber mats, netting, gravel, rip-rap, mulches, grasses and other erosion and sediment control devices and methods.

The temporary erosion and sediment controls shall be coordinated with permanent erosion controls to assure economical, effective and continuous control of erosion and sediment throughout the construction and post construction period.

220.03 CONSTRUCTION METHODS. The Contractor shall submit his proposed schedule for accomplishing the temporary erosion control, temporary sediment control and the permanent erosion control work for his clearing and grubbing operations. He shall also submit his proposed method of erosion control on haul roads and borrow pits, and his plan for disposal of waste materials. The work shall not be started until the proposed erosion and sediment control schedules and methods of operations have been reviewed and approved by the Engineer.

The Engineer may increase or decrease the amount of area exposed by construction operations and direct the Contractor to provide immediate temporary or permanent erosion control measures to prevent siltation as determined by field conditions. Temporary or permanent erosion or sediment control measures shall be initiated on excavation or embankment slopes as work progresses unless otherwise directed by the Engineer.

Clearing and grubbing operations shall be scheduled and performed so that grading and permanent erosion control operations can follow immediately. Should seasonal limitations make such coordination and scheduling unrealistic, temporary erosion and sediment control measures shall be required during successive construction stages.

The Contractor shall conform to the following practices and controls:

A. Waste areas and construction areas shall be located and constructed in a manner to prevent sediment from entering streams.

B. Frequent crossing of live streams will not be permitted until temporary crossing structures of non-erodible materials have been constructed and approved by the Engineer. Unless otherwise approved in writing by the Engineer, mechanized equipment shall not be operated in live streams.

C. When work areas are located in or adjacent to live streams, such areas shall be separated from the main stream by a dike or other approved barrier. Care

shall be taken during the construction and removal of such barriers to minimize the siltation of the stream.

D. All waterways shall be cleared as soon as practicable of falsework, piling, debris, or other obstructions placed during construction and which are not a part of the finished work.

E. Drainage water from material stockpiles and plant sites on the right-of-way shall be controlled by sediment basins, filters or other means to reduce the sediment content.

F. The Contractor shall take sufficient precautions to prevent pollution of streams, lakes and reservoirs from fuels, oils, bitumens, calcium chloride or other harmful materials.

G. In the execution of any work within or adjacent to any State or National forest, park or other public lands, the Contractor shall comply with all of the regulations of the appropriate authority having jurisdiction over those lands and in accordance with Subsection 107.12.

Temporary erosion and sediment control measures which are required due to unforeseen construction problems and are not shown on the Plans shall be constructed when directed by the Engineer. Accountability and payment will be in accordance with Subsection 104.03.

221.00 TEMPORARY SEDIMENT CONTROL SLOPE DRAINS

221.01 DESCRIPTION. This work shall consist of the construction, maintenance and removal of temporary slope drains and diversion dikes at locations shown on the Plans or determined by the Engineer.

221.02 MATERIALS. Materials used for construction of slope drains may be flexible tubing, plastic sheeting, plastic screen, burlap, asphalt, pipe or as shown on the Plans. Inlet materials may be wood, pipe end sections or other solid material. Outlets may be constructed of loose rock, brush, straw, waste concrete or pipe end sections.

221.04 CONSTRUCTION METHODS. Diversion dikes shall be constructed in fill sections at the end of each day's operation. At points along the diversion dikes as specified on the Plans or by the Engineer, the Contractor shall construct or extend slope drains at the end of each day's operations. Slope drains shall be constructed from the toe of slope in order that they may be extended as additional fill is completed. Inlets shall be provided with each slope drain. The type of outlet control will be determined by existing conditions, materials available, and in a manner approved by the Engineer.

Slope drains on backslopes shall be placed on the slope as the excavation of the cut area progresses, until the final grade is obtained and permanent controls are in place.

The slope drains and diversion dikes shall be maintained in such a manner as to be free from debris and open to the flow of water. Slope drains may be removed or left in place as determined by the Engineer as the permanent controls are completed and functioning.

221.05 METHOD OF MEASUREMENT. Slope drains will be measured by the linear foot in place. Measurements will be taken only on the completed cut or fill slope when to grade. Inlets, outlets and diversion dikes will be considered as an integral part of the drain.

221.06 BASIS OF PAYMENT. Accepted slope drains, measured as provided above, will be paid for at the contract unit price bid for:

Temporary Slope Drains Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

222.00 TEMPORARY SEDIMENT CONTROL BALE BARRIERS

222.01 DESCRIPTION. This work shall consist of the construction, maintenance and removal of temporary bale barriers at locations shown on the Plans or determined by the Engineer. Bale barriers shall be used to trap sediment at the toes of slopes, or across ditches and defined waterways.

222.02 MATERIAL. The vegetative materials shall consist of baled straw or baled hay. The bales of straw or hay shall be standard sized rectangular bales approximately 18 x 20 x 36 inches in size and shall be securely bound with wire or twine.

The stakes used to anchor the bales may be hardwood lumber, timber, or metal approximately 36 inches long, of sufficient strength to be driven firmly in the ground.

222.04 CONSTRUCTION METHODS. As slope barriers, the bales shall be placed end to end and staked down, a maximum distance of 4 feet out from the top of the slope. At locations determined on the site, a bale will be left out and a pile of loose rock or other acceptable filtering material shall be placed in the opening to approximately 2/3 of the height of the bale to act as a spillway type outlet.

As ditch checks, the bales shall be placed in a staggered position across the defined waterways and staked in place. The bales shall be placed up the slope on either side of the flow line, higher than the elevation of the bale in the center of the waterway.

The Contractor shall keep the barrier in good condition by replacing broken or damaged bales immediately after damage occurs. Removal of silt when specified by the Plans shall be measured and paid for in accordance with Section 226.

Bale barriers may be removed or left in place at the discretion of the Engineer.

222.05 METHOD OF MEASUREMENT. Bale barriers will be measured by the linear foot in place. Measurement will include the areas of the spillways, but the spillway material will not be measured as a separate item for payment. Measurements for Type I Bale Barriers will be taken along the ground line perpendicular to the flow line.

222.06 BASIS OF PAYMENT. Accepted bale barriers, measured as provided above, will be paid for at the contract unit price bid for:

Temporary Bale Barrier	Lin. Ft.

which shall be full compensation for furnishing all materials, labor, equipment and incidentals to complete the work as specified.

223.00 TEMPORARY SEDIMENT CONTROL SILTATION SCREEN

223.01 DESCRIPTION. This work shall consist of the construction, maintenance and removal of siltation screens at locations shown on the Plans or as determined by the Engineer. A siltation screen is a barrier constructed specifically to trap sediment and debris.

223.02 MATERIALS. The framework shall be of any type material, capable of supporting various filtering materials and withstanding the force of water flowing through the screen.

Filtering materials may be burlap, wire screen, wire mesh, woven or non-woven fabrics, expanded metal, plastic or plastic sheeting.

The maximum size opening for any type screen, mesh or other filtering material shall not exceed ¼ inch.

223.04 CONSTRUCTION METHODS. Siltation screens shall be installed at least 6 feet from the right-of-way fence. Framework supports shall have a maximum spacing of 10 feet center to center, or as shown on the Plans. Filter materials shall be secured to the ground between supports to prevent the material from curling or rolling up. Siltation screens may be removed or left in place as determined by the Engineer.

Siltation screens shall be kept free of debris that would damage the filtering material or impede the flow of water. Sediment removal when specified by the Engineer will be measured for payment in accordance with Section 226.

223.05 METHOD OF MEASUREMENT. Siltation screens as shown on the Plans or established by the Engineer will be measured by the linear foot in place.

223.06 BASIS OF PAYMENT. Accepted siltation screens, measured as provided above, will be paid for at the contract unit price bid for:

Temporary Siltation Screen	Lin. Ft.

which shall be full compensation for furnishing all materials, labor, equipment and incidentals to complete the work as specified.

224.00 TEMPORARY SEDIMENT CONTROL FILTERS

224.01 DESCRIPTION. This work shall consist of the construction, maintenance, and removal of temporary sediment filters. Sediment filters shall be constructed to trap silt and debris prior to its entry into any drainage inlet or other similar structure which empties into a waterway or its subsidiary.

224.02 MATERIALS. The bales of straw and stakes shall conform to the requirements of Section 222.

Materials for sediment filter may be any type of non-erodible material available, such as: loose rock, broken concrete, or other salvageable materials.

224.04 CONSTRUCTION METHODS. Sediment filters shall be constructed as soon as the inlets are completed sufficiently to receive runoff water, at locations shown on the Plans or determined by the Engineer.

The bales for sediment control shall be placed and staked tightly together in such a manner to cause the waterflow to be slowed and go over the bales, prior to entering the inlet.

The non-erodible filter material shall be placed around the inlet, between the inlet and the flow of water. The placement of this material shall be in such a manner that the water will be slowed and then flow over and through the material prior to entering the inlet.

The Contractor shall keep the filters (bales or other materials) in good condition by repairing any damage or break in the filters immediately. Removal of silt, when specified by the Plans, shall be measured and paid for in accordance with Section 226.

Sediment filters may be removed as determined by the Engineer.

224.05 METHOD OF MEASUREMENT. Sediment filters will be measured by the number of units in place.

224.06 BASIS OF PAYMENT. Accepted sediment filters, measured as provided above, will be paid for at the contract unit price bid for:

Temporary Sediment Filter	Ea.

which shall be full compensation for furnishing all materials, labor, equipment and incidentals to complete the work as specified.

225.00 TEMPORARY SEDIMENT CONTROL BASINS

225.01 DESCRIPTION. This work shall consist of the construction, maintenance, and removal of temporary sediment basins at locations shown on the Plans or determined by the Engineer. The approximate size and shape shown on the Plans may vary depending on the soil type, the drainage area, and available right-of-way at the exact construction locations selected by the Engineer.

225.02 MATERIALS. Materials used for both the inlet and outlet flows of the sediment basins may be loose rock of sufficient size to withstand anticipated water velocity displacement or other non-erodible materials approved by the Engineer. When Type I Sediment Basins are specified, the outflow pipe shall be at least a 12-inch diameter pipe installed in a manner approved by the Engineer.

225.04 CONSTRUCTION METHODS. Inlets shall be shaped to confine the water to the defined channel as it enters the basin. Outlets shall be constructed to slow the velocity of water so sediment will be retained in the sediment basin. Material excavated shall be used on the sediment basin dikes or stockpiled as directed by the Engineer.

Sediment basins shall be maintained by the Contractor until permanent erosion control has been completed and effectively operational. Sediment removal, when specified by the Engineer, will be measured for payment in accordance with Section 226.

225.05 METHOD OF MEASUREMENT. Sediment basins will be measured by the number of units constructed as specified above. Inlets and outlets will be considered an integral part of the basin.

225.06 BASIS OF PAYMENT. Accepted sediment basins, measured as provided above, will be paid for at the contract unit price for:

Temporary Sediment Basin	Ea.

which shall be full compensation for furnishing all materials, labor, equipment and incidentals to complete the work as specified.

226.00 TEMPORARY SEDIMENT REMOVAL

226.01 DESCRIPTION. This work shall consist of removing sediment which has become trapped by the various temporary or permanent erosion and sediment control devices.

226.04 CONSTRUCTION METHODS. Sediment shall be removed at the direction of the Engineer from the control devices. After sediment removal has been completed, the control device shall be left in the operable condition for which it was designed. Any damage to the control devices shall be replaced at the Contractor's expense. Materials removed shall be disposed of at locations and in a manner approved by the Engineer.

226.05 METHOD OF MEASUREMENT. The number of times that the sediment needs to be removed will be determined by the Engineer. Sediment removal will be measured by the cubic yards of material removed and disposed of in an approved manner.

226.06 BASIS OF PAYMENT. Accepted sediment removal, measured as provided above, will be paid for at the contract unit price bid for:

Temporary Sediment Removal	Cu. Yd.

which shall be full compensation for furnishing all materials, labor, equipment and incidentals to complete the work as specified.

228.00 NYLON EROSION CONTROL MAT

228.01 DESCRIPTION. This work shall consist of furnishing and installing a nylon erosion control mat for ditch lining and slope protection in accordance with these Specifications and within reasonable close conformity with the lines and dimensions shown on the Plans or established by the Engineer.

228.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Nylon Erosion Control Mat	735.05
Mat Fasteners	735.06
Seed	735.04

228.03 EQUIPMENT. The Contractor shall furnish equipment required for satisfactory progress and completion of acceptable work in accordance with Subsection 108.06.

228.04 CONSTRUCTION METHODS.

A. Placing Mat.

1. *General.* All surfaces to be protected with nylon erosion control mat shall be graded, shaped and finished so that the surfaces are stable, firm and free of rocks or obstructions which would prevent the mat from lying in direct contact with the soil surface.

2. *Ditches.*

   2.1 Three widths of mat will be required for the standard ditch placement: the center width placed first, then the two side widths. Lap joints of 3 inches shall be used.

   2.2 At the terminal ends of the ditch, the mat shall be buried at least 12 inches vertically in an anchor slot dug into the soil. The mat shall be secured in the anchor slot by fasteners prior to backfilling the slot. The backfilled soil shall be firmly compacted in the anchor slot.

   2.3 On ditches with grades exceeding 6 percent, a 6 inch deep check slot shall be installed every 25 feet and the mat secured in the check slots by fasteners.

   2.4 Seeding, Ditches only. When mats are installed and approved during the normal out of planting season, common Bermuda grass seed at the rate of 6 lbs. per acre shall be uniformly seeded on the exposed areas of soil beneath the mat.

During the planting season, the specified plant material (sodding, sprigging, or seeding) shall be completed prior to placing the mat in ditches.

3. *Slopes.*

3.1 When placing mat on slopes, the top end shall be buried at least 12 inches vertically in an upper anchor slot and the bottom end shall be buried at least 6 inches in the lower anchor slot. The mat shall be secured in the anchor slots by fasteners, prior to backfilling the slot. The backfill soil shall be firmly compacted in the anchor slots.

3.2 The mat shall be installed in a manner that will allow the downgrade edge to overlap the previously laid strip. Lap joints of 3 inches shall be used.

3.3 On slopes exceeding 60 feet in slope length, a 6 inch deep check slot shall be installed every 40 feet and the mat secured in the check slot by fasteners.

3.4 During the planting season, the specified plant material shall be completed prior to placing the mat on the slopes. During the out of planting season, the mat shall be placed as temporary and permanent protection until the specified plant material can be applied during the proper season.

4. *End of Roll.* The ends of the roll of the mat shall overlap 36 inches with the upslope end on top.

B. Fastening the Mat. The normal spacing for fastening the mat shall be 36 inches along the edge lap joint and down the center of each width of mat. The center fasteners shall be offset 18 inches from the edge fasteners.

The mat shall be held firmly in place with fasteners shown on the Plans. Fasteners shall be pressed firmly against the mat and securely driven into the underlying soil.

The mat shall be fastened across the width, in anchor slots, in check slots and end overlaps on 18 inch centers.

C. Seeding. When seeding is required in ditches, due to the out of planting season, it shall be applied by Seeding Method A, as specified in Subsection 232.04 B., or Hand Broadcasting.

D. Maintenance. The Contractor shall be responsible for the proper maintenance of the area until the entire project has been completed. This shall include refilling of washed out areas, reseeding, and replacing mat.

228.05 METHOD OF MEASUREMENT. Nylon erosion control mat installed in place, including the seeding, shall be measured by the square yard of area covered.

228.06 BASIS OF PAYMENT. Accepted quantities, measured as provided above, will be paid for at the contract unit price for:

Nylon Erosion Control Mat	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

229.00 DITCH LINER PROTECTION

229.01 DESCRIPTION. This work shall consist of furnishing and installing excelsior mat or solid slab sod as ditch liner protection in accordance with these Specifications and in reasonable close conformity with the areas and locations shown on the Plans or established by the Engineer.

229.02 MATERIALS.

A. Excelsior Mat. This material shall meet the requirements for Subsection 735.05 D.

B. Solid Slab Sod. This material shall meet the requirements for Subsection 735.02 B. 1.

C. Mat Fasteners. Mat fasteners used for anchoring the excelsior mat shall meet the requirements for the type specified on the Standard Drawings

229.03 CONSTRUCTION METHODS.

A. Excelsior Mat. The mat shall be placed as shown on the Plans so that the fibers are in contact with the soil and the netting is on the top. A single strip of mat shall be placed parallel to each side of the ditch liner.

B. Solid Slab Sod. The sod shall be placed as shown on the Plans and in accordance with Subsection 230.04 A. One-hundred, eighty-five gallons of water and five pounds of 10-20-10 fertilizer shall be applied per 100 linear feet of ditch liner.

C. Fastening the Mat. After placement, the excelsior mat shall be held firmly in place with fasteners as shown on the Plans. Fasteners shall be pressed firmly against the mat and securely driven into the underlying soil.

D. Repairs. If the ditch liner protection material becomes damaged, it shall be replaced in kind promptly. If the soil beneath or surrounding the ditch liner becomes eroded, the area shall be restored to the original condition and grade prior to placement of the protection material.

229.05 METHOD OF MEASUREMENT. Ditch liner protection will be measured by the linear foot of ditch liner in place. All materials and work necessary for repairs will not be measured for payment.

229.06 BASIS OF PAYMENT. Ditch liner protection, completed and accepted in place and measured as provided above, will be paid for at the contract unit price for:

Ditch Liner Protection	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

230.00 SODDING AND SPRIGGING

230.01 DESCRIPTION. This work shall consist of furnishing and planting viable Bermuda grass sod or sprigs in accordance with these Specifications and in reasonable close conformity with the areas and locations shown on the Plans or as established by the Engineer.

230.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Bermuda Grass Solid Slab Sod	735.02
Bermuda Grass Mulch Sod	735.02
Bermuda Grass Mulch Sprigging	735.02
Bermuda Grass Row Sprigging	735.02
Bermuda Grass Broadcast Sprigging	735.02

Water shall be free from harmful quantities of toxic salts or other substances that might interfere with the establishment or future subsistence of turf or plants.

230.03 EQUIPMENT. The Contractor shall furnish equipment in accordance with Subsection 108.06 and as prescribed herein.

A. Rolling Equipment. Unless otherwise approved by the Engineer, the machine for compacting mulch sodding or mulch sprigging shall be equipped with a single or tandem axle corrugated roller. It shall weigh not less than 125 or more than 300 pounds per foot of rolling width for each axle. It shall be operated approximately parallel to the contour of slopes.

B. Watering Equipment. Equipment shall apply water as specified without operating on the slopes. Water tanks shall be calibrated. If a sprinkler type irrigation system is used, the Contractor shall furnish approved equipment for metering the water.

C. Fertilizer Equipment. Equipment shall conform to Subsection 234.03 B.

D. Sprigging Equipment.

1. *Sprig Harvester.* This machine shall have been designed and manufactured to harvest sprigs. It shall excavate sprigs from the soil, remove excess adhering soil and load the clean sprigs into a trailing vehicle having solid sides, all in one simultaneous operation.

2. *Sprig Planter for Broadcast Sprigging.* This machine shall have been designed and manufactured to broadcast and plant sprigs. It shall be equipped with an adjustable mechanism for accurately distributing sprigs at specified rates on the surfaces to be planted. It shall be equipped with straight disks spaced on 2-inch centers on tandem axles. The rear disk

wheels shall be placed so they trail between the front disks. The machine shall have an accurate and adjustable mechanism for adjusting the depth of sprig placement. The broadcasting and pressing operation shall be performed simultaneously.

3. *Sprig Planter for Row Sprigging.* The equipment for row planting of sprigs shall automatically open the furrows, place the sprigs in the furrow, then cover the sprigs and furrow with soil all in one continuous operation.

230.04 CONSTRUCTION METHODS.

A. Solid Slab Sodding Operations.

1. Preparation of areas to be sodded shall include filling, reshaping of eroded areas, cleaning ditches, refinishing slopes and medians to the established typical grading section.

2. The area shall be cleared of all litter and debris.

3. The location, placement and seasonal requirements for areas to be solid slab sodded will be as shown on the Plans.

4. The slabs of sod shall be placed soil side down. They shall be placed in rows, which on slopes shall run parallel to the roadway. Each slab shall fit tightly against the edge of adjoining slabs and shall be placed so that the vertical joints are not continuous across adjoining horizontal rows. Voids shall be filled with additional sod. All slabs shall be thoroughly pressed into firm contact with the soil beneath.

5. After the slabs have been placed, the sodded area shall be thoroughly watered. When sufficiently dry, additional voids shall be filled with good soil and watered again. The area shall then be watered daily for a period of at least 7 days after placement. Remaining watering operations shall conform to Subsection 230.04 G.

6. Fertilizer shall be applied in accordance with Subsection 230.04 H.

B. Mulch Sodding Operations.

1. Preparation of areas to be mulch sodded shall include filling, reshaping eroded areas, cleaning ditches and refinishing slopes and medians to the established typical grading section.

2. Prior to placing the mulch sod, the cut and fill slopes shall be tilled to a depth of at least 4 inches.

3. The sod shall be placed on the prepared areas and spread uniformly to such a depth that when thoroughly compacted, with a roller conforming to Subsection 230.03, a thickness of 3 inches shall be obtained. Rolling of slopes shall be carried out along approximate contour lines unless otherwise directed.

4. The mulch areas shall be watered immediately after rolling. The remaining watering operation shall conform to Subsection 230.04 G.

5. Fertilizer shall be applied in accordance with Subsection 230.04 H.

C. Mulch Sprigging Operations.

1. Preparation of areas to be mulch sprigged shall be thoroughly tilled to a depth of at least 4 inches and all foreign material removed.

2. Fertilizer shall be applied in accordance with Subsection 230.04 H.

3. Mulch sprigging material shall be spread over all areas where topsoil exists at the rate of one cubic yard of material per 24 square yards or approximately 1.5 inches thick. All dried out material will be rejected.

4. Immediately after spreading, the mulch sprigging material shall be thoroughly disked into the surface without disturbing the uniform distribution.

5. After disking, the area shall be rolled along the approximate contour lines with a corrugated roller, as specified in Subsection 230.03, until the surface presents a level appearance. In inaccessible places and locations where rolling is impracticable, the Contractor shall hand tamp such areas in an acceptable manner. Tooth harrows, rakes, drags with spikes and other implements which would tear out the sprigs shall not be used.

6. The areas shall be watered immediately after rolling.

D. Row Sprigging Operations.

1. Preparation of areas to be row sprigged shall consist of tilling the specified areas to a depth of at least 4 inches with an offset disk plow or a tandem disk plow.

2. Fertilizer shall be applied in accordance with Subsection 230.04 H.

3. The sprigs shall be planted with an automatic sprig planter conforming to Subsection 230.03 except that hand planting may be used in areas where the sprig planter cannot operate. The sprigs shall be planted in furrows

parallel to the approximate contour lines of the slopes. The distance between furrows shall not exceed 20 inches on centers. The sprigs shall be placed approximately 3 inches deep at the rate of approximately 30 bushels per acre with the ends of sprigs meeting or overlapping.

4. The sprig planter shall not be operated in excess of 4 miles per hour.

5. Immediately following planting, the soil shall be compacted by rolling. The rolling of slopes shall be along approximate contour lines. All sprigged areas shall be rolled the same day they are planted.

6. The row sprigged areas shall be watered immediately after rolling. The remaining watering operation shall conform to Subsection 230.04 G.

E. Broadcast Sprigging Operations.

1. *Broadcast Sprigging Method A.* Preparation of areas for Broadcast Sprigging Method A shall consist of tillage with either a tandem disk plow, or an offset disk plow until the areas are suitable for sprig planting. The depth of tillage shall be approximately 6 inches. If rains or other conditions should pack the soil before being planted, the tillage shall be repeated. At least 80 bushels of sprigs shall be planted per acre unless otherwise shown on the Plans.

The sprigs shall be broadcast evenly and uniformly on the soil surface and immediately pressed into the soil. The planting depth mechanism shall be adjusted to cause the disk wheels to penetrate 4 inches deep. Within two hours after the sprigs have been planted, the areas shall be disked to a depth of approximately 3 inches with either a tandem or offset disk plow.

2. *Broadcast Sprigging Method B.* At least 12 bushels of sprigs shall be thoroughly incorporated into 100 cubic yards of stockpiled Method B salvaged topsoil. A method approved by the Engineer shall be used to meter and distribute the sprigs into the stockpiled topsoil. During the mixing operation, both the soil and sprigs shall be kept moist. Preparation of areas for Broadcast Sprigging Method B shall consist of scarifying on the contour, with approved equipment, the designated areas shown on the Plans prior to placing the soil-sprig mixture.

The soil-sprig mixture shall be spread on the designated areas 5 inches thick, within 4 hours of manipulation.

3. *Fertilizing, Rolling and Watering*. The following procedures shall be used for both Method A and Method B of Broadcast Sprigging:

a. Fertilizer shall be applied in accordance with Subsection 230.04 H.

b. The planted areas shall be rolled and compacted with equipment conforming to Subsection 230.03 A. Rolling of slopes shall be along approximate contour lines and in a manner approved by the Engineer.

c. The sprigged areas shall be watered immediately after rolling. Remaining watering operations shall conform to Subsection 230.04 G.

F. Planting Season and Weather Restrictions.

1. Permanent erosion control operations shall be performed only during the seasonal periods shown on the Plans. As cut and fill sections are brought to grade and constructed to the lines and dimensions shown on the typical sections, the salvaged topsoil shall be promptly placed, finished and the specific erosion control item or items shall be constructed, if in accordance with seasonal limitations, as shown on the Plans. Regardless of the dates specified, the work shall be suspended during excessively wet or dry weather conditions that would cause unsatisfactory results.

2. This work shall begin promptly and shall proceed without undue delay until completed or until interrupted by the out-of-season period. When construction of an operation is interrupted by the out-of-season period, construction shall be resumed immediately with the beginning of the in-season period for that operation. During the out-of-season period, the Contractor shall be responsible for repair and maintenance as specified in Subsection 230.04 I.

3. Temporary erosion control operations shall be applied on all cuts, fills, and other disturbed erodible areas where the permanent operation was interrupted by seasonal limitations. This work shall begin immediately after placement of topsoil or as otherwise directed by the Engineer and shall continue without undue delay.

G. Soil Moisture Requirements.

1. Soil moisture shall exist throughout the zone from one inch below the surface to at least 5 inches below the surface at the time of planting. The required moisture content of the soil may be estimated and judged closely by the hand-squeeze test. The soil should readily form a tight cast when squeezed in the hand. The cast should break into two pieces without crumbling and without leaving excess water on the hand after casting.

2. Sodded or sprigged areas shall be watered for 30 days after planting unless otherwise directed. The depth of watering with moving equipment shall be carried out on short sections until the soil is moist throughout the top one inch.

3. The application rate and fineness of the spray shall be adjusted according to wind velocity to provide uniform infiltration without appreciable erosion or excessive runoff.

H. Fertilizer Operations.

1. Fertilizer shall not be placed on hard or glazed surfaces. Fertilizer shall be applied at the rates shown on the Plans, but shall not exceed one (1) pound actual nitrogen per 1000 sq. ft.

2. When satisfactory results can be obtained, disking for soil preparation, weed removal, and incorporation of fertilizer may be accomplished in one operation.

3. If a fertilizer containing phosphorous is specified, one-half of the fertilizer shall be applied before placement of solid slab sod, mulch sod, mulch sprigging, row sprigging or broadcast sprigging and shall then be incorporated into the soil by disking. After placement and compaction of the sod, the remaining one-half of the fertilizer shall be applied and immediately incorporated into the soil with water.

4. Fertilizer containing nitrogen only shall be applied after the sodding and sprigging operations have been completed.

I. Repair and Maintenance. The Contractor shall be responsible for repairs and maintenance of areas designated for sodding or sprigging until all work on the Contract or designated portion thereof has been completed and approved for final acceptance.

1. *Repair.* This work shall include recovery, replacement and compaction of soil that has been removed by erosion, filling and reshaping eroded areas, cleaning ditches, and refinishing slopes and medians to the approximate typical grading section shown on the Plans or as determined by the Engineer. Repair shall include re-sodding or sprigging, re-fertilizing, and watering damaged areas, which shall be performed during the specified planting season.

2. *Maintenance.* This work shall consist of weed control by mowing, hand cutting, herbicides, or other approved methods. Weed growth on sodded areas shall be removed as often as determined by the Engineer. If herbicides are used, they shall be used in accordance with label instructions and shall have prior approval from the Engineer. Mowing shall be in accordance with Section 241.

230.05 METHOD OF MEASUREMENT.

A. Solid Slab Sodding, Mulch Sodding, Mulch Sprigging, Row Sprigging, Broadcast Sprigging Method A and Method B, will be measured by the square yard of sodded area.

B. Watering will be measured by the 1,000 gallons of water. The water will be measured as delivered in calibrated tanks, or by pipe line with a reasonably accurate method of measuring.

C. Fertilizer will be measured and paid for in accordance with Section 234.

D. Mowing, when directed by the Engineer, shall be measured and paid for in accordance with Section 241.

230.06 BASIS OF PAYMENT. Accepted sodding, measured as provided above, shall be paid for at the contract unit price for:

Solid Slab Sodding	Sq. Yd.
Mulch Sodding	Sq. Yd.
Mulch Sprigging	Sq. Yd.
Row Sprigging	Sq. Yd.
Broadcast Sprigging (Method A)	Sq. Yd.
Broadcast Sprigging (Method B)	Sq. Yd.
Watering	M. Gal.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

231.00 PLANTING

231.01 DESCRIPTION. This work shall consist of furnishing, handling, planting and establishing plant materials in accordance with these Specifications and in reasonably close conformity with the areas and locations shown on the Plans or established by the Engineer.

231.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Plant Materials	735.03
Planting Soil Mix	735.03
Vegetable Compost	735.03
Asphaltum Tree Paint	735.03
Tree Wrap	735.03

Water shall be free from harmful quantities of toxic salts or other substances that might interfere with the establishment and growth of plants.

231.03 EQUIPMENT. The Contractor shall furnish equipment meeting the requirements of Subsection 108.06 and as prescribed herein.

The Contractor shall furnish an approved tree digging machine for the machine planting of trees with all the necessary accessories capable of digging, lifting, carrying and depositing into an excavation (previously dug by the same or identical type machine), a plant, intact, without damage to the ball of soil or the plant.

231.04 CONSTRUCTION METHODS.

A. General.

1. All work shall be performed under the supervision of a competent and experienced nurseryman.

2. The Contractor shall take adequate precautions to protect all new plants and existing trees, shrubs, and turf from damage or injury before, during and after construction and plant establishment operations.

3. Bare-rooted plants will be designated by BR and the balled and burlapped plants by B&B. Canned plants are those which are container grown.

B. Care and handling of Plants.

1. While BR or B&B plants are being transported to the project site, moved to and from the heeling-in beds, being distributed in planting beds, or awaiting planting after distribution, the Contractor shall protect the roots and balls from drying out.

2. BR plants, if not planted within 2 hours after delivery to the project site or planting location shall be heeled-in, in moist soil or sawdust in accordance with acceptable horticultural practices.

3. B&B plants, if not planted within 24 hours after delivery to the project location, shall have the balls adequately protected with moist soil or sawdust until removed for planting.

4. Containerized plants shall be protected in the same manner as B&B plants.

5. All heeled-in plants shall be properly maintained by the Contractor until planted. Plants remaining heeled-in during the summer will not be acceptable.

6. In digging, loading, unloading, planting and other handling operations, the Contractor shall exercise utmost care to prevent injuries to the roots, stems or branches of the plants. The solidity of the ball of the B&B plants shall be carefully preserved. B&B plants shall be handled by the rootball, not by the stems or trunk. The Contractor shall replace, at his own expense, any plants that are rendered unfit for planting.

7. Collected plants shall be dug with extreme care in a manner satisfactory to the Engineer. Digging, transporting and replanting of collected plants shall be performed in accordance with acceptable horticultural practices. An approved tree digging machine may be used to dig, transport and plant collected plants.

8. Unless plants are dug, transported and planted by approved tree-digging machines, all evergreens shall be balled and burlapped (B&B) except when they are container (canned) grown and are still in the container. Deciduous plants may be either B&B, BR, or canned, as specified on the Plans.

C. Seasonal Planting Restrictions.

1. Planting operations for deciduous plants shall be restricted to the period from November 25th to the following March 31st and the planting operations for evergreen plants shall be restricted to the period from October 1st to the following May 15th.

2. Regardless of the specified planting dates, the work shall be suspended when the temperature is below 25° F., the wind velocity over 25 miles per hour, the natural ground or topsoil is frozen or too wet, or the continuation of prevailing weather would likely cause unsatisfactory results.

3. The Contractor shall complete his planting operations as early in the specified season as practicable.

4. Plants that do not meet specifications for any reason after planting shall be removed immediately, and if within the current planting season, be replanted immediately, or if out of planting season, be replanted the following season all in accordance with these Specifications.

D. Plant Locations.

1. The plant locations shown on the Plans are approximate and may be adjusted to suit actual field conditions as determined by the Engineer.

E. Plant-Hole Excavation.

1. Unless plant holes are dug with an approved tree digging machine, all plant holes shall be cylindrical in shape with approximately vertical sides. Excavations in rocky subsoil or any impervious material that would hamper proper drainage and would likely retard normal root development and growth shall be loosened by methods approved by the Engineer.

2. Holes shall be excavated sufficiently deep to provide space for at least 6 inches of planting soil mix below the roots or balls as the case may be, and to let the plant in its final position stand slightly deeper than it stood in the nursery or collecting field. Regardless of the minimum size holes shown in the following table for BR plants, the diameters shall be large enough to allow at least 8 inches of backfill between the outside tip of fully spread roots and the sides of the hole.

SIZE OF PLANT (Inches)	MINIMUM SIZE OF HOLE EXCAVATION (Inches)	
	DIAMETER	DEPTH
Trees up to 1 in. caliper	36	30
Trees up to 2 in. caliper	44	36
Trees over 2 in. caliper	15x caliper	12x caliper
Shrubs 24-36 high or smaller	30	18
Shrubs 36-48 high or larger	36	18
Roses or Vines	18	18

Caliper determinations shall be in accordance with current USA Standard for Nursery Stock USAS Z 60.1. The minimum size holes for B&B plants are as follows:

BALL DIAMETER (Inches)	MINIMUM HOLE DIAMETER (Inches)
Less than 12 More than 18	Ball diameter 16 Twice the ball diameter
BALL HEIGHT (Inches)	**MINIMUM HOLE DEPTH (Inches)**
Less than 18 More than 18	Ball height 8 Ball height 10

3. Plant holes for potted or canned plants shall be 3 times the diameter of the container and 6 inches deeper than the height of the container, unless otherwise specified on the Plans.

4. When plants are to be grouped together in a plant bed, the entire area of the plant bed shall be loosened and clods broken to a depth of at least 6 inches prior to excavating plant holes.

5. Excess material from plant-hole excavations shall be thinly spread over the surrounding area, forming a neat appearance. Material of such a nature that cannot be spread shall be disposed of in a manner approved by the Engineer.

F. Pruning.

1. Before planting, the root systems of all BR plants shall be examined and any bruised or broken parts shall be cut off smoothly.

2. The tops of all plants shall be pruned in accordance with acceptable horticultural practices, as determined by the type, shape, size and condition of the plant.

3. All cut surfaces one inch or larger in diameter shall be painted with approved orange shellac.

G. Planting Procedures.

1. The subsoil in the bottom of the plant hole shall be loosened 6 inches deep. Then a layer of planting soil mix 6 inches or more in depth shall be placed and firmed in the bottom of the hole, to provide correct final planting elevation, before the plant is placed.

2. The plant shall then be placed in the prepared hole at the proper position with regard to depth, alignment, final grade of surrounding ground level, and vertical placement of the trunk or stems and this position shall be maintained during all subsequent backfilling and watering operations. The plants shall stand, at the time of completion of the planting operation slightly deeper than they stood in the nursery or collecting field, except that spreading evergreen plants shall stand slightly higher than stood in the nursery.

3. After BR plants are placed in the proper position, the hole shall be backfilled with friable planting soil mix conforming to Subsection 735.03 which shall be placed in thin layers and carefully worked and firmed around the roots in such a manner as to avoid bruising or breaking the roots.

4. When ½ to 2/3 of the backfilling has been completed, sufficient water shall be applied to settle the soil mix. The soil mix shall not be saturated to the extent of filling voids and excluding all oxygen from around the roots. After sufficient water absorption has occurred the remainder of the hole shall be filled as previously specified.

5. B&B plants shall be handled by the ball and placed in the hole in such a manner that the soil of the ball shall not be loosened from the roots. Backfilling, firming and settling shall be carefully done in the same manner as specified for BR plants. Just before the final backfilling above the top of the ball, the burlap shall be loosened or cut away from around the stem, the edges laid back and the plant thoroughly watered.

6. On relatively flat areas, a shallow saucer-like depression shall extend from around the plant to 18 inches outside the plant hole. On steeper slopes, a ridge of firmly compacted soil, of sufficient plasticity to withstand washing and approximately 6 inches high, shall be constructed 18 inches outside and around the lower half of the plant hole.

7. Upon completion of planting operations, an area extending 18 inches outside the original plant hole, shall be loosened by spading to a depth of 6 inches. Care shall be taken during spading to prevent injury to plant roots.

H. Vegetable Compost.

1. A 2-inch covering of approved vegetable compost, conforming to Subsection 735.03, shall be placed over the entire spaded area around each plant. When plants are placed in beds, the entire bed shall receive a covering of the compost. This compost shall be maintained as fine textured mulch around the plants until acceptance of the project.

I. Water.

1. Water, in sufficient quantity, shall be furnished and applied by the Contractor, whenever necessary, to keep the plants in a live and healthy condition, from the time of delivery to the final acceptance at the end of the plant establishment period. Plants replanted the following season shall be watered sufficiently to become established.

J. Wrapping.

1. All deciduous trees shall be wrapped with an approved tree wrap as specified in Subsection 735.03. The wrap shall begin just below the ground-line and be wrapped spirally up and around the trunk, much the same way as surgical bandage is applied, at an angle that permits sufficient overlap to make a double thickness. The wrap should extend up to and over the lowest main branch and shall be firmly and securely fastened to the trunk with binder twine wound in the opposite direction of the wrap.

K. Staking.

1. All trees shall be staked as show on the Plans. Staking shall be performed immediately following application of vegetable compost and shall present a neat appearance. Precautions shall be taken during staking operations to prevent damage or injury to the plants and roots.

L. Plant Establishment Period and Replacements.

M. The acceptability of the plant material furnished and planted as specified shall be determined at the end of a period of establishment. The Contractor shall employ all possible means to keep the plants in healthy growing condition during the life of the Contract. The plant establishment period shall be from the initial planting season to the following October 1st. Good horticultural practices during the establishment period may include spraying for insects and disease control, watering, pruning, cultivating, adjustment of guys and stakes and such other work as ordered by the Engineer. Dead, damaged or otherwise unacceptable plants shall be promptly removed from the project and if during the current planting season shall be replaced and planted during the current planting season. Plants removed during the establishment period shall be replaced and planted during the following planting season. A semifinal inspection by the Contractor and the Engineer will be held to determine the acceptability of the plant material 15 days before the end of the full growing season. During the next planting season following completion of spring or fall planting, all dead and unsatisfactory plants shall be replaced in kind or quantity and size with live healthy plants installed as originally specified. Alternate or substitute varieties of plants shall be used only if approved by the Engineer. When replacement plantings are necessary in the following planting

season, the final inspection of the replaced plants shall be at least 30 days after planting.

N. Method of Determining Progress Percentages.

1. When all plants are planted on the project during the initial planting season, the Contractor will have completed 50 percent of the Contract work.

2. If in the opinion of the Engineer, the Contractor has performed all necessary work during the establishment period, as specified in (1) above, an additional 20 percent of the Contract work will have been completed by July 1 and an additional 20 percent by September 1.

3. The remaining 10 percent of the Contract work will be considered complete when the work is accepted.

O. Carryover of Work not Completed During Specified Season.

1. If any of the proposed planting items are not completed at expiration of the initial planting season, planting work on the uncompleted items shall stop immediately, and the period during which the planting may be performed, regardless of the reason for failure to complete work, will not be extended. The work shall be carried over and completed the following planting season in accordance with these Specifications and the Plans.

2. During the carryover period, the Contractor shall be responsible for maintenance of planted areas and plant material. This work shall be as described in Subsection 231.04 L.

3. Time will be charged from the beginning of the following planting season until all carryover work is planted. Time will not be charged during the period from October 1st to November 25th for deciduous plants, or when replanting only is involved.

P. Machine Planting of Trees. For machine planting of trees the following additional requirements shall apply.

1. *Digging.* Excavated plants shall have a ball of soil encompassing their root systems. The size of the balls of all plants shall conform to the recommended specifications of ANSI-Z-60.1, Nursery Stock.

2. *Transporting.* The plants shall be transported from the nursery to their new locations on the project by the same machine that dug them.

3. *Transplanting.* Trees to be transplanted shall be placed in holes previously dug by the same or identical type machine. The top of the ball shall be placed in its final position at a slightly lower elevation than the existing surrounding ground. After the machine is removed, and any necessary backfill is applied, the plant shall be thoroughly watered and mulched, then staked as shown on the Plans.

231.05 METHOD OF MEASUREMENT. Live and healthy plants in satisfactory condition will be measured by each and the quantities to be paid for under this item will be the number of each kind of: (A) trees, (B) shrubs, (C) vines or ground covers, and (D) trees—machine planted.

231.06 BASIS OF PAYMENT. Accepted planting, measured as provided above, will be paid for at the contract unit price for:

(A)	Trees (Kind)	Ea.
(B)	Shrubs (Kind)	Ea.
(C)	Vines or Ground Covers (Kind)	Ea.
(D)	Trees—Machine Planted (Kind)	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

232.00 SEEDING

232.01 DESCRIPTION. This work shall consist of seed bed preparation, furnishing and planting seeds in accordance with these Specifications and in reasonably close conformity with the areas and locations shown on the Plans or established by the Engineer.

232.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Seed	735.04
Fertilizer	735.07

Water shall be free from harmful quantities of toxic salts or other substances that might interfere with the establishment and growth of turf.

232.03 EQUIPMENT. The Contractor shall furnish equipment in satisfactory working condition, and in sufficient quantity to perform the work as specified. The equipment shall be on the project site and approved by the Engineer before work on the corresponding item begins.

A. Hydraulic Seeder.

1. This equipment shall be factory designed and built with sufficient pump capacity to apply specified quantities. The tank shall hold a minimum of 1,000 gallons and be equipped with a mechanical agitation system with an operating capacity sufficient to suspend and homogeneously mix the seed and water. The distribution hoses shall be large enough to prevent clogging and be equipped with spray nozzles that will provide even distribution on designated areas.

2. The equipment shall be mounted on a traveling unit, which may be either self-propelled or pulled, capable of getting the tank and nozzles within sufficient proximity of the area to be seeded without the wheels operating on the areas to be seeded.

B. Grass Seed Drill. **The drill shall be an approved native grass seed drill,** which shall be equipped with two separate planter boxes and planting mechanisms which will plant large chaffy seed and fine clean seed simultaneously. The drill shall be equipped with a mechanism for accurately adjusting the rate of seed flow. The drill shall be equipped with double-disk openers designed to open furrows on 8-inch or less centers, with each disk having a depth regulating band one-inch from the disk edge.

Each furrow opener shall be equipped with heavy press wheels to firm the soil behind the opener and leave the seed covered to an average depth of ½ to ¾ inch.

C. Corrugated Roller Seeder. The seeder shall be equipped with corrugated roller wheels mounted on tandem axles. The roller wheels shall be spaced on approximately 2-inch centers and shall place the seed at a depth of ¼ to ½ inch. The seeder shall be equipped with two separate planter boxes and planting mechanisms, which will plant clean, fine seed and large, chaffy seed simultaneously. The seed shall also be equipped with a mechanism for accurately adjusting the rate of seed flow. The seeder shall weigh approximately 125 to 250 pounds per linear foot of rolling width.

D. General. Rolling, fertilizing and watering equipment shall meet the requirements of Subsection 108.06.

232.04 CONSTRUCTION METHODS.

A. Seed Bed Preparation.

1. Preparation of areas to be seeded shall include filling and reshaping eroded areas, cleaning ditches, refinishing slopes, and medians to the established typical grading sections. All live plants shall be eliminated by mowing and disking.

2. Thick layers of previously applied mulching materials or residues of vegetation shall be completely incorporated into the soil by disking, unless otherwise directed. Soil shall be tilled on the contour to a depth of 4 inches. All clods larger than 1 inch in diameter shall be crushed and then packed. The tillage shall consist of disking, harrowing and rolling. Where necessary, water shall then be applied.

3. When hydraulic seeding is specified, the seed bed surface shall be left rough or made sufficiently rough before seeding.

B. Planting Methods.

1. General. All seed shall be planted uniformly at the specified rate. When several species are specified and cannot be combined due to different characteristics such as size, weight, hulled or unhulled, the seed shall be planted separately to obtain the specified seeding rate. Equipment shall not be operated on areas where rutting or slippage would mar the soil surface.

2. Seeding Method A – Hydraulic Seeder Method. The seed shall be placed in water in the spray tank of a hydraulic seeder conforming to Subsection 232.03 A. The seed shall then be distributed uniformly by power spraying through a suitable nozzle. Inoculants for legumes, if specified, may be placed in the spray tank with the seed in accordance with approved methods. The seed loaded into 1,000 gallons of water in the spray tank shall not exceed the quantity specified for two acres. If less than 1,000

gallons of water is used, the amount of seed, other specified materials, and the area seeded per load shall each be reduced in proportion to the water.

3. *Seeding Method B – Grass Seed Drill Method.* The seed shall be planted with a grass seed drill conforming to Subsection 232.03 B. All drilling shall be carried out on the approximate contour lines.

4. *Seeding Method C – Corrugated Roller Seeder Method.* The seed shall be distributed with a corrugated roller seeder conforming to Subsection 232.03 C. that has been adjusted to accurately apply the specified quantities. Planting on slopes shall be along the approximate contour lines.

5. *Hand Broadcasting Method.* Hand broadcasting shall not be used except in areas that are too small or inaccessible to accommodate the specified equipment.

C. Planting Season and Weather Restrictions.

1. Permanent erosion control operations shall be in accordance with Subsection 230.04 F.

D. Soil Moisture and Watering Requirements.

1. Soil moisture shall exist throughout the zone from 1 inch to at least 5 inches below the surface at the time of planting. The required moisture content of the soil may be estimated and judged closely by the hand squeeze test. The soil should readily form a tight case when squeezed in the hand. The cast should break into two pieces without crumbling and without leaving excess water on the hand after casting.

2. Watering of the areas seeded shall be performed if called for on the Plans or as determined by the Engineer.

E. Fertilizer Application.

1. Fertilizer application shall be in accordance with Section 234 and the following requirements.

2. When a fertilizer with 0 percent nitrogen, but containing either phosphoric acid or potash (0-20-20 or 0-46-0) is specified, it shall be spread on the soil surface and then thoroughly incorporated into the soil by disking. This operation may be performed as a part of seed bed preparation.

3. When a fertilizer containing a percentage of all three nutrients, nitrogen, phosphoric acid and potash (10-20-10), or a fertilizer containing only

nitrogen (33.5-0-0) is designated for seeding; the application of the fertilizer shall be delayed for at least 30 days but not more than 60 days after the seeding operation has been completed.

F. Repairs and Maintenance.

1. *General.* The Contractor shall be responsible for repairs and maintenance of areas designated for seeding until all work on the Contract or designated portion thereof has been completed and approved for final acceptance.

2. *Repair.* This work shall include the restoration of all eroded areas to the approximate typical grading section shown on the Plans or as determined by the Engineer. Repair shall include seeding, fertilizing, and watering damaged areas, which shall be performed during the specified planting season.

3. *Maintenance.* This work shall consist of weed control by mowing, hand cutting, herbicides, or other approved methods. Weed growth on sodded areas shall be removed as often as determined by the Engineer. If herbicides are used, they shall be used in accordance with label instructions and shall have prior approval from the Engineer. Mowing shall be in accordance with Section 241.

232.05 METHOD OF MEASUREMENT.

A. Seeding will be measured by the acre. Work and material used in repair of seeding will not be measured for payment.

B. Watering will be measured by the 1,000 gallons of water. The water will be measured as delivered in calibrated tanks or by pipelines with a reasonably accurate method of measuring. Water used as a carrier for seed in hydraulic seeding operations is considered subsidiary to seeding and will not be measured for payment.

C. Fertilizer will be measured and paid for in accordance with Section 234.

D. Mowing will be measured and paid for in accordance with Section 241.

232.06 BASIS OF PAYMENT. Accepted seeding, measured as provided above, will be paid for at the contract unit price bid for:

(A)	Seeding Method A	Ac.
(B)	Seeding Method B	Ac.
(C)	Seeding Method C	Ac.
(D)	Watering	M. Gal.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

233.00 MULCHING

233.01 DESCRIPTION. This work shall consist of furnishing, applying and fastening mulching materials on the soil surface in accordance with these Specifications and in reasonably close conformity with the areas and locations shown on the Plans or established by the Engineer.

233.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials. These materials can be used either as a temporary protective item or as protective mulch for seeded, sodded or planted areas.

Vegetative Mulch	735.05 A.
Fiber Glass Rovings	735.05 B.
Asphalt Mulch	735.05 C.
Excelsior Mat	735.05 D.
Jute Mesh	735.05 E.
Excelsior Mulch	735.05 F.
Wood Cellulose Fiber	735.05 G.
Mulch Fasteners	735.06

233.03 EQUIPMENT. The Contractor shall furnish equipment in accordance with Subsection 108.06.

A. Equipment for Vegetative & Excelsior Mulch.

1. *Adhesive Spray Method.* The machine for applying and fastening Vegetative and Excelsior Mulch shall have a blower mechanism for distributing the vegetative material and an asphalt pump for distributing the asphalt. The discharge pipe of the blower and the discharge nozzles of the asphalt hoses shall be arranged so that the asphalt is evenly distributed into the mulch as it emerges from the blower discharge spout. The asphalt hoses shall have suitable valves and nozzles to provide distribution of the asphalt at the prescribed rate. Sufficient power shall be provided on the machine to operate the asphalt pump and the mulch blower and distribute the asphalt-bound mulch over the designated areas at the required rate with a single pass of the machine. The beater mechanism shall be adjusted so that the stem lengths are not materially shortened.

2. *Mulching Tiller Method.* The machine for applying vegetative or excelsior mulch shall be the same as specified for the Adhesive Spray Method, except that the asphalt pump and accessories may be omitted. The mulching tiller shall be a heavy disk-type roller, having flat disks about ¼ inch thick and spaced not more than 12 inches apart.

B. Equipment for Fiber Glass Rovings.

1. Pneumatic ejector capable of applying roving at a minimum rate of two pounds per minute.

2. Air compressor capable of supplying at least 40 CFM at 80 to 100 psi with sufficient air hoses to reach designated areas.

3. Asphalt distributor or equipment meeting the requirement for the vegetative mulching equipment in Subsection 233.03 A. above may be used.

C. Equipment for Wood Cellulose Fiber Mulch.

1. The hydraulic equipment used to apply wood cellulose mulch shall be factory designed and built with sufficient pump capacity to apply specified quantities. The slurry tank shall hold a minimum of 1,000 gallons and be equipped with a mechanical agitation system with operating capacity sufficient to suspend and homogeneously mix the mulch and water. The slurry distribution hoses shall be large enough to prevent clogging and be equipped with spray nozzles that will provide even distribution of the slurry on designated areas.

2. The equipment shall be mounted on a traveling unit which may be either self-propelled or pulled, capable of getting the tank and nozzles within sufficient proximity of the area without tracking into the mulching area.

D. Equipment for Asphalt Mulch.

1. The distributor equipment shall be equipped with a pressure gauge and accurate volume measuring device or a calibrated tank. Also, the distributor shall be equipped with a power unit for the pump, and a full circulation, adjustable, spray bar and hand operated spray bar.

2. A check of distribution rate and uniformity of application shall be made when directed by the Engineer.

E. Equipment for Jute Mesh.

1. A lightweight, smooth roller (lawn type) shall be used to press the mesh into direct contact with the soil.

233.04 CONSTRUCTION METHODS.

A. Mulching Operation.

1. When the mulch material is used as a temporary protective item, eroded areas shall be repaired and the ground shall be cleared of all debris that would hinder the even application of the mulching material.

2. When the mulch material is used as a protective mulch over seeding or sodding, it shall be applied within 24 hours after an area is seeded or sodded. If mulched areas become damaged, the area shall be reshaped and then sodded or seeded and mulched again as originally specified.

3. Mulching operations shall not be performed during weather that would result in non-uniform application or waste of material.

B. Type of Application.

1. Adhesive Spray Method for Excelsior and Vegetative Mulch.

The vegetative or excelsior mulch shall be broadcast into a continuous, unbroken cover of approximate uniform thickness. The vegetative mulch shall be applied at the rate of 2 tons per acre. During the spreading operation, the adhesive material shall be ejected simultaneously into the mulch at the mulch blower discharge spout, giving a uniform distribution on the mulching material. Emulsified asphalt, SS-1 shall be used unless otherwise specified on the Plans at the rate of 200 gallons per acre. If other types of fasteners are to be used, the type and quantity will be shown on the Plans. To avoid displacement of mulch by wind, a bank of soil or a complete coverage of asphalt shall be placed along the edge of the mulched area. Clumps of excess material shall be removed promptly.

2. Mulching Tiller Method for Excelsior and Vegetative Mulch.

The mulching materials shall be uniformly spread as specified in the Adhesive-Spray Method. The rates of application shall be 2.5 tons of vegetative mulch per acre or 2 tons of excelsior mulch per acre. Following closely behind the mulch spreading operation, a tiller shall be rolled over the mulched area, pressing the material into the soil approximately 3 inches. Dry, impermeable soil shall be tilled with a disk plow to the degree necessary to permit the 3-inch incorporation. When mulching loose sandy soil, precautions shall be taken not to incorporate an excess amount of the mulch into the soil. When mulching slopes, the tiller shall be operated along the contour of the slope.

3. *Asphalt Mulching.*

The mulching asphalt shall be diluted with 3 parts water to one part emulsified asphalt. 1.25 gallons of the mixture shall be applied per square yard of ground surface, unless otherwise specified. If soils to be mulched are impervious and cause appreciable mixture runoff, the water shall be reduced so that the specified quantity 0.3125 gallons per square yard of emulsified asphalt can be applied. When asphalt mulch is to be applied over sodded areas, the sod shall be watered immediately before applying the asphalt mulch.

4. *Wood Cellulose Fiber Mulch.*

Wood cellulose fiber mulch shall be applied at the rate of not less than 1,200 pounds of air dry material per acre. The quantity of water used in dispersing, suspending and applying the material shall be at the rate of 3.3 gallons of water to one pound of material. The cellulose fiber shall be applied to form an evenly distributed layer over the area. Seed, fertilizer, lime and other erosion control items shall be completed before applying cellulose material.

5. *Fiber Glass Rovings.*

Fiber glass roving shall be spread uniformly over the designated areas forming a mat of continuous fibers. It shall be applied at the rate of 0.25 to 0.35 pounds per square yard. The rovings shall be anchored with an adhesive fastener, emulsified asphalt (SS-1, undiluted as specified in Subsection 735.06) which shall be applied uniformly over the glass fiber at the rate of 0.18 to 0.25 gallons per square yard. If watering is specified for the seeded or sodded areas, it shall be done prior to the application of the adhesive fastener and after the rovings are in place. When used as a protective device in slope drains and ditches, the upstream edge shall be buried 4 inches below the flow line.

6. *Excelsior Mat.*

The mat shall be placed as shown on the Plans so that the fibers are in contact with the soil and the netting is on the top. Each strip of mat shall be placed parallel to the direction of the flow of water.

7. *Jute Mesh.*

When jute mesh is used over sodded or sprigged areas, it shall be placed prior to watering operations. Unless the hydro-seeding method is called for on the Plans, the jute mesh shall be placed after the seed or sod has been planted.

The mesh shall be placed and secured as shown on the Plans. The Contractor shall maintain the jute mesh covered areas until all work on the project is completed and accepted. Damaged slopes shall be reshaped to their original slope lines and shall be fertilized, seeded or sodded and covered with jute mesh again as originally specified.

233.05 METHOD OF MEASUREMENT. The mulching items will be measured as follows:

1. Vegetative mulching, excelsior mulching, and wood cellulose fiber will be measured by the acre.

2. Asphalt mulching will be measured by the gallon of undiluted emulsified asphalt.

3. Fiberglass rovings, excelsior mat and jute mesh will be measured by the square yard of area covered.

233.06 BASIS OF PAYMENT. Accepted mulches, measured as provided above will be paid for at the contract unit price for:

(A)	Vegetative Mulching	Ac.
(B)	Excelsior Mulching	Ac.
(C)	Asphalt Mulching	Gallon
(D)	Wood Cellulose Fiber	Ac.
(E)	Fiber Glass Rovings	Sq. Yd.
(F)	Excelsior Mat	Sq. Yd.
(G)	Jute Mesh	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

234.00 FERTILIZING AND AGRICULTURAL LIMING

234.01 DESCRIPTION. This work shall consist of furnishing and applying fertilizer or agricultural liming materials in accordance with these Specifications and in reasonably close conformity with the areas and locations shown on the Plans or established by the Engineer.

234.02 MATERIALS. Materials shall meet the requirements specified in the following subsections of Section 700 – Materials.

Fertilizer	735.07
Agricultural Limestone	706.04
Hydrated Lime	706.01

234.03 EQUIPMENT.

A. General.

The Contractor shall furnish equipment in satisfactory working condition and in sufficient quantity to perform the work as specified. The equipment shall be on the project site and approved by the Engineer before work on the corresponding item begins.

B. Fertilizer and Lime Spreaders.

1. Vertical Drop and Broadcast Type.

The machine for applying dry fertilizer or lime shall be an approved agricultural type spreader. It shall be capable of distributing the specified material uniformly on the designated area at specified rates of application without damaging the fertilizer granules or lime.

2. Power Spray.

The equipment for distributing fertilizer or lime in water shall comply with the specifications for Hydraulic Seeding, Subsection 232.03 A.

234.04 CONSTRUCTION METHODS.

A. General.

1. Unless otherwise indicated on the Plans, the lime or fertilizer shall be applied with the vertical drop or broadcast spreader. The lime or fertilizer shall not be applied during weather that would result in waste or poor distribution. When lime is specified, it shall be applied prior to or during the ground preparation for seeding or sodding and incorporated into the soil. These areas shall not be seeded or sodded for a minimum of 3 days.

B. Methods of Applying Fertilizer or Lime.

1. Vertical Drop or Broadcast Method.

The fertilizer or lime shall be applied uniformly at the specified rate with a spreader conforming to the requirements of Subsection 234.03. The equipment shall not rut or otherwise damage the prepared surface.

2. Power Spray Method.

The fertilizer or lime shall be applied in water at the rate shown on the Plans. The material shall be distributed without appreciable runoff. The maximum quantity of fertilizer placed in the spray tank with 1,000 gallons of water shall not exceed the quantity specified for two acres of seeding or sodding. The maximum amount of lime placed in the spray tank with 1,000 gallons of water shall not exceed the quantity specified for one acre of seeding or sodding. If less than 1,000 gallons of water is loaded into the spray tank, the quantity of fertilizer or lime loaded and the area treated per load shall be reduced in proportion to the water.

3. Hand Broadcast Method.

On areas inaccessible to large spreaders or power sprayers, the lime or fertilizer shall be applied with hand-operated equipment.

234.05 METHOD OF MEASUREMENT.

A. Fertilizing will be measured by the ton of specified material, as determined by approved scales or guaranteed weights of sacks shown by the manufacturer. If a substitute grade of fertilizer is furnished, the amount of material measured for payment will not exceed the amount called for on the Plans. Fertilizer used in repair of unacceptable work will not be measured for payment.

B. Agricultural limestone or agricultural hydrated lime will be measured by the ton, as determined by approved scales or by guaranteed weights of sacks shown by the manufacturer.

234.06 BASIS OF PAYMENT. Accepted fertilizing and agricultural liming, measured as provided above, will be paid for at the contract unit price for:

(A)	Fertilizing	Ton
(B)	Agricultural Limestone	Ton
(C)	Agricultural Hydrated Lime	Ton

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

240.00 REMOVAL OF TREES

240.01 DESCRIPTION. This work shall consist of removing trees where called for on the Plans and shall include cutting such trees, removing their stumps and roots, and properly disposing of the material.

This Specification is not intended to cover such as would be included under Clearing and Grubbing, Section 201 of these Specifications on ordinary highway work but is to cover only removal of trees on projects where specified on the Plans.

240.04 CONSTRUCTION METHODS. Trees shall be removed and disposed of in a manner approved by the Engineer. All stumps and roots shall be removed to a depth of not less than 12 inches below the finished sub-grade elevation.

240.05 METHOD OF MEASUREMENT. The size of trees will be determined by the average diameter of the tree trunk taken at a point measured four feet above the base of the tree at the ground line. The diameter will be measured to the nearest full inch.

240.06 BASIS OF PAYMENT. Trees to be removed under this item will be measured as provided above and will be paid for at the contract unit price per each tree in accordance with the following schedule of size:

(A)	Removing trees 6-12 inches in diameter	Ea.
(B)	Removing trees 13-18 inches in diameter	Ea.
(C)	Removing trees 19-24 inches in diameter	Ea.
(D)	Removing trees 25 inches in diameter	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Removing trees less than 6 inches in diameter will be considered as incidental work and will not be paid for directly, but the cost will be included in other items.

If the contract does not include a separate item for removing trees, then all work specified in this Section will be considered as incidental work and will not be paid for directly, but its cost will be included in other items.

241.00 MOWING

241.01 DESCRIPTION. This work shall consist of mowing designated areas to a height not less than 6 inches when, and as directed by the Engineer until acceptance of the Contract.

241.03 EQUIPMENT. Equipment used for mowing operations shall be mechanical and have a minimum cutting width of 5 feet.

241.04 CONSTRUCTION METHODS. Mowing shall be done only when the ground is sufficiently firm to prevent rutting. Any damage to the surface shall be repaired by the Contractor at no additional cost to the Department.

Litter, debris and excessive amounts of grass clippings of sufficient magnitude to smother or retard grass growth shall be removed from the areas as necessary to restore the sightliness of the areas. Mowing required for seed bed preparation shall be included in other items of work.

In areas inaccessible to mechanical mowers, hand cutting methods shall be used so the entire designated areas shall be uniform in appearance.

241.05 METHOD OF MEASUREMENT. Mowing, when directed by the Engineer, will be measured by the acre of mowing the designated areas in a manner approved by and accepted by the Engineer.

241.06 BASIS OF PAYMENT. Mowing, measured as provided above, will be paid for at the contract unit price for:

Mowing	Ac.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

300.00 BASES

301.00 GENERAL REQUIREMENTS FOR BASES

301.01 DESCRIPTION. This Section covers requirements common to all or designated types of base construction.

301.02 MATERIALS.

A. General. Unless otherwise shown on the Plans, the Contractor shall furnish all materials meeting the requirements of Section 300 Bases. The Contractor shall make such preliminary investigations as may be necessary to locate the proposed source of acceptable material.

B. Density. Standard density and field density of soils and aggregates shall be determined in accordance with Subsection 106.03 unless otherwise specified.

301.03 EQUIPMENT.

A. General. All equipment necessary for base construction shall meet the requirements of Subsection 108.06. The general requirements for certain types of equipment for base construction shall be that accepted by the industry which produce the quality of work specified.

B. Mixing Equipment.

1. Traveling Plants.

Traveling plants shall be approved types of either the single or multiple pass type which will thoroughly pulverize and mix the materials of the job-mix formula to the required size and uniformity. The plant shall be mounted on wheels or tread equipment of such type that when loaded to capacity, the sub-grade will not be rutted or damaged.

The plant shall have provisions for introducing water or other liquids at the time of mixing through a metering device or other approved methods. Leakage of liquids from the equipment shall be corrected before proceeding further. The single-pass machine shall be designed to pick up the material to be mixed from a windrow or blanket and shall be equipped so that during at least 50 percent of the mixing cycle all the material is picked up and mixed while separated from the mixing table.

2. *Stationary Plants.*

Stationary plants shall be either the batch type using revolving blade or rotary drum mixers or by continuous type mixing. The aggregates and other ingredients of the job-mix formula may be proportioned either by

weight or by volume. There shall be means by which the Engineer can readily verify the proportions in each batch or the rate of flow for continuous mixing.

The charge and mixing time in a batch mixer or the rate of feed to a continuous mixer shall be such to obtain complete mixing of all the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected. The plant shall deliver a uniform mixture meeting all specification requirements.

C. Compactors.

1. *Nonvibratory Steel-Wheeled Roller.* Unless otherwise provided, non-vibratory steel-wheel rollers shall be of the tandem or 3-wheel self-propelled type or steel-wheel trailer type weighing not less than 5 tons. When drive rolls or trailer type rolls produce a compressive force of not less than 200 pounds per linear inch of contact area, a roller weighing less than 5 tons may be permitted. When the weight of the roller is specified in tons, the roller shall not be weighted above the manufacturer's maximum rating. The roller shall be operated within the manufacturer's speed range.

2. *Vibratory Compactors.* Vibratory compactors may be of the roller or pan type. The compactor shall be equipped with amplitude and frequency controls and specifically designed for the compaction of the material on which it is to be used.

3. *Pneumatic Tired Roller.* This shall be an approved type with pneumatic tired wheels mounted on two or more axles and spaced in such manner that all tires have uniform load and contact with the surface and that the rear group of tires will cover the gap between adjacent tires of the forward group. The roller shall be of the self-propelled or trailer type so constructed as to provide for the addition of weights.

   It shall weigh, under operating conditions, not less than 5 tons for a rolling width of 60 inches. The pressure of the tires shall be such that the tire is riding square on the tread. The roller shall be operated at a speed neither less than 3 nor more than 8 miles per hours.

4. *Tamping Type Roller.* The tamping type roller, under working conditions, shall have a minimum weight of 90 pounds per linear inch of length of drum and a minimum load on each sheeps-foot of 100 pounds per square inch of cross-sectional area of the sheeps-foot in contact with the ground. Maximum area of the face of each sheeps-foot shall not be more than 12 square inches. The feet on the sheeps-foot roller shall project not less than 7 inches from the face of the drum and the roller shall be equipped with teeth cleaning devices. The feet in adjacent rows shall be spaced so

that the distance from center to center of adjacent parallel rows is neither less than 6 inches nor more than 11 inches. Individual drums of the roller shall not exceed 5 feet in width and shall oscillate independently. Roller and tractor for pulling shall travel at a speed of approximately 3 to 6 miles per hour.

D. Sprinklers. Sprinklers shall be equipped with positive and rapidly working cut-off valves and approved spray bars, which will insure uniform and continuous discharge for its full length.

E. Distributors and Supply Tanks. Distributor and supply tanks shall meet the requirements of Subsection 401.03.

301.04 CONSTRUCTION METHODS.

A. General. In order to provide the required sub-grade, sub-base and pavement structure of acceptable smoothness and thickness, reasonably accurate control shall be maintained in the compaction of the sub-grade, smoothness of the sub-grade and smoothness and thickness of the component parts of the pavement structure.

The Contractor shall use equipment as may be required to provide acceptable construction within the prescribed tolerances. The Contractor's construction methods and equipment shall meet the requirements of Subsection 108.06. The sub-grade compaction requirement shall be 95 percent or greater of the standard density for acceptable construction. Unless otherwise provided, tolerances for the sub-grade, sub-base and various bases and surfaces of bases are as follows:

BASES	SECTION	TOLERANCES	
		SURFACE	THICKNESS
Sub-grade	310	½ inch in 10 feet	
Sub-base	306	½ inch in 10 feet	Job average within ¼ inch of Plans. Not more than ½ inch deficient at any point except as provided in Subsection 301.04 B.
Aggregate Base	303	½ inch in 10 feet	Same as above
Caliche Base	305	½ inch in 10 feet	Same as above
Sand Cushion	308	½ inch in 10 feet	Same as above
Cement Treated Base	312	¼ inch in 10 feet	Same as above
Soil Asphalt Base	313	¼ inch in 10 feet	Same as above
Plant Mix Bituminous Base-Fine Aggregate	314	¼ inch in 10 feet	Reasonable conformity with Plans
Plant Mix Bituminous Base-Coarse Aggregate	315	¼ inch in 10 feet	Reasonable conformity with Plans

Surface tolerances of lower courses may be 1/8 inch more in 10 feet than the above tolerances specified for the surface of the completed base.

B. Checking for Compliance with Tolerances.

1. *Surface.* Testing with a 10-foot straightedge or other approved device for compliance with specified surface tolerances will be done by the Engineer at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed the specified tolerance. All humps or depressions exceeding the specified tolerance shall be corrected in an acceptable manner.

2. *Width and Thickness.* Width and thickness tolerances for bases and sub-bases paid for on the compacted volume in place (the theoretical cross-section shown on the Plans or established by the Engineer, multiplied by the length). Sections 303, 305, 306, 308, 312 and 313 will be determined as follows:

   The minimum width shall be in reasonably close conformity with the dimensions shown on the Plans or established by the Engineer. The completed thickness of the base or sub-base shall be the nominal thickness shown on the Plans. The thickness of the base or sub-base shall be measured at intervals of not more than 500 feet for each dual lane width. Where the measured thickness of the base or sub-base is

more than ½ inch deficient in the thickness, the Contractor shall correct the deficiency in an acceptable manner with no additional compensation. Where the measured thickness of the base or sub-base is thicker than shown on the Plans, it shall be considered as conforming with the specified thickness. All material and labor required in constructing the base in excess of the required width and thickness, including tolerances, will be considered as having been provided by the Contractor for his convenience and at his expense.

303.00 AGGREGATE BASE

303.01 DESCRIPTION. This work shall consist of furnishing and placing one or more courses of aggregates and additives, if specified, on a prepared sub-grade or sub-base in accordance with these Specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross-sections shown on the Plans or established by the Engineer.

Aggregate base may be mixed off the roadbed and may be blended by plant mixing or other approved methods.

Aggregate base may be mixed on the roadbed with approved methods that will produce a uniformly blended material. Aggregate base shall not be mixed on any completed base or surface course.

303.02 MATERIALS. Materials shall conform to the requirements specified in the following Subsection of Section 700 – Materials, for the type gradation specified:

Aggregate Base	703.01

The gradation may be either Type A or Type B unless otherwise specified on the Plans or in the Proposal. After work starts the same gradation type and source as specified or selected shall be used throughout the project unless otherwise permitted in writing by the Engineer, except as follows:

The gradation shall be Type A in the top 3 inches on any base course except when the specified thickness is 6 inches or less where it shall be for the total thickness.

303.04 CONSTRUCTION METHODS.

A. Preparation of Sub-grade. Prior to placing any new base material or sub-base and base course material on the roadbed, the sub-grade shall have been completed according to the requirements of Method B of Section 310, Sub-grade, of these Specifications or the method specified on the Plans or in the Proposal.

If there is an existing aggregate course in place, it shall be prepared in accordance with the requirements of the method of Section 311, Processing Existing Base and Surface, of these Specifications as indicated on the Plans and in the Proposal.

B. Mixing Aggregate Base.

1. *Offsite Mixing.* When mixing or blending of materials for aggregate base is done at an approved location off the roadbed one of the following procedures shall be used.

1.1 *Stationary Plant – Mixing Method.* The aggregate and water shall be mixed in an approved central mixing plant of the pugmill type, rotary drum type, or in a continuous type of mixer.

Water shall be added during the mixing operation in the amount necessary to provide the proper moisture content for satisfactory compaction. If a pugmill type or rotary drum type of mixer is used, the materials shall be proportioned by batch weights, and if a continuous type of mixer is used, the materials may be proportioned by volume or by weight.

Should the Contractor elect to proportion the materials by volumetric methods and perform the mixing in a continuous type mixer, the completed mixture shall be uniform in character and of the same consistency with respect to aggregates and water as that obtained by weight proportioning and batch mixing.

If a continuous type mixer is used, the correct proportions of each aggregate size introduced into the mixer shall be drawn from storage by an approved type of continuous feeder through adjustable calibrated gates, which shall supply the correct amount of coarse aggregate and fine aggregate required to meet the specified gradation, and so arrange that the proportion of each aggregate size can be separately adjusted. The storage of materials shall be sufficient to supply the mixer when it is in operation at full capacity.

The weight of charge in a batch mixer or the rate of feed to a continuous type mixer shall not exceed that which will permit complete mixing of the material.

Mixing of materials shall be continued until a uniform mixture is obtained.

1.2 *Travel Plant-Mixing Method.* This method of producing aggregate base shall be performed at an approved location off the roadbed. The area selected to do this work shall be cleaned of vegetation or other deleterious substance, overlaid with a minimum of 3 inches of base material and compacted to provide a satisfactory working table for mixing operations.

When the aggregates required to produce the specified mixture are to be combined and blended on the working area, the weighed material shall be delivered and placed in measured windrows, each in the proper portions before blending. In the event a machine for mixing requires a blanket of material, the windrow shall be spread to a reasonably uniform depth and width which the machine is capable of handling. The water shall be applied by means of controls which

will supply a uniform rate of water in the proper amount for satisfactory compaction. Application of excess water shall be avoided, either during mixing or during compaction, in order that undue softening of the sub-grade will not develop.

The device by which the mixing machine picks up the material shall be subject to control and shall be so controlled and operated on each pass of the mixer as to pick up the material to be treated and at the same time avoid cutting into the working area.

Mixing may be accomplished in one or more passes of the mixer through the material, but in any event shall be continued until the aggregate and water are evenly distributed through the mass and a uniform mixture meeting Specification requirements is obtained.

In the process of mixing, compensation shall be made for any tendency of the mixing equipment to shift material in a longitudinal direction.

2. *Onsite Mixing.* When the materials required to produce the specified mixture are to be combined and blended on the roadbed, the weighed material shall be delivered and placed in measured windrows, each in the proper proportions before blending. Fine aggregate to be added to the mixture shall be pulverized to 100 percent passing the one-inch sieve and not less than 80 percent passing the No. 4 sieve.

   The total quantities for blending at one operation shall not be in excess of the amount that can be readily handled and thoroughly and uniformly mixed and blended to these requirements.

   During the latter stages of the mixing and before the final mixing is completed, the mixture shall be moistened as deemed necessary to provide a suitable working condition during the final stages of mixing. Such application of water shall be accurate and uniform throughout the length of the section being treated so that no excess wet or dry spots will be evidenced in the finished blend. Application of excess water should be avoided, either during mixing or during compaction, in order that undue softening of the sub-grade will not develop.

C. Spreading. Aggregate base materials mixed at locations off the roadbed shall be transported to the roadbed by means of suitable vehicles and deposited by means of approved spreading equipment. The layers shall be placed so that when compacted they will be true to the grades or levels required with the least possible surface disturbance. The Contractor shall make such adjustments in placing procedures or equipment as may be required to obtain true grades, to minimize segregation and degradation, to reduce or accelerate loss or accretion of water, and to assure an acceptable base.

The aggregate base material shall be spread and compacted to the required density in one or more layers, as specified below, and of such width and thickness that after compacting, the finished base will conform to the required grade and cross-section. The aggregate base material for each separate course shall be spread for the full width of the roadbed before the placing of the succeeding courses. Longitudinal and transverse joints shall be staggered a minimum of 12 inches in succeeding course.

Aggregate base material shall be laid in courses of a minimum of 3 inches compacted thickness and shall not exceed a maximum of 6 inches compacted thickness, except when shoulders are shown on a typical section to be constructed as a separate operation, then they may be constructed in one course providing they do not exceed 8 inches in thickness, and in two approximately equal courses where they exceed 8 inches. In either case, the compacted shoulders shall meet specified density requirements.

After the blended and flattened windrow of aggregate base material mixed on the roadbed has been tested and approved by the Engineer, it shall be spread uniformly as specified above over the full length and width of the section to be compacted. This spreading shall be done in such a manner as to prevent segregation of the mixture.

D. Shaping and Compaction. Compaction of each layer shall continue until a density of not less than 100 percent of standard density, as determined by AASHTO T-180, Method D, has been achieved. Provided, that aggregate base outside the pavement edge for new construction, or outside the old pavement edge for widening, shall have a minimum density of 95 percent of standard density, AASHTO T-180, Method D. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture is produced and the aggregates firmly keyed. Water shall be uniformly applied over the base materials during compaction in the amount necessary for proper consolidation.

Before applying the prime coat, the aggregate base material shall have cured or seasoned sufficiently to permit the prime coat to be properly applied.

E. Tolerances. Tolerances for surface, width and thickness shall be in conformity with Section 301.

303.05 METHOD OF MEASUREMENT. Aggregate base will be measured by the cubic yard, compacted in place to the specified density. Measurement will be based on the actual length multiplied by the theoretical cross-section shown on the Plans.

303.06 BASIS OF PAYMENT. Accepted aggregate base, measured as provided above, will be paid for at the contract unit price for:

Aggregate Base	Cu. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Rolling and water as required to obtain a specified density will not be a separate pay item, but the cost of same shall be included in the price of other bid items.

306.00 SUB-BASE

306.01 DESCRIPTION. This work shall consist of furnishing and placing sub-base of the type shown on the Plans and in reasonably close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

306.02 MATERIALS. Materials shall meet the requirements specified in Section 704 for the type and gradation specified.

Sub-base material shall meet the specified requirements prior to final incorporation in the work. After work starts, the same type, gradation and source as specified or selected by the Contractor shall be used throughout the project unless otherwise permitted in writing by the Engineer.

306.04 CONSTRUCTION METHODS.

A. Preparation of Sub-grade. The sub-grade shall be constructed as specified for Method B of Section 310 of these Specifications, or the method indicated on the Plans and in the Proposal.

B. Compaction-Density. The sub-base material shall be placed on the roadbed in sufficient quantities and uniformly spread to such thickness and width that the completed sub-base will conform to the Plan width, thickness and grade within the specified tolerances.

The sub-base material shall be compacted to not less than 100 percent of standard density as determined by AASHTO T-99, Method D.

C. Tolerances. Tolerances for surface, width and thickness shall be in conformity with Section 301.

306.05 METHOD OF MEASUREMENT. Sub-base will be measured by the cubic yard, compacted in place, to the specified density. Measurement will be based on the actual length multiplied by the theoretical cross-section shown on the Plans.

306.06 BASIS OF PAYMENT. Accepted sub-base, measured as provided above, will be paid for at the contract unit price for:

Sub-Base	Cu. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

307.00 LIME TREATED SUB-GRADE

307.01 DESCRIPTION. This work shall consist of furnishing and placing one or more courses of a mixture of soil, lime and water in accordance with these Specifications and in reasonably close conformity with the lines, grades, thickness and typical cross-sections shown on the Plans or established by the Engineer.

In sub-grade extents designated on the Plans or by the Engineer as having excessive rock, the dimensions or quantities of which 25 percent or more is greater than 2.5 inches which makes full compliance impractical, the Engineer may waive certain portions of the Standard Specifications as described below. The Engineer may require exploratory scarifying by the Contractor before designation of extents for which the full compliance of Specifications is waived.

307.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Water	701.04
Hydrated Lime	706.01
Quick Lime	706.02
By-Product Lime	706.03

When lime is stored, it shall be stored in a suitable weather-tight building or compartment that will protect the lime from dampness and placed in such a manner as to permit easy access for proper inspection and identification of each shipment. Lime, which for any reason has become partially set or which contains hard lumps or cakes, shall not be used. Lime from different sources, although tested, shall not be mixed in storage.

By-product lime from residual or waste piles from approved sources may be used in lieu of hydrated or quick lime.

307.03 EQUIPMENT. Equipment meeting the requirements of Subsection 301.03 shall be used on the project.

307.04 CONSTRUCTION METHODS.

A. General. It is the primary requirement of these Specifications to secure a completed course of treated material containing a uniform lime mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of his work, to use the proper amount of lime, to maintain the work, and to rework the courses as necessary to meet the above requirements.

B. Weather Limitations. Lime shall not be applied unless the air temperature is at least 40° F and rising. The air temperature shall be taken 4 feet above the ground in the shade and away from artificial heat. Lime shall be applied when the low temperature for a minimum of 48 hours is projected to fall below 35° F.

C. Preparation of Existing Roadbed. Prior to beginning any lime treatment, the roadbed shall be compacted and shaped to reasonably close conformity with the typical sections, lines and grades as shown on the Plans or established by the Engineer. The Contractor shall be required to roll the sub-grade as directed by the Engineer, and to correct any soft areas that this rolling may reveal.

D. Scarifying and Loosening. Scarifying and loosening may be required prior to the application of lime to achieve the desired results as determined by the Engineer. Precautions shall be taken to avoid forming furrows of loosened material below the depth specified for the bottom of the treated sub-grade. Except by special permission from the Engineer, the length of roadway scarified and loosened at any time shall not exceed the length in which the first mixing (paragraph 307.04 F. 1.) can be completed in two calendar days.

E. Application of Lime. General. The proportion of lime indicated on the Plans is approximate.

Lime shall be applied at the rate as prescribed by the Engineer, based on tests of the sub-grade soil. Equipment necessary for proper control of application rate of the lime shall be provided by the Contractor. Where tests indicate a significant change in the sub-grade soil, the Engineer will establish a new rate as deemed necessary for the section of road affected, and at the time of placing and spreading the lime, will advise the Contractor of the final rate for said section.

Lime shall not be applied when wind conditions are such that blowing lime becomes objectionable to traffic and adjacent property owners. A motor grader shall not be used to spread hydrated lime.

When lime is applied to the soil ahead of the mixing plant, the lime shall be placed only on that area where the first mixing operations can be completed during the same working day. During the interval of time between application and mixing, lime that has been exposed to the open air for a period of 6 hours or more may not be accepted for payment. Payment will not be made for lime loss due to excessive washing or blowing.

1. Dry Method.

1.1 Quick Lime. When quick lime is used, the equipment for spreading lime shall be an approved type which shall demonstrate its ability to distribute the lime at controlled amounts uniformly.

1.2 Hydrated Lime. Bagged hydrated lime may be used for dry method application only under unusual circumstances when it would be impossible or impracticable to use other methods and only upon written approval of the Engineer provided that all applicable Federal, State and local laws are met. The bagged lime shall bear the manufacturer's certified weight.

2. *Slurry Method.* Lime shall be mixed with water into a slurry by either of the following methods.

2.1 Central Plant. Agitation shall be accomplished through integral paddles, recirculating pumps, or a combination of these devices. The slurry distributor truck, hauling from the central plant, shall be equipped with a recirculating pump or agitator of sufficient size which will keep the lime and water in a uniform mixture until spread.

2.2 Transit Mix. The lime from the storage bin shall be metered or weighed by an approved method into the tank transit mix equipment. The tank truck shall be equipped with a recirculating pump or agitator to maintain a uniform mixing of the lime and water while in transit.

The distributor using either method, shall be equipped with a pump. The slurry will be applied through the spray bars under pressure to assure a uniform flow and distribution.

Use of compressed air for mixing will not be permitted. The slurry produced by either method shall consist of a minimum mixture of approximately one ton of lime to each 500 gallons of water and shall not contain more than 40 percent lime.

3. *By-Product Lime.* When by-product lime is used, the equipment for spreading lime shall be an approved type which will demonstrate its ability to uniformly distribute the lime at controlled amounts.

F. Mixing. The mixing procedure shall be as hereinafter described:

1. *First Mixing.* The soil, lime, and water shall be mixed until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2.5 inch diameter size. The quantity of water necessary for the first mixing operation will vary with the nature of the material, normally 3 to 5 percentage points above the optimum moisture content of the compacted treated soil. Sufficient water shall be added in

the first mixing process to insure proper chemical action between the lime and soil. When proper mixing has been accomplished, the mixture shall be left to cure. During the curing period the material shall be maintained in a moist condition.

It will be permissible to seal the surface of the modified area by light rolling to the extent that the surface will repel water and contain the moisture below, provided that the material is evenly distributed in the roadway.

When deemed necessary by the Engineer, any portion of the area under modification shall be rescarified for additional sprinkling to insure proper moisture for the curing.

2. *Final Mixing.* After the required curing time, the material shall be uniformly mixed by approved methods. All clods shall be reduced in size until the soil-lime mixture meets the following requirements when tested dry by laboratory sieves:

Minimum passing 1.5 inch	100%
Minimum passing No. 4 sieve	60%

3. *Depths of 2 feet or greater.* For depths of 2 feet or greater either the dry or slurry method may be used. When the dry method is used, the lime may be spread either before or after initial plowing. Following application of lime, alternate plowing and wetting shall continue until the lime and moisture are dispersed throughout the required depth of the course.

   It is the intent that no course treated shall exceed 2 feet in depth. If the depth of material to be treated in cut sections is more than 2 feet, that portion above the lower 2 feet shall be removed so the bottom course can be treated in place. The upper portions of the cut section shall be treated in courses not more than 2 feet in depth. Lime treatment may be accomplished by adding and mixing the amount of lime as required on the Plans to each 8-inch lift during normal fill construction or by completing a 2-foot depth of fill to the typical section shown on the Plans and then adding lime in the required amount for the 2 feet of fill.

   On each properly compacted 2-foot course, the initial mixing shall be considered the final and only mixing necessary.

4. *Designated Excessive Rock Areas.* In areas designated by the Engineer as excessive rock areas, it is the intent that the completed course of treated material shall comply with the Standard Specifications as to uniformity of lime mixture, density, moisture content and depth insofar as practicable. Mixing and pulverization shall be accomplished in two stages and shall be

sufficient to accomplish the intent of the Specifications. The particle size requirement may be waived by the Engineer.

5. *Quick Lime Mixing.* Within two hours after spreading quick lime and before water is added, approved means shall be used to turn under a significant portion of the quick lime to reduce harmful exposure to the heat of hydration. (Caution – uncovered quick lime may be hazardous when in the presence of moisture.) Sufficient water shall be added within 6 hours after spreading to permit hydration of the quick lime.

G. Compaction. Compaction of the mixture shall be accomplished during the same day as the final mixing unless approval is obtained from the Engineer to continue compaction on the following day. The target density shall be determined in the field by the soil-lime mixture obtained from the roadway when compaction is started. The test method for the target density will be as specified in Subsection 106.03 modified to provide one compacted specimen of the soil-lime mixture as obtained from the roadway and separate portions of the sample used for additional specimens with the moisture reduced or increased. The material shall be aerated or sprinkled as necessary to provide the optimum moisture within plus or minus 2 percentage points. Compaction shall continue until the entire depth of mixture is uniformly compacted to not less than 100 percent of the target density. Field density will be determined in accordance with Subsection 106.03.

Depths of 2 feet compacted thickness may be compacted in one operation. The material shall be sprinkled or dried as necessary to provide the moisture for proper compaction. Compaction shall continue until the entire depth of mixture is compacted to a satisfactory condition as demonstrated by test rolling (Section 203) with the further requirement that the top 6 inches of the uppermost course be compacted to not less than 100 percent of the target density established in accordance with the paragraph above.

The material shall be sprinkled and rolled. All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and re-compacting by sprinkling and rolling.

In addition to the requirements specified for density, the full depth of the material shown on the Plans shall be uniformly compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests as necessary will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation, the shape of the course shall be maintained and the surface upon completion shall be smooth and in conformity with the typical sections shown on the Plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density or finish before the next course is

placed or the work is accepted, it shall be re-compacted and refinished at the sole expense of the Contractor.

In areas designated by the Engineer as excessive rock areas, it is the intent that compaction be in substantial compliance with the Standard Specifications. However, it is recognized that the soil-lime mixture may not be uniform and some variation is to be expected in both the target density and optimum moisture dependent on the lime content of a given sample. In the event that the in-place density tests are not practical because of rock in the soil-lime mixture, the Engineer may waive the density and moisture content requirements and approve compaction by visual observation in lieu of such tests.

H. ***Finishing and Curing.*** After the final layer of the lime treated sub-grade has been compacted, it shall be brought within reasonable compliance to the lines, grades and typical sections. The completed section shall then be finished with a suitable roller sufficiently light to prevent hair cracking. The treated material shall be maintained at a moisture content satisfactory for proper curing by sprinkling for a period of 14 days or until a prime, seal, or succeeding course is placed, whichever occurs first.

I. ***Tolerance.*** The finished surface tolerance shall be in conformity with Section 301.

307.05 METHOD OF MEASUREMENT.

A. Hydrated lime or quick lime will be measured by the ton.

B. Lime treatment sub-grade will be measured by the square yard.

C. Water and rolling will not be measured for payment.

307.06 BASIS OF PAYMENT. Accepted quantities, measured as provided above, will be paid for at the contract unit price for:

(A)	Lime	Ton
(B)	Lime Treated Sub-grade	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Rolling and water as required to obtain a specified density will not be a separate pay item, but the cost of same shall be included in the price of other bid items.

Payment for quick lime shall be based upon a 90 percent available lime index by rapid sugar method, calculated as percent CaO by weight. Payment for hydrated

lime shall be based upon a 90 percent available lime index by rapid sugar method, calculated as percent Ca(OH)2 by weight.

By-product lime will be paid for as hydrated or quick lime based on a substitution ratio calculated on a 90 percent available lime index by rapid sugar method.

When the available lime index percentage falls below 90 percent, payment will be made at an adjusted price. The adjusted price shall be reduced at the rate of one percent of the contract unit bid price for lime for each percent, or fraction thereof, from 90.0 percent down to and including an available lime index of 80.0 percent.

When the available lime index falls below 80.0 percent for the type of lime used, the Contractor shall add a sufficient quantity of additional lime of the same type to bring the total amount to the required 90.0 percent of available lime index at no additional cost to the City.

308.00 SAND CUSHION

308.01 DESCRIPTION. This work shall consist of furnishing and placing a course of sandy material as a foundation for concrete in accordance with these Specifications and in reasonably close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

308.02 MATERIALS. Materials shall meet the requirements specified in Subsection 704.02.

308.04 CONSTRUCTION METHODS.

A. Preparation of Sub-Grade. The sub-grade shall be constructed as specified for Method B of Section 310 of these Specifications or the method indicated on the Plans and in the Proposal.

B. Compaction-Density. The sand cushion material shall be placed in sufficient quantities and uniformly spread to such a thickness and width that the completed sand cushion will conform to the Plan width, thickness and grade within the specified tolerances.

The sand cushion material shall be manipulated, sprinkled and rolled to secure not less than 100 percent of standard density.

C. ***Tolerances.*** Tolerances for surface, width and thicknesses shall be in conformity with Section 301.

308.05 METHOD OF MEASUREMENT. Sand cushion will be measured by the square yard or cubic yard as show on the Plans and in the Proposal.

308.06 BASIS OF PAYMENT. Accepted quantities of sand cushion, measured as provided above, will be paid for at the contract unit price for:

Sand Cushion	Sq. Yd. or Cu. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Rolling and water as required to obtain a specified density will not be a separate pay item, but the cost of same shall be included in the price of other bid items.

309.00 ROLLING AND SPRINKLING

309.01 DESCRIPTION. This work shall consist of authorized rolling of embankments, sub-grades, sub-bases, bases or surface courses. When specified, rolling and/or sprinkling shall be done as directed by the Engineer in accordance with the Specifications for the particular type of work under construction.

309.03 EQUIPMENT.

A. General. When end results only are specified, the Contractor will have the option of using compaction methods that will satisfactorily produce the end results. When specific equipment is designated, it shall meet the requirements of Subsection 301.03.

309.04 CONSTRUCTION METHODS. Water shall be applied in the amount required to place the course or layers in the most satisfactory condition for proper compaction. Rolling shall be done in the amount required to obtain the required density for the type of material being compacted.

Rolling shall begin at the edges and be continued until the outside portion and the edges of the course are thoroughly compacted. After the edges have been firmly rolled, the rolling shall progress gradually toward the center, parallel to the center line of the roadway, uniformly lapping each preceding track and covering the entire surface with the rear wheels for the full width of the course. Subsequent rolling shall start at the edges and proceed as before, covering the full width across the road, and continuing until all parts of the course are thoroughly keyed and compacted to the satisfaction of the Engineer. On super elevated curves after the edges have been thoroughly rolled as specified above, the rolling shall continue from the inside edge to the outside edge instead of from the edges to the center. The rollers shall be operated at the speed previously specified. When operations are such that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided and operations continued in a manner approved by the Engineer.

309.05 METHOD OF MEASUREMENT.

A. When an item for rolling is shown on the Plans or in the Proposal as a pay item, rolling will be measured by the hour and pay quantities will be as follows:

The number of hours that the roller actually works will be divided by 5 and the quotient thus obtained multiplied by the actual outside rolling width in feet of the roller tread. In case of sheeps-foot rollers, the width to be used will be the sum of the widths in feet of the individual drums composing the roller. No time will be allowed for moving the roller to and from the location of the work being rolled.

B. When an item for sprinkling is shown on the Plans or in the Proposal as a pay item, sprinkling will be measured by the 1,000 gallon increments or fractional part thereof, of water used and will be measured as delivered in calibrated tank trucks, or if water is obtained by pipe line, the Contractor shall supply an accurate water meter for measuring the water.

309.06 BASIS OF PAYMENT. When an item for rolling is shown on the Plans or in the Proposal as a pay item, rolling, measured as provided above, will be paid for at the contract unit price per hour for rolling and such payment shall be full compensation for furnishing the roller, operator, all equipment, fuel and incidentals necessary to complete the work as specified.

When an item for sprinkling is shown on the Plans or in the Proposal as a pay item, sprinkling, measured as provided above, will be paid for at the contract price per 1,000 gallons for sprinkling, and such payment shall be full compensation for the cost of the water, for hauling, applying and furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

(A)	Rolling	Hr.
(B)	Sprinkling	M. Gal.

310.00 SUB-GRADE

310.01 DESCRIPTION. This work shall consist of preparing the sub-grade for the immediate construction of sub-base, base, sand cushion, pavement or surface.

The sub-grade shall be constructed in accordance with one of the methods specified herein or by the method indicated on the Plans or in the Proposal for the work.

310.04 CONSTRUCTION METHODS

Method A (Traffic Bound Surface Course). The full width of the existing roadbed shall be shaped and crowned with a blade grader to the approximate grade and section required. Unless otherwise indicated the completed section shall have a crown of at least 0.25 inch per foot. All exposed rock larger than 3 inches in diameter and any unstable soil shall be removed and replaced with acceptable material. The finished roadbed shall be smooth and uniform and be maintained in this condition until the next specified course is placed.

Method B (All other sub-bases, bases, pavement or surface). When an item under Section 311 is not included in the Contract, any asphalt surfacing shall be removed and disposed of by the Contractor at locations shown on the Plans. The stockpile shall be left in a neat and workmanlike manner. The aggregate in place shall be used on or incorporated in the full width of the sub-grade to provide a uniform sub-grade as specified.

The sub-grade shall be scarified or otherwise processed to permit uniform dispersion of moisture to a depth of approximately 6 inches. Areas of the sub-grade through rock cuts that cannot be scarified or otherwise processed shall be shaped with soil meeting the requirements of select borrow Subsection 202.02 F, unless otherwise specified, to conform to the planned profile and cross-section. When the loosened soil has been pulverized, it shall be thoroughly and uniformly compacted with the suitable equipment to at least 95 percent of standard density in accordance with Subsection 106.03 for a depth of approximately 6 inches. Moisture content of the sub-grade material at the time of compaction shall be within two points of the optimum moisture content as determined by AASHTO T 99 unless otherwise specified. Areas of the sub-grade which are not accessible to rolling equipment shall be compacted to the required density with approved mechanical tampers.

The surface of the finished sub-grade will be tested by the Engineer at selected locations. The variation of the surface shall meet the tolerance requirements of Subsection 301.04. Unless otherwise provided, points closer than 50 feet shall not vary more than 0.5 inch from the approved grade in place.

Tests of the sub-grade in place shall be made immediately in advance of placing the subsequent course and shall not vary more than the tolerances heretofore specified

and any deficiency shall be corrected before material is placed for the subsequent course.

When the condition of the sub-surface materials in excess of 12 inches below sub-grade elevations prevents the satisfactory construction of the sub-grade, all of the excavation required to remove the unstable material for an area and to a depth designated by the Engineer and the backfill with acceptable material to sub-grade elevation shall be done in accordance with Subsection 202.04. Material unsuitable for backfill shall be wasted as directed by the Engineer and the backfill made with acceptable material obtained from borrow in accordance with Subsection 202.04.

When grading and surfacing operations are let in one contract, removal and replacement of unstable material will not be measured or paid for in fill areas.

Instability due to excess moisture in the top 12 inches will not be recognized as justification for removal of unstable material, and payment will not be made for manipulation and aeration of materials in place, necessary to establish a satisfactory sub-grade.

Measurement of the excavation required for removal of unstable material and excavation for borrow required for backfill with acceptable material as provided above will made in accordance with Subsection 202.05.

Excavation required for removal of unstable material and excavation for borrow for backfill with acceptable material measured as provided above will be paid for at the contract unit price per cubic yard for unclassified excavation.

310.05 METHOD OF MEASUREMENT. Sub-grade will be measured by the square yard.

310.06 BASIS OF PAYMENT. Accepted sub-grade quantities, measured as provided above, will be paid for at the contract unit price for:

(A)	Sub-grade Method A	Sq. Yd.
(B)	Sub-grade Method B	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, tools, labor and incidentals to complete the work as specified.

It is the intent of this Specification that payment for this item will be made only one time for work performed on the sub-grade as defined in Subsection 101.75 regardless of the number of sub-base or base courses placed on the sub-grade.

311.00 PROCESSING EXISTING BASE AND SURFACE

311.01 DESCRIPTION. This work shall consist of the removal, processing, re-use or disposal of existing aggregate surface course or base course and asphalt surface.

This work shall be done in accordance with one of the following methods as specified herein and shown on the Plans or as indicated by a pay item on the Plans and in the Proposal.

311.04 CONSTRUCTION METHODS.

General. The aggregate or other materials in place shall be loosened by scarifying or the use of other suitable methods to its full depth and width. All loosened aggregate or asphalt shall be processed and broken into pieces which will pass a 3-inch sieve. The materials shall be windrowed on the sub-grade or shoulder as the case may require. Care shall be exercised in loosening, removing, processing and storage of aggregate to avoid the addition of excess amounts of soil or other foreign material which would render it unsuitable for the use hereafter specified. Damaged material resulting from improper workmanship of the Contractor will not be measured for payment.

Method A – for Salvage and Stockpiling. The processed materials shall not contain detrimental amounts of sub-grade or soil or other foreign materials. The processed material shall be loaded and hauled to storage locations indicated on the Plans. All materials shall be stored in a neat and workmanlike manner. All grass, weeds and other rubbish shall be removed from the storage area prior to stockpiling material.

Method B – for Use in Sub-grade. The processed materials shall be windrowed on the shoulders during the shaping and conditioning of the sub-grade. The materials shall then be spread uniformly over the full width of the section and compacted and completed with the sub-grade in accordance with the method specified.

Method C – for Use as a Sub-base. The processed materials shall be spread evenly on the previously completed and compacted sub-grade and then compacted to the requirements specified for the method of sub-grade preparation.

Method D – for Use in New Base Courses, Shoulders, or Ramps. The processed materials may be placed on the completed sub-grade as a base course, shoulders or ramps, or it may be blended uniformly with new material for any course. The suitability of the removed materials shall be determined by the Engineer and materials used as authorized.

These materials shall be compacted to not less than 95 percent of standard density for shoulders, ramps and base courses.

311.05 METHOD OF MEASUREMENT. Processing existing base and surface will be measured by the station of 100 feet or fraction thereof measured along the center line of the roadbed.

311.06 BASIS OF PAYMENT. Accepted quantities for processing existing base and surface, measured as provided above, will be paid for at the contract unit price for:

(A)	Processing Existing Base and Surface, Method A	Sta.
(B)	Processing Existing Base and Surface, Method B	Sta.
(C)	Processing Existing Base and Surface, Method C	Sta.
(D)	Processing Existing Base and Surface, Method D	Sta.

which shall be full compensation for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

312.00 PORTLAND CEMENT TREATED BASE

312.01 DESCRIPTION. This work shall consist of constructing one or more courses of a mixture of soil-aggregate and portland cement on a prepared sub-grade or sub-base in accordance with these Specifications and in reasonably close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

312.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Soil-Aggregate	704.04
Portland Cement	701.02
Water	701.04
Asphalt Membrane, RC-250 or MC 250, unless otherwise specified	708.03

Cement in bulk, meeting the above requirements, may be used provided the manner and method of handling is approved by the Engineer. Bulk cement shall be weighed on approved scales as prescribed under Section 414.

When cement is stored, it shall be stored in a suitable weather tight storage facility, which will protect the cement from dampness, and stored in such manner as to permit easy access for proper inspection and identification of each shipment. Any cement which for any reason has become partially set or which contains hard lumps or cakes shall be rejected. Cement salvaged from discarded or used bags shall not be used. Cement from different mills, although tested and approved, shall not be mixed.

312.03 EQUIPMENT. Equipment necessary for the proper construction of the work shall meet the requirements of Subsection 301.03.

312.04 CONSTRUCTION METHODS.

A. Weather Limitations. Mixing will not be permitted when the aggregate or sub-grade is frozen. The air temperature shall be at least 40° F in the shade and rising. The Contractor shall be responsible for the protection and quality of the base under any weather conditions.

B. Preparation of Existing Roadbed. When grading and surfacing operations are let as one contract, prior to start of paving, base or sub-base operations, the sub-grade shall be prepared as specified under Section 310, Method B, of these Specifications.

Asphalt surfacing which cannot be pulverized to meet gradation requirements shall be removed from the existing roadbed and disposed of by the Contractor at locations shown on the Plans or directed by the Engineer. The existing

roadbed then shall be graded and shaped to conform with the grades, lines and cross-sections shown on the Plans or directed by the Engineer. Where the addition of suitable soil is required, it shall be spread uniformly to the specified width and depth over the previously shaped roadbed.

All loose material shall be disked, harrowed or otherwise processed to break up all clods and pulverize the material sufficiently to permit uniform dispersion of moisture. Then the roadbed shall be thoroughly and uniformly compacted with suitable equipment to at least 95 percent of standard density.

C. Application of Cement. Cement shall not be applied when the moisture content of the loose soil exceeds the specified optimum moisture for the soil-cement mixture by more than 2 percentage points.

Only spreading and mixing equipment will be allowed to pass over the freshly spread cement.

When bulk cement is used, the Contractor shall have equipment for handling, weighing and spreading the cement in a satisfactory manner.

The Contractor will be required to replace cement lost at his own expense.

D. Mixing.

1. *General.* Imported soil-aggregate or roadbed soil shall be pulverized to the extent that 80 percent of the cement treated mixture by dry weight shall pass a No. 4 sieve, exclusive of gravel or stone retained on a No. 4 sieve. Gravel or stone retained on a 2.5 inch sieve shall be removed before mixing. When sandstone is approved for use, 80 percent of the entire mix shall pass the No. 4 sieve except as provided herein.

   A job-mix design will be set by the Engineer based on a representative sample submitted by the Contractor. The job-mix formula for the mixture shall establish a single percentage of aggregate passing each sieve. The aggregate shall meet this established percentage within +7 percent as set by the design mix except that in no event shall the amount passing the No. 4 sieve be less than 55 percent.

2. *Traveling Plant.* The cement shall not be applied to the soil for a greater distance than the traveling plant will normally mix in one hour. Mixing shall continue at such a rate of speed of the traveling plant as will produce a uniform mixture of soil-cement and water.

   The compaction operation shall be a continuation of the mixing operation in such a manner that the moistened soil-cement mixture does not remain undisturbed after mixing and before compacting for more than 30 minutes.

3. *Stationary Plant.* The aggregate shall be proportioned and mixed with cement and water in a stationary plant meeting the requirements of Subsection 301.03 B. 2. Mixing shall continue until a uniform mixture of aggregate, cement and water has been obtained.

   Mixed material shall be transported to the roadway in suitable vehicles and spread on a moistened sub-grade or base in a uniform layer by a self-propelled or other approved spreader. Not more than 60 minutes shall elapse between the addition of cement to the mixer and starting compaction of the mixture on the prepared sub-grade.

E. Compacting and Finishing. Compaction of the cement treated mixture shall begin not later than 30 minutes after the mixture is spread on the roadbed. The target density shall be determined in the field by moisture density tests on representative samples of cement treated mixture obtained from the roadway at the conclusion of spreading operations. The test method for the target density will be as specified in Subsection 106.03, Method C, modified to provide one compacted specimen of the soil-cement mixture as obtained from the roadway, and separate portions of the sample used for additional specimens with the moisture reduced or increased. The soil-cement mixture shall be mixed and compacted within plus or minus 2 percentage points of optimum moisture content specified by the Engineer before there is any appreciable moisture loss. Compaction shall continue until the entire depth of cement treated mixture is uniformly compacted free of laminations and to a minimum density of 95 percent of target density. Field density will be determined in accordance with Subsection 106.03. The rate of operation and the number of rollers shall be sufficient to uniformly compact the section of roadway being processed to the specified width and depth within 2 hours.

After the mixture is compacted, the surface of the treated roadway shall be moistened and reshaped to the required lines, grades and cross-sections, and if necessary, shall be lightly scarified to remove any imprints left by the compacting or shaping equipment. The surface then shall be thoroughly rolled with steel wheel and pneumatic tired rollers.

When necessary to eliminate irregularities to meet surface tolerance, the trimming of not more than 0.25 inch average thickness of the base is recognized as a construction operation for which no deduction in pay quantities will be made. The excess material shall be deposited on the shoulder slopes or as directed by the Engineer.

Surface finishing methods may be varied from this procedure provided a dense, uniform surface free of surface compaction planes is produced. The surface shall be maintained in a moist condition during finishing operations. Compaction and finishing shall be done in such a manner as to produce a

smooth, dense surface free of surface compaction planes, ridges, or loose material.

At all places inaccessible to rollers or finishing and shaping equipment (such as immediately adjacent to the completed base, approach slabs to bridges, etc.), the mixture shall be thoroughly compacted to the required density by other compacting methods approved by the Engineer and shaped and finished as specified.

F. Asphalt Membrane. The top of the base course shall be finished to within the specified tolerances and kept moist until the asphalt seal is applied. Excessive flushing of the surface will not be permitted. Asphalt shall be uniformly applied through spray nozzles at the rate of 0.15 to 0.3 gallons per square yard as directed by the Engineer.

At the time of bituminous material application, the soil-cement surface shall be dense, free of all loose and extraneous material, and shall contain sufficient moisture to prevent penetration of the bituminous material. If needed, water shall be applied to fill the surface voids of the soil-cement immediately before the bituminous material is applied.

Should it be necessary for construction equipment or other traffic to use the bituminous covered surface before the bituminous material has dried sufficiently to prevent pickup, sufficient sand cover shall be applied before such use.

The curing, including the asphaltic seal, shall be maintained by the Contractor for a period of 7 days so that all of the soil-cement base course will be covered effectively during this period.

Any finished portion of the base course adjacent to construction which is traveled by equipment used in constructing an adjoining section shall be protected in such a manner as to prevent equipment from marring or damaging the completed work. Unless otherwise provided, the asphalt seal shall be maintained by the Contractor until the treated base is protected by a subsequent course.

G. Construction Joints and Traffic. At the start of the day or in case of an unavoidable interruption of operations that would form a joint in the base, the edge of the base shall be cut back to leave a vertical face or as is necessary to secure a satisfactory riding surface. All base removed shall be replaced by the Contractor at his own expense.

Base courses for roads, streets or similar areas shall be processed and finished full width each day without longitudinal construction joints. The turning or operation of rollers, sprinklers, maintainers or other equipment on the

previously completed or previously compacted and shaped base during the operations of laying, compacting and shaping base will not be permitted.

The passage of traffic or equipment over, along or across the base from the time the compaction and shaping of the base is completed will not be permitted until after 7 days have elapsed except as otherwise provided hereinafter.

Crossing the base after it has been cured for a period of 14 hours will be permitted provided such crossing is made over satisfactorily protected crossing areas constructed and maintained in accordance with one of the following requirements:

1. A layer of sand-clay, or other equally stable earth, of not less than 8 inches compacted depth, placed over the base for such width as required to adequately protect the base during such crossings.

2. A solid mat consisting of a floor of timbers or other suitable material laid across the base on not less than one inch of earth cover of such length, width, and thickness as required to adequately protect the base from damage.

H. ***Tolerances.*** Tolerances for surface, width and thickness shall be in conformity with Section 301.

I. ***Maintenance.*** The Contractor shall maintain the entire base course within the limits of his Contract in good condition to the satisfaction of the Engineer from the time he first starts work until the base has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur either before or after the cement is applied. Such work shall be done by the Contractor at his own expense and repeated as often as may be necessary to keep the area continuously intact. Repairs are to be made in a manner to insure restoration of a uniform surface and durability of the part repaired. 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 rather than by adding a thin layer of soil-cement to the completed work.

312.05 METHOD OF MEASUREMENT.

A. Cement will be measured by the ton. When bulk cement is used, the Contractor shall furnish the Engineer with copies of bills for shipments. Only the actual amount of cement used in the construction as directed by the Engineer will be measured for payment.

B. Imported soil-aggregate for cement treated base will be measured by the cubic yard, compacted in place, to the specified density. Measurement will be based

on the actual length multiplied by the theoretical cross-section shown on the Plans.

C. Processing (manipulation) of the soil-aggregate and cement, whether mixed with a traveling or stationary plant, will be measured by the cubic yard compacted in place to the specified density. Measurement will be based on the actual length multiplied by the theoretical cross-section shown on the Plans.

D. Asphalt for asphalt membrane will be measured by the gallon in accordance with Section 109.

312.06 BASIS OF PAYMENT. The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

(A)	Cement for Stabilization	Ton
(B)	Imported Soil-Aggregate	Cu. Yd.
(C)	Processing (Manipulation)	Cu. Yd.
(D)	Asphalt for Asphalt Membrane	Gal.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Water will not be a separate pay item, but the cost of same shall be included in the price of other bid items.

317.00 FLY ASH MODIFIED SUB-GRADE

317.01 Description. This work shall consist of constructing one or more courses of a mixture of soil, fly ash, lime as required and water, in accordance with these Specifications and in reasonably close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

317.02 Materials. Materials shall meet the requirements specified in the following Sections and Subsections of Section 700 – Materials:

Fly Ash	702
Hydrated Lime	706.01
Quick Lime	706.02
By-Product Lime	706.03
Water	701.04

317.03 Equipment.

A. General. All equipment necessary for construction of fly ash modified sub-grade shall be furnished in accordance with the requirements of Subsection 108.06 and the following.

B. Traveling Plants. Traveling plants used for soil pulverization and mixing shall be approved in accordance with the requirements of Subsection 301.03 B.

C. Compactors. Equipment for compaction shall meet the requirements of Subsection 301.03 C.

D. Sprinklers. Sprinklers shall meet the requirements of Subsection 301.03 D.

317.04 CONSTRUCTION METHODS.

A. General. It is the primary requirement of these Specifications to secure a completed course or courses of sub-grade material containing a uniform fly ash mixture of uniform density and moisture content, free from loose or segregated areas and well bound for its full depth with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of his work, to use the prescribed amount of fly ash, to maintain the work and rework the courses as necessary to meet the above requirements.

B. Weather Limitations. Fly ash mixing operations shall not be performed when the sub-grade is frozen or when the air temperature is less than 40° F. The air temperature shall be taken 4 feet above the ground in the shade and away from artificial heat. Fly ash shall not be applied when the low temperature for a minimum of 12 hours after final compaction is projected to fall below 40° F.

C. Preparation of Existing Roadbed. Prior to the application of fly ash, the roadbed shall be compacted and shaped to reasonably close conformity with the typical sections, lines and grades as shown on the Plans or established by the Engineer.

The Contractor shall be required to roll the sub-grade and to correct any soft areas that this rolling may reveal.

D. Scarifying and Loosening. Scarifying and loosening may be required prior to the application of fly ash to achieve the desired results as determined by the Engineer. Precautions shall be taken to avoid forming furrows of loosened material below the depth specified for the bottom of the fly ash modified sub-grade. Except by special permission from the Engineer, the length of roadway scarified and loosened at any time shall not exceed the length in which mixing and compaction can be completed in two calendar days.

In sub-grade extents designated on the Plans or by the Engineer as having excessive rock, the dimensions or quantities of which 25 percent or more are greater than 2.5 inches in size makes compliance with these Specifications impractical, the Engineer may waive certain portions of the work as described below. The Engineer may require exploratory scarifying by the Contractor before the designation of extents for which full compliance of these Specifications is waived.

E. Application of Fly Ash. General. Fly ash shall be applied at the rate prescribed by the Engineer based on tests of the sub-grade soil. Equipment necessary for proper control of the application rate of fly ash shall be provided by the Contractor. Where tests indicate a significant change in the sub-grade soil, the Engineer will establish a new rate as deemed necessary for the section of road affected and at the time of placing and spreading the fly ash will advise the Contractor of the final application rate.

Fly ash shall not be applied by the slurry method. The fly ash shall not be placed on wet sub-grade or otherwise allowed to become wet during application.

Dry methods of application shall be utilized for placement of the fly ash onto the sub-grade. Equipment for spreading shall be approved types which demonstrate the ability to distribute fly ash uniformly.

Fly ash shall not be applied when wind conditions are such that blowing fly ash becomes objectionable to traffic or adjacent property owners. Fly ash shall be placed only that area of roadway where mixing, compaction and finishing can be completed in the allotted time. During the interval of time between application and completion of the first mixing operations, fly ash that has been exposed to weather conditions resulting in wetting or excessive loss by blowing

will not be accepted for payment. Fly ash unacceptable as the result of wetting shall be removed from the roadway at the direction of the Engineer.

F. Mixing.

1. General. Mixing of the fly ash with the sub-grade soil shall follow application and spreading as a continuous construction operation. Work areas for mixing shall not exceed 5,000 square yards unless otherwise authorized by the Engineer.

The mixing procedure shall be as hereinafter described:

1.1 First Mixing. The moisture content of the sub-grade soil shall not exceed 80 percent of optimum as determined by AASHTO T 99 at the time of first mixing. The soil and fly ash shall be mixed until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2.5 inch diameter size. The addition of water will not be permitted during the first mixing. First mixing operations shall begin no later than one hour after application of the fly ash.

When deemed necessary by the Engineer, any portion of the work area shall be re-scarified and additional fly ash added to ensure adequate soil modification.

The fly ash and soil shall be thoroughly mixed prior to the beginning of final mixing operations.

1.2 Final Mixing. After the dry soil and fly ash have been satisfactorily mixed, additions of water shall be made in the final mixing operations to initiate soil-fly ash reaction. The method of mixing shall be an approved procedure utilizing a traveling mixing plant which demonstrates uniform dispersion of fly ash and water throughout the soil materials. The quantity of water necessary for the final mixing operations will vary with the nature of the materials, normally 2 to 5 percentage points above the optimum moisture content of the compacted modified soil. Sufficient water in any case shall be added in the final mixing process to insure chemical action between the fly ash and soil.

All clods shall be reduced in size by mixing until the soil-fly ash mixture meets the following size requirements when tested with laboratory sieves:

SIEVE SIZE	PERCENT PASSING
1 inch	100
¾ inch	50 minimum

2. *Lime Additive.* The addition of lime may be specified or approved to facilitate mixing fly ash with soil materials. When specified or directed by the Engineer in writing, lime shall be used to prevent fly ash flash set or retard soil-fly ash reactivity occurring during final mixing. Lime additive shall be uniformly blended with the fly ash on the roadway for incorporation with soil materials during first mixing operations unless other methods of application are approved.

   The proportion of lime additive with the fly ash will be based on laboratory testing and field trial procedures necessary to determine proper soil modification. The addition of lime will permit a reduction of the fly ash requirement on a replacement basis as approved by the Engineer.

G. Compaction. Compaction of the soil-fly ash mixture shall be performed immediately after final mixing, wherein the compaction operation shall be a continuation of the final mixing operation. The target density shall be determined in the field by moisture density tests on representative samples of the soil-fly ash mixture obtained from the roadway when compaction is started. The test method for the target density will be as specified in Subsection 106.03 modified to provide one compacted specimen of the soil-fly ash mixture as obtained from the roadway, and separate portions of the sample used for additional specimens with the moisture reduced or increased.

The soil-fly ash mixture shall be compacted without delay and before any appreciable loss of mixing moisture occurs. Mixing and compaction operations shall be performed in such a manner that the mixture will be compacted within plus or minus 3 percentage points of optimum moisture content. However, during the course of construction, changes or adjustments in the specified moisture requirements to meet field conditions may be authorized.

Compaction shall continue until the entire depth of the mixture is uniformly compacted to not less than 100 percent of target density. Field density will be determined in accordance with Subsection of 106.03. The rate of operation and the number of rollers shall be sufficient to uniformly compact the section of roadway being processed within 2 hours of final mixing.

The material shall be sprinkled and rolled. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and reshaping and re-compacting by sprinkling and rolling.

In addition to the requirements specified for density, the full depth of the material shown on the Plans shall be uniformly compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, density tests as necessary will be made by the Engineer for acceptance. If the material fails to meet the density requirements, it shall

be reworked as necessary to meet these requirements. Throughout this entire operation the shape of the course shall be maintained and the surface upon completion shall be smooth and in conformity with the typical section shown on the Plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, or finish before the next course is placed or the work is accepted, it shall be reworked and refinished at the sole expense of the Contractor.

In areas designated by the Engineer as excessive rock areas, it is the intent that compaction be in substantial compliance with these Specifications. However, it is recognized that the soil-fly ash mixture may not be uniform and some variation is to be expected in both the target density and optimum moisture dependent on the fly ash content of a given sample. In the event the in-place density tests are not practical because of rock in the soil-fly ash mixture the Engineer may waive the density and moisture content requirements and approve compacting by visual observation in lieu of such tests.

H. Finishing and Curing. After the final layer of the fly ash modified sub-grade has been compacted, the completed section shall then be finished with a suitable roller sufficiently light to prevent hair cracking. The modified material shall be maintained at a moisture content satisfactory for proper curing by sprinkling for a period of 14 days or until a prime, seal, or succeeding course is placed, whichever occurs first.

I. Surface Tolerance. The finished surface tolerance shall be in conformity with Section 301.

317.05 METHOD OF MEASUREMENT.

A. Fly ash will be measured by the ton.

B. Lime will be measured by the ton.

C. Fly ash modified sub-grade will be measured by the square yards of sub-grade modification completed in place.

D. Water will not be measured for payment.

317.06 BASIS OF PAYMENT. Accepted quantities for fly ash modified sub-grade, measured as provided above, will be paid for at the contract unit price for:

(A)	Fly Ash	Ton
(B)	Lime	Ton
(C)	Sub-grade Modification	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Payment for quick lime shall be based upon a 90 percent available lime index by rapid sugar method, calculated as percent CaO by weight. Payment for hydrated lime shall be based upon a 90 percent available lime index, by rapid sugar method, calculated as percent Ca(OH)2 by weight.

When the available lime index percentage falls below 90 percent, payment will be made at an adjusted price. The adjusted price shall be reduced at the rate of one percent of the Contract unit bid price for lime and for each percent, or fraction thereof, from 90.0 percent down to and including an available lime index of 80.0 percent.

When the available lime index falls below 80.0 percent for the type of lime used, the Contractor shall add a sufficient quantity of additional lime of the same type to bring the total amount to the required 90.0 percent of the available lime index at no additional cost to The City.

400.00 BASES

401.00 GENERAL REQUIREMENTS FOR SURFACES

401.01 DESCRIPTION. This Section covers requirements common to all or designated types of surface construction.

401.02 MATERIALS. Materials as required for construction of the various surface types shall meet the requirements set forth in the appropriate Subsections of Section 700 – Materials. The particular Subsection is designated under materials for each surface type.

401.03 EQUIPMENT.

A. Distributors and Supply Tanks. The distributor shall be so designed, equipped, maintained and operated that bituminous material at uniform heat may be applied uniformly on variable widths of surface up to 26 feet at readily determined and controlled rates from 0.1-1.0 gallon per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.03 gallons per square yard.

Distributor equipment shall include a tachometer, pressure gauges, accurate volume metering devices or a calibrated tank, and thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

The distributor shall be equipped with a positive shut-off valve and fittings as needed to prevent the spray bar or other mechanisms from dripping bituminous material. Distribution of the bituminous material shall be so regulated, and sufficient material left in the distributor at the end of each application to insure a uniform distribution of bituminous material. In no case shall the distributor be allowed to blow. The angle of the spray nozzles and height of the spray bar shall be frequently checked and adjusted to insure uniform distribution of the bituminous material. Drilling, clogging, or streaking of the bituminous material is not an acceptable application of the material and corrective measures shall be taken by the Contractor before distribution is resumed.

A check of distribution rate and uniformity of distribution shall be made when directed by the Engineer.

Supply tanks shall meet the requirements of AASHTO M-156 Section 3.

B. Compactors. Rollers shall be steel wheel, pneumatic tire, vibratory or a combination of these types, as the Contractor may elect. They shall be in good condition, capable of reversing without backlash, and shall be operated at

speeds slow enough to avoid displacement of the bituminous mixture. Vibratory rollers shall be equipped with amplitude and/or frequency controls specifically designed for compaction of the material on which it is to be used. The type, number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which crushes the aggregate will not be permitted.

401.04 CONSTRUCTION METHODS.

A. Tolerances. In order to provide a surface course or courses of acceptable smoothness, width and thickness, reasonable accurate control shall be maintained in placing, spreading, finishing and compacting of surface courses. The Contractor shall use equipment as may be required to provide acceptable construction within the prescribed tolerances.

		TOLERANCES	
SURFACE TYPE	**SECTION**	**SURFACE**	**THICKNESS**
Asphalt Surface (Hot Mix-Cold Laid)	405	3/16 inch in 10 ft.	Reasonable conformity w/the Plans
Plant Mix Asphalt Concrete Pavement	411	1/8 inch in 10 ft.	Same as Above
P.C. Concrete Pavement	414	1/8 inch in 10 ft.	See Section 414

All pavement will be subject to straightedge inspection during construction operations.

Testing with a 10-foot straightedge or other approved device for compliance with specified surface tolerances will be made by the Engineer at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed the specified tolerance. Humps or depressions exceeding the specified tolerance shall be corrected in an acceptable manner.

B. Prime Coat. Prime coat shall meet the requirements of Section 408.

C. Tack Coat. Tack coat shall meet the requirements of Section 407.

403.00 TRAFFIC BOUND SURFACE COURSE

403.01 DESCRIPTION. This work shall consist of a surface course composed of hard durable particles of sand, gravel, mine chats, crushed stone or disintegrated granite of the type shown on the Plans or in the Proposal, constructed on the prepared sub-grade in accordance with these Specifications and in reasonable close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

403.02 MATERIALS. Materials shall meet the requirements specified in Subsection 703.03.

Materials to be used in driveways, detours and incidental areas may be selected by the Contractor provided it meets the requirements specified above.

403.04 CONSTRUCTION METHODS.

A. Preparation of Sub-grade. Prior to placing the surfacing material on the roadbed, the sub-grade shall have been completed according to the requirements of Method A of Section 310 (Sub-grade) of these Specifications for Types A, B and D, and Method B of Section 310 (Sub-grade) for Type C.

B. Hauling and Placing. The surfacing material shall be transported and delivered in approved vehicles.

The material shall be deposited in windrows on the shoulders. The Contractor shall be responsible for its uniform distribution throughout the length of each station, unless other methods are approved by the Engineer. The windrow shall be formed on the same day the material is hauled.

C. Shaping and Maintenance. Material placed in driveways and incidental areas adjacent to the roadway shall be properly shaped and compacted in a manner approved by the Engineer.

Holes, waves and undulations which develop shall be corrected by blading and by adding more material from the windrow. The shaping of the surface material shall be continued until it is well-compacted, free from ruts, waves, and undulations and conforms to the cross-section shown on the Plans and until final acceptance.

Excess material not required for maintenance shall be removed and stockpiled at a place approved by the Engineer.

D. Traffic Control. The road shall not be closed to traffic during this construction work. The Contractor shall so carry on his operations so as to interfere the least possible with the movement of traffic, and he shall maintain sufficient warning signs and lights as required to safeguard against accidents.

Windrows or piles of material shall not be left on the traveled roadway overnight but must be placed on the shoulders.

403.05 METHOD OF MEASUREMENT. Traffic bound surface course will be measured by the ton. All moisture in excess of 5 percent oven dry weight will be deducted.

403.06 BASIS OF PAYMENT. Accepted quantities of traffic bound surface course, measured as provided above, will be paid for at the contract unit price for:

(A)	Traffic Bound Surface Course, Type A	Ton
(B)	Traffic Bound Surface Course, Type B	Ton
(C)	Traffic Bound Surface Course, Type C	Ton
(D)	Traffic Bound Surface Course, Type D	Ton
(E)	Traffic Bound Surface Course, Type E	Ton

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

405.00 ASPHALT SURFACE COURSE (HOT MIX-COLD LAID)

405.01 DESCRIPTION. This work shall consist of a surface course or leveling course composed of a mineral aggregate uniformly coated with bituminous binder in a stationary plant and laid on an approved base in accordance with these Specifications and in reasonably close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

405.02 MATERIALS. Materials shall meet the requirements specified in Section 708.

Leveling course, when required, shall be of the same material specified for surfacing.

405.04 CONSTRUCTION METHODS.

A. Weather Limitations. No asphalt material shall be applied or mixed material laid down and consolidated on a wet surface, when the temperature in the shade is below 50° F or when frost is in the underlying course or foundation.

B. Preparation of Site and Transportation of Mixtures. Sites for stockpiles shall be approved by the Engineer. The ground on which the stockpile is to be placed shall be well-drained, cleaned of weeds, grass, loose earth, dust and other foreign material before any asphalt material is placed thereon. The site shall be well drained, smoothed and compacted, by sprinkling and rolling if necessary, to obtain a smooth dense surface from which a maximum amount of material can be reclaimed without being mixed with foreign material.

The material shall be transported to the work in tight vehicles previously cleaned of foreign material. Dispatching of the vehicles shall be so arranged that materials delivered may be placed and shall have received initial compaction in daylight.

C. Preparation of Base. Prior to the placing of the asphalt surface course, the base shall be brought reasonably true to the lines, grades and cross-sections shown on the Plans or established by the Engineer.

Material used for this purpose shall conform to the type indicated on the Plans and in the Proposal. Patching material shall be thoroughly bound to the existing base and compacted.

After the base has been patched, the road shall be thoroughly cleaned of dust, clay or other foreign matter.

If the base is asphaltic concrete, brick, portland cement concrete or other type of rigid base course, the surface shall be cleaned thoroughly. This shall include the removal of asphalt patches or excessive joint filler, rich in asphalt or

volatiles. The clean surface shall then be given a coat of the approved asphalt material.

Where old pavement is shattered or broken to such an extent that it will not provide a suitable foundation, the Engineer will designate the areas to be removed and replaced with approved material indicated on the Plans or in the Proposal. Such work shall be done prior to placing of the tack coat.

Any depressions in this type of old pavement that would tend to increase the thickness of the surface course more than one inch over that specified on the Plans, shall be built up with a leveling course composed of asphalt surface course as specified herein.

When a leveling course is used, a tack coat shall be applied previous to placing leveling course material. No tack coat will be required on this course in advance of surfacing.

D. Prime Coat. Prime coat, if specified, shall meet the requirements of Section 408.

E. Tack Coat. Tack coat, if specified, shall meet the requirements of Section 407.

F. Placing of Bituminous Surface Course. One edge of the asphalt surface course shall be established by a string or wire line in advance of the placing of the material. The material shall be laid only on an approved base course or pavement which has been primed or tack coated as previously specified and is reasonably free of objectionable material and only when the surface of the base course is dry and weather conditions are suitable. Contact surfaces of curbs, structures and joints shall be painted with a thin uniform coating of materials as specified for tack coat. The mixture shall be aerated, if required, and may then be spread in a uniform layer of such depth that after receiving ultimate compaction by rolling the requirements of the typical cross-section will be fulfilled. Hand spreading will be permitted where the mixture is placed on narrow strips or small irregular areas.

G. Compaction. Rolling equipment shall be in good operating condition and of an approved type which will produce a pavement of the required density. Rolling shall start longitudinally at the sides and proceed toward the center of the pavement. Alternate trips of the roller shall be different in length. Rolling or compaction shall continue until the compressed mixture has a density of not less than 95 percent of the laboratory compacted density for the mixture. Final compaction shall be made with steel wheel rollers. The operation of the rollers shall be such as to avoid displacement of the mixture. Adhesion of the mixture to the roller wheels will not be permitted. Necessary precautions shall be taken to prevent the dripping of gasoline, oil, grease or other foreign

matter on the pavement, either when the rollers are in operation or when standing.

H. Joints. Placing of the mixture shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the courses is discontinued or interrupted for an appreciable period and joints shall be formed at such points.

Where joints are to be formed, the previous work shall be cut back so as to expose the full depth of the course.

I. Surface Tolerances. Surface tolerance shall be in conformity with Section 401.

J. Opening to Traffic. The pavement shall be open to traffic as directed by the Engineer at any time after completion of final compaction, but any damage to the surface prior to final acceptance shall be satisfactorily repaired. If the surface becomes rough or wavy under traffic the Engineer may require the Contractor to loosen the surface, reshape and re-compact as hereinbefore specified.

405.05 METHOD OF MEASUREMENT.

A. Asphalt surface course, hot-mix cold laid, will be measured by the ton.

B. Prime material, if required, will be measured and paid for in accordance with Section 408.

C. Tack coat for rigid bases, painting curbs, headers, etc. will be measured and paid for in accordance with Section 407. When asphalt-emulsion is used, it will be measured for payment before dilution in accordance with Section 407.

405.06 BASIS OF PAYMENT. The accepted quantities, measured as provided above, will be paid for at the Contract unit price for:

(A)	Asphalt Surface Course (Hot Mix-Cold Laid) Type HC-1	Ton
(B)	Asphalt Surface Course (Hot Mix-Cold Laid) Type HC-2	Ton
(C)	Asphalt Surface Course (Hot Mix-Cold Laid) Type HC-3	Ton
(D)	Asphalt Surface Course (Hot Mix-Cold Laid) Type HC-4	Ton

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

407.00 TACK COAT

407.01 DESCRIPTION. This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material in accordance with these Specifications and in reasonably close conformity with the lines shown on the Plans or established by the Engineer.

407.02 MATERIALS. Materials shall meet the requirements specified in the following Subsection of Section 700-Materials.

Emulsified Asphalt	708.03

The emulsified asphalt may be diluted as specified or approved by the Engineer.

407.03 EQUIPMENT. Distributors, heating equipment and supply tanks shall meet the requirements of Subsection 401.03.

407.04 CONSTRUCTION METHODS. The existing surface or course shall be clean to the satisfaction of the Engineer before tack coat is placed. The tack coat shall be applied, as directed by the Engineer, at the rate of not to exceed 0.10 gallons per sq. yd. of surface. All contact surfaces of curbs and gutters, manholes, and other structures shall be painted with a thin uniform coat of asphalt material used for the tack coat. In case no tack coat is shown in the Plans, curbs and other structures shall be painted with a thin uniform coating of the approved tack coat material and included in other items of work.

The tack coat shall be applied in such manner as to minimize damage and to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material.

Tack coat shall not be applied during wet or cold weather, when wind drift presents a potential problem to the traveling public or adjacent property, after sunset, or to a wet surface; however, the surface may be damp. Tack coat that is not "covered" the same day may be reapplied at a rate that insures proper adhesion as directed by the Engineer.

The quantity, rate of application, temperature and areas to be treated shall be approved prior to application.

407.05 METHOD OF MEASUREMENT. Tack coat will be measured by the gallon before dilution. Water used in dilution of emulsified asphalt will not be measured for payment.

407.06 BASIS OF PAYMENT. The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

Tack Coat	Gal.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

408.00 PRIME COAT

408.01 DESCRIPTION. This work shall consist of preparing an existing surface with bituminous material and blotter material, if required, in accordance with these Specifications and in reasonable close conformity with the lines shown on the Plans or established by the Engineer.

408.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700-Materials.

Prime Materials MC-30 or MC-70	708.03

Blotter material, if required, shall meet the requirements of Subsection 402.04.J.

408.03 EQUIPMENT. Distributors, heating equipment and supply tanks shall meet the requirements of Subsection 401.03.

408.04 CONSTRUCTION METHODS.

A. Weather Limitations. Bituminous materials shall not be applied when the temperature is below 50° F air temperature in the shade, unless otherwise provided, or when weather conditions would otherwise prevent the proper construction of the prime coat.

B. Preparation of Surface. Before priming, the sub-grade, sub-base or base shall be cleaned of loose material and shall be in a condition that maximum penetration of the prime will be obtained.

C. Priming Sub-grades, Sub-bases or Bases That Are Non-Cohesive. Subject to the acceptance by the Engineer, when friable or non-cohesive materials are encountered in the surface to be primed, the bituminous material shown on the Plans may be changed to an asphalt emulsion. The bituminous materials shown on the Plans may also be changed to an asphalt emulsion in those areas of the State in which the use of cutback asphalt is prohibited. Sprinkling water with asphalt emulsion added may used in the final operations of sprinkling, manipulation, shaping and rolling of the sub-grade, sub-base or base. Additional applications may be made if required to form a firm, bonded, working table.

D. Application of Bituminous Material. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread at the approximate rate of 0.1 to 0.4 gallon per square yard as directed by the Engineer. When traffic is maintained, not more than 1/2 of the width of the section shall be treated in one application. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Excess bituminous material shall be removed from the surface. Skipped areas or

deficiencies shall be corrected.

When traffic is to be maintained, one-way traffic shall be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portion and the remaining width of the section shall be primed.

Succeeding applications of bituminous materials or other courses shall not be applied until after sufficient time has elapsed to allow both proper penetration and hardening of the prime coat.

E. Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate within the time specified and the roadway must be used by traffic, blotter material shall be spread in the amounts required to absorb any excess bituminous material.

408.06 BASIS OF PAYMENT. When indicated on the Plans or required on the project accepted quantities of prime coat shall be included in other items of work, which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

411.00 PLANT MIX ASPHALT CONCRETE PAVEMENT

411.01 DESCRIPTION. This work shall consist of acceptable constructed bituminous mixtures in accordance with these Specifications and requirements for the type of plant mix asphalt concrete under contract. The finished products shall meet the specific requirements of the Contractor's approved mix design, materials gradation, blend of materials, bitumen content, roadway density, and stability, and be in close conformity with the lines, grades, thickness and typical cross-sections shown on the Plans or established by the Engineer. The finished surface shall be free from short wavelength roughness as evidenced by meeting the specification for surface tolerance, non-uniform mat texture and segregation, bleeding or fat spots, surface cracking and poor construction joints.

411.02 MATERIALS. Materials shall meet the requirements of Section 708. The Contractor shall have ample material in the stockpiles at the plant site at the beginning of each day's operation to supply and be used for that day's operation.

Reclaimed asphaltic concrete materials or reclaimed portland cement concrete materials, that have been processed into quality aggregates that meet the requirements of Section 708 of these Specifications, may be used with prior written permission by the Engineer.

411.03 EQUIPMENT.

A. Mixing Plants. At all times the Contractor shall have available at the plant site a legible copy of the manufacturer's specifications for the mixing plant and any modifications made to the plant including the manufacturer's tolerances for points of wear effecting the production of bituminous mixtures. Mixing plants shall be inspected and found to be within manufacturer's tolerances, in good working order, and be of sufficient capacity and coordinated to adequately produce the required bituminous mixture. All plants used by the Contractor for preparation of bituminous concrete mixtures shall conform to the requirements of AASHTO M 156 for plants and shall be able to meet the Oklahoma Department of Transportation certification requirements. Batch plants shall be equipped with a mechanical batch counter.

1. *Calibration Charts.* The Contractor shall develop and maintain calibration charts for each cold feed for the job aggregates or other suitable evidence of compliance with the paving mixture Specifications.

B. Scales. The bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. When an approved automatic printer system is used in conjunction with an automatic batching and mixing control system, the printed batch weights may be used in lieu of truck scales. Such weights shall be evidenced by a weigh ticket for each load. Scales shall be inspected and certified as often as the

Engineer deems necessary to assure their accuracy but not less than once every 6 months.

C. Bituminous Pavers. Bituminous pavers shall be in good working order, self-contained, power-propelled units, provided with an activated heated screed, with an approved automatic control device for laying the mixture to the specified slope and grade, and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thicknesses shown on the Plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the Plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation and equipped with a distribution system to place the mixture uniformly in front of the screed.

The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

When laying mixtures, the paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture.

The Contractor may use an approved strike-off assembly, heated if necessary, provided the finished surface produces the required evenness and uniform texture without tearing, shoving, or gouging the mixture.

D. Trucks and Transports.

1. Trucks used for hauling bituminous mixtures shall comply with legal load limits and have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of soap solution, lime solution or other approved material to prevent the mixture from adhering to the beds. Anti-adhesive solutions shall not be allowed to pond in the truck beds. The use of solutions which contain diesel fuel or other contaminating solvents will not be allowed between daily truck deliveries.

Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

2. Transports used for hauling liquid asphalt materials shall comply with Subsection 708.03.B. The Contractor shall keep a log or diary containing the delivery date, asphalt grade, source, quantity, invoice number and the material hauled in the previous load. This information shall be furnished to the Engineer upon request.

411.04 CONSTRUCTION METHODS.

A. Stockpiling Materials. Delivering and stockpiling of aggregates shall be in accordance with Subsection 106.07.

B. Preparation of Materials.

1. The bituminous material and aggregate shall be heated to the temperature specified in Subsection 708.03 and in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

2. Flames used for drying and heating the aggregate shall be properly adjusted to avoid damage to the aggregate and avoid soot on the aggregate.

3. For plants controlling gradation of hot dry aggregates, the aggregate shall be screened and stored in separate bins.

C. Mixing. The aggregates shall be combined in the mixer in the amount of each fraction of aggregates required to meet the approved job-mix formula. The bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula. The moisture content of the bituminous mixture at the point of discharge shall not exceed 0.75 percent. Uncoated or non-uniform mixtures will not be accepted.

During daily start-up or shutdown of plant operations, sufficient material shall be wasted to assure that all deliveries to the storage silo or roadway are in compliance with the Specification requirements for the type mixture specified. At any time during the course of producing bituminous mixtures, the Contractor shall not change from one type of mixture to another until the plant has been emptied and the cold feed bins charged with the proper aggregates.

D. Segregation of Mixture. Segregation of the mixture will not be acceptable.

E. Tack Coat. Tack coat, if required, shall be in accordance with Section 407.

F. Weather Limitations. The minimum surface temperature of the foundation course on which asphalt concrete may be laid shall be as shown in the following table.

Compacted Lift Thickness (Inches)	Surface Temperature (Minimum)
3 or more	40° F
1½ to 3	45° F
Less than 1½	50° F

Asphalt concrete shall not be laid when there is frost in the foundation course. When a strong wind is blowing or conditions otherwise are such that the material becomes chilled to an extent which prevents proper leveling and thorough consolidation, the laying of the asphalt concrete shall be stopped.

G. Spreading and Finishing. The asphalt mixture shall be laid with a paver meeting the requirements of Subsection 411.03 C. and upon an approved surface which is dry. The mixture shall be delivered on the job at an optimum workable temperature which will produce the density herein specified after final compaction. After the optimum workable temperature is determined, it shall not vary more than + 20° F.

The alignment of one edge of the asphalt mixture shall be established by a string or wire line in advance of the placing of the asphalt mixture.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be dumped, spread, raked and luted by hand tools to give the required compacted thickness.

Placing of mixtures shall be as continuous as possible.

Immediately adjacent to curbings, gutters, manholes, and other structures, the wearing course mixture shall be spread uniformly high so that after compaction it will be level with the edges of such structures. Before placing the mixture against them, all contact surfaces of curbs, gutters, headers, manholes, etc., shall be cleaned and painted with a thin uniform tack coat of a type specified herein.

When an unsatisfactory asphalt course is being produced, the Contractor shall immediately make the necessary corrections to obtain a satisfactory surface. If deemed necessary, the Engineer may terminate the lay-down operation until such time as satisfactory performance can be obtained and require that the unsatisfactory material be removed as unacceptable work.

H. Joints. Longitudinal and transverse joints on succeeding lifts shall be staggered approximately 6 inches and made in a careful manner.

The longitudinal joints in the top layer shall be at lane lines.

Well bonded and sealed joints are required. Joints between old and new

pavements or between successive days' work shall be carefully made in such a manner as to insure a thorough and continuous bond between the old and new surfaces. The edge of the previously laid course shall be cut back to its full depth so as to expose a fresh surface, after which the edge shall be painted with a tack coat and the hot mixture shall be placed in contact with it and raked to a proper depth and grade.

I. Compaction.

1. *General.* Compacting and smoothing shall be accomplished by use of self-propelled steel wheel and pneumatic tired compactors. Steel wheeled compactors shall weigh not less than ten tons.

   Pneumatic tired compactors shall have at least seven pneumatic tires of equal size and diameter. They shall be constructed so that their total weights shall be varied to produce an operating weight of not less than 3500 pounds per tire. The tires shall be capable of being inflated to at least 110 pounds per square inch (psi) and be spaced so that the gaps between adjacent tires shall be covered by the following tires. Operating tire pressure (after one hour of operation) shall be maintained at 90 to 110 psi with variance in pressure between tires not to exceed 10 psi.

   Compactors shall be of adequate number, size and weight and designed and properly maintained so that they are capable of accomplishing the required compaction and shall be operated in accordance with the manufacturer's recommendations.

   During compaction, any displacement occurring as a result of the reversing of direction of compactor, or other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in compaction not to displace the line and grade of the edges of the bituminous mixture. Damage, caused by adhesion of the mixture to the compactors, will not be permitted.

   Along forms, curbs, headers, walls, and other places not accessible to the compaction equipment, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers. A trench compactor to transmit compression to a depressed area may be used when approved by the Engineer.

   Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced at the expense of the Contractor as unacceptable work.

2. Acceptance.

All lifts 1½ inches or greater in nominal (Plan) thickness including both new construction and overlays will be accepted on the basis of density as specified in Subsection 2.1.

All lifts less than 1½ inches in nominal thickness will be accepted on the basis of compactive effort as specified in Subsection 2.2.

Both new construction and overlays (all thickness) will be tested every 450 tons or 1700 sq. yds. of asphalt, extraction and gradation and stability hveems, and every 600 tons or 2300 sq. yds. for field densities.

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250° F. The target density of thicker lifts and optimum densities of thinner lifts shall be obtained before the mat temperature of the lift under compaction drops below 180° F.

2.1 All lifts 1½ inches or greater in nominal (Plan) thickness. The target density of each lot shall be 94 percent of Maximum Theoretical Specific Gravity at the Job Mix Formula (JMF) asphalt content determined by the most recent specific gravity of the bituminous paving mixture in accordance with AASHTO T209.

The roadway density for each lot will be the average of three separate tests taken randomly within the limits of the area represented by the lot.

2.2 All lifts less than 1½ inches in nominal (Plan) thickness. Through the use of test strips and daily monitoring of asphalt placement, the Engineer and Contractor will determine the rolling patterns necessary to obtain optimum compaction. While 94 percent of maximum theoretical density shall be considered the target, acceptance will be based on the Contractor performing as agreed to obtain compaction.

New monitoring and/or test strip shall be required either when ordered by the Engineer or requested by the Contractor under one or more of the following conditions:

(a) There is a change in the material or mix design.

(b) There is reason to believe the material being placed or the underlying material has changed significantly.

Compaction shall consist of an established sequence of coverage using specified types, sizes and weights of compactors adjusted as necessary to obtain optimum density.

The rolling sequence, the type of compactor to be used, and the maximum roller speed shall be as follows:

Rolling Sequence	Type Compaction	Max. Roller Speed (MPH)
Initial	Steel Wheel or Pneumatic Tired	2½
Intermediate	Pneumatic Tired	2½
Finish	Static Steel	3

Changes to the compactive effort shall be made as directed by the Engineer based upon results from monitoring and/or any subsequent test strips.

J. Tolerances.

1. *Surface.* The surface tolerance shall be in conformity with Section 401.

2. *Width and Thickness.* The width shall be in reasonably close conformity with the dimensions shown on the Plans or established by the Engineer.

   The thickness of individual courses and the total thickness of the asphalt concrete pavement shall be in reasonably close conformity with the thicknesses shown on the Plans or established by the Engineer.

K. Opening to Traffic. Traffic shall not be permitted on the asphalt concrete pavement until it has received its final rolling and the mat temperature has stabilized.

411.05 METHOD OF MEASUREMENT.

A. Plant mix asphalt concrete pavement including the aggregate, liquid asphalt and other ingredients as specified in the job-mix formula shall be measured by the ton of combined mixture.

B. Tack coat will be measured and paid for in accordance with Section 407.

411.06 BASIS OF PAYMENT. Accepted quantities for plant mix asphalt concrete pavement, measured as provided above, shall be paid for at the contract unit price for:

(A)	Asphalt Concrete, Type A	Ton
(B)	Asphalt Concrete, Type B	Ton
(C)	Asphalt Concrete, Type C	Ton
(D)	Asphalt Concrete, Type D	Ton

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

414.00 PORTLAND CEMENT CONCRETE PAVEMENT

414.01 DESCRIPTION. This work shall consist of constructing a jointed pavement composed of portland cement concrete (P.C.C.) with or without reinforcement or continuously reinforced pavement, as specified, on a prepared base course in accordance with these Specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross-sections shown on the Plans or established by the Engineer.

414.02 MATERIALS.

Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Portland Cement Concrete	701
Fly Ash	702
Steel Reinforcement, Dowell Bars & Tie Bars	723

Tie bars which are bent and later straightened to facilitate construction shall conform to:

Deformed Billet-Steel Bars for Concrete Reinforcement	AASHTO M 31	Grade 40

Steel for wide flange terminal joint steel beams shall meet the requirements of AASHTO M 183. Terminal joint steel beams shall be galvanized in accordance with AASHTO M 111 after fabrication (including end plates and shear studs).

Reclaimed portland cement concrete materials may not be used. The Contractor shall furnish to the City copies of his quality control tests.

414.03 EQUIPMENT. Equipment and tools necessary for handling materials and performing all parts of the work shall be the responsibility of the Contractor as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations.

A. Plants and Equipment.

1. *General.* The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. All controls, gauges, revolution counters, etc. shall be properly functioning.

The Contractor shall provide, if requested, documented evidence to The City that the batching plant is producing quality concrete, and that the plant is functioning in proper working order at all times. See AASHTO M 157 Annex "Concrete Uniformity Requirements". The mixing plant shall conform to requirements of AASHTO M 157 as appropriate.

The mixers shall be cleaned at suitable intervals. The pickup and throw-over blades in the drum or drums shall be repaired or replaced when they are worn. The Contractor shall have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth.

Storage silos for cement and fly ash shall be properly vented during filling or use.

Plants and scales shall be inspected and certified as often as the Engineer may deem necessary to assure their accuracy but not less than every 6 months.

B. Finishing Equipment.

1. *Finishing Machine.* The finishing machine shall be equipped with at least two oscillating type transverse screeds or other approved methods of striking off the concrete. Rotary type finishing machines will not be accepted, except in areas in accessible to mainline paving equipment. When this type of equipment is approved for use, the finished pavement shall meet the specified paving tolerances.

2. *Vibrators.* Vibrators, for full width vibration of concrete paving slabs, may be the internal type with either immersed tube or multiple spuds. Pan type vibrators, if used, shall be used in conjunction with internal type vibrators. They may be attached to the spreader of the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, sub-grade, or side forms. The rated frequency of the surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand-operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.

3. *Transverse Grooving Machine.* The transverse grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb bar near the edge of the pavement to minimize edge damage. Hand

grooving methods will be permitted in a manner accepted by the Engineer in those areas where the mechanical equipment cannot be used.

C. Concrete Saw. The Contractor shall provide sawing equipment in good working condition, adequate in number of units and power, to complete the sawing to the required dimensions and at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. All of this equipment shall be on the job both before and continuously during concrete placement.

D. Forms. Straight side forms shall be made of a metal having a thickness of not less than 7/32 inch and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth at least equal to the prescribed thickness of the concrete and a base width that will provide adequate support for all equipment operating on the forms. Flexible or curved forms of proper radius shall be used for curves of 100 feet radius or less. Flexible or curved forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than 2/3 height of the form. Forms with battered top surfaces, and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4 inch. The forms shall be cleaned of old accumulated concrete, grout, or other materials. The forms shall be sprayed or covered with a form release agent prior to their use.

E. Header Boards. Header boards to be used when paving operations are stopped shall be of 2 inch material, cut to the exact cross-section of the paving slab and set to a line parallel to the transverse joint. The boards shall be so designed as to insure accurate installation of dowels or tie boards as called for on the Plans.

F. Longitudinal Float. The longitudinal float may either be a mechanical float or screed mechanism acceptable to the Engineer or a manually operated float. The hand operated float shall be a rigid straightedge float not less than 12 feet nor more than 18 feet in length with a troweling or smoothing surface not less than 8 inches nor more than 12 inches in width, and shall be worked from bridges spanning the pavement.

Longitudinal floats shall be maintained in good repair and working order at all times. If satisfactory results are not being obtained by use of a mechanical float, a manually operated float shall be available on the job for immediate use in lieu of the mechanical float.

The mechanical float shall be so adjusted and so operated that the screed will have a small quantity of concrete in front of it at all times. The screed shall not be raised or lowered solely for the purpose of maintaining the proper amount of concrete in front of the screed.

In lieu of the mechanical or hand operated longitudinal float, the use of a finishing machine with the float pan type finisher will be permitted provided that satisfactory performance and specified surface smoothness and tolerances are obtained.

G. Small Tools, Belt and Burlap Drag. The Contractor shall furnish a sufficient number of work bridges, hand floats, 10 foot straightedges, and small tools to satisfactorily complete the pavement as specified herein. Any float or straightedge which becomes warped or distorted and any belts or finishing tools which are defective, shall be promptly replaced with acceptable appliances.

The burlap drag shall consist of a seamless strip of burlap or cotton fabric, which shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. The dimensions of the drag shall be such that a strip of burlap or fabric at least 3 feet wide is in contact with the full width of the pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 6 inches wider than the upper layer.

H. Spraying Equipment. The equipment for applying the white pigmented curing membrane shall be the fully atomizing type equipped with a tank agitator which will keep the compound thoroughly mixed during application. Hand sprayers of the pressure tank type accepted by the Engineer may be used to apply curing membrane to vertical surfaces, irregular areas or edges after form removal.

I. Joint Sealing Equipment. All necessary equipment shall be furnished by the Contractor in accordance with the requirements of Subsection 108.06. Minimum requirements for construction equipment as required to complete the work are specified herein.

1. *Concrete Saw.* The Contractor shall provide sawing equipment adequate in size and power to complete the sawing of concrete joints to the required dimensions.

2. *Hydroblast Unit.* High pressure cold water jet system for cleaning joints as specified, utilizing 2,000 psi minimum nozzle pressure.

3. *Air Compressors.* Air compressors capable of delivering compressed air having a pressure in excess of 90 psi and equipped with suitable traps for removal of all free water and oil from the compressed air.

4. *Extrusion Pump.* Air-powered extrusion pumps for applying the joint sealant shall have an output capable of delivering a sufficient volume of sealant to the joint.

5. *Injection Tool.* A mechanical injection device shall be furnished for applying the sealant into the joint.

6. *Sand-Blast Unit.* The sand-blasting equipment shall provide oil and moisture-free air and be adequate in size and power to clean the joints.

7. *Joint Sealer Kettle.* When the joint sealant requires heating, the kettle shall be a double bottom oil bath indirect flame type, adequate in size and power to mix, heat, deliver and maintain the desired temperature.

414.04 CONSTRUCTION METHODS.

A. Preparation of Grade. After the roadbed has been graded and compacted, the grade shall be trimmed approximately to correct elevation, extending the work beyond each edge of the proposed concrete pavement. When the foundation is stabilized with an admixture, it shall be within the tolerances provided for the foundation type.

B. Setting Forms. Forms shall be set to line and grade by shimming or other approved methods. Imperfections or variations in the base or foundation which prohibits the placement of forms to the specified lines or grades shall be corrected in a manner accepted by the Engineer. Forms shall be staked into place. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than 0.25 inch at any point. No excessive settlement or springing of forms under the finishing machine will be tolerated. Forms shall be cleaned and oiled prior to the placing of concrete.

1. *Grade and Alignment.* The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and re-checked.

C. Conditioning of Sub-grade or Base Course. When sideforms have been securely set to grade, the sub-grade or base course shall be brought to proper cross-section.

When cementitious bases are used, material trimmed from high areas shall be removed and low areas shall be filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

Unless waterproof sub-grade or base course cover material is specified, the sub-grade or base course shall be uniformly moist when the concrete is placed.

D. Handling, Measuring and Batching Materials. The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the work. The quantities of materials available at the concrete plant at no time shall be less than that required for a normal day's paving operation. Delivering and stockpiling materials shall be in accordance with Subsection 106.07.

Materials for concrete shall be measured and batched in accordance with AASHTO M 157, except as otherwise specified. The fine aggregate and each size of coarse aggregate shall be separately weighed into hoppers in the respective amounts set in the job mix. Cement shall be measured by weight. Separate scales and hoppers shall be used for weighing the cement, with a device to indicate positively the complete discharge of the batch of cement into the batch box or container.

E. Mixing Concrete. Concrete shall be mixed and delivered in accordance with AASHTO M 157 except as otherwise specified. The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type ad capacity. Mixing time shall be measured from the time all materials, except water, are in the drum. There shall be a maximum time limit of 1 hour from the time that the water, cement and aggregate are combined until the mixed concrete is deposited in its final position in the forms.

When mixed at the site of the work or in a central mixing plant, the mixing time shall not be less than 50 seconds nor more than 90 seconds. Four seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included

in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixers nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10 percent above the mixers nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

Re-tempering concrete by adding water or by other means will not be permitted, except that when concrete is delivered in transit mixers or agitators additional water may be added to the batch materials and additional mixing performed at 20 revolutions at mixing speed, provided the design maximum water-cement ratio is not exceeded.

F. Limitations of Mixing. No concretes shall be mixed, placed or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50° F and not more than 90° F at the time of placing it in the forms.

Concreting under adverse weather conditions, as defined in Section 101, shall be according to Section 509.04 F. The Contractor shall be responsible for the protection and quality of concrete placed during any weather conditions.

G. Placing Concrete. The concrete shall be deposited on the grade in such a manner as to require as little re-handling as possible. Unless truck mixers, truck agitators or non-agitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such a manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon existing lane of pavement, that lane shall have attained the strength specified for opening to traffic (Subsection 414.04 Q). If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after 3 days.

Concrete shall be thoroughly consolidated against the supporting grade and against the face of all forms and joint assemblies throughout their full length. The vibrator shall not be operated in any one location longer than necessary to complete the consolidation.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

Concrete shall not be placed unless an inspector is present.

H. Test Specimens. The Contractor shall furnish the concrete necessary for performing acceptance testing.

I. Joints. Joints shall be constructed perpendicular to the surface of the slab and of the type, dimensions, and at locations shown on the Plans. Suitable guide lines or devices shall be used to assure satisfactory alignment of joints.

All sawed joints shall be reasonably straight and true to line as to be pleasing in appearance. Those not shall be repaired or corrected to the satisfaction of the Engineer.

The sawed joints shall be thoroughly cleaned by hydroblasting and/or sand blasting methods, to be determined by existing field conditions. The joints are to be free from all dust coating, any contaminates and free from all moisture that might interfere with the proper and satisfactory bonding of the approved joint sealing material.

1. *Longitudinal Joints.* Longitudinal joints shall be formed by sawing. Deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to the longitudinal joint. Tie bars shall be placed, by approved mechanical equipment or rigidly secured by chairs or other approved supports, to prevent displacement. Tie bars shall not be painted or coated with asphalt or other materials or enclosed in tubes or sleeves.

The longitudinal joint shall be sawed as soon as possible to the depth shown on the Plans without causing damage to the pavement or joint. The sawed area shall be thoroughly cleaned and be free from dust, chalk, contaminants and filled with an approved joint sealing material.
Construction equipment and other vehicles which may cause damage to the pavement joints shall not be allowed on the pavement before the end of the curing period.

When tested with a straightedge, the surface across any joint shall not vary from the straightedge by more than 1/8 inch.

2. *Transverse Joints.*

2.1 Expansion Joints. The expansion joint filler shall be continuous from form to form, shaped to the sub-grade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

Pre-molded joint filler shall be appropriately punched to the exact diameter and location of the dowels. It shall, unless otherwise provided, be furnished in lengths equal to the pavement width. However, in cases where pavement two or more traffic lanes wide is being placed, the pre-molded filler may be furnished in sections, provided the length of each section is equal to the width of one lane. Where more than one section is used in a joint, the sections shall be securely laced or clipped together. The pre-molded joint filler shall be placed on the side of the installing bar nearest the mixer. The bottom edge of the filler shall project to or slightly below the bottom of the slab and unless otherwise prescribed, the top edge shall be one inch below the surface of the pavement. While the concrete is being placed, the top edge of the filler shall be protected by a metal channel cap of at least 10-gauge material, having flanges not less than 1½ inches in depth.

After concrete has been placed on both sides of the joint and struck off, the installing bar shall be slowly and carefully withdrawn leaving the pre-molded filler in place. Before the installing bar and channel cap is completely withdrawn, the concrete shall be carefully vibrated and additional freshly mixed concrete worked into any depression left by the removal of the installing bar. The filler must be exposed for the full width of the slab. The installing bar must be cleaned and re-oiled prior to each installation of a joint. After the removal of the side forms, the ends of the transverse joints at the edges of the pavement shall be carefully opened for the entire depth of the slab. Before the pavement is opened to traffic, pre-molded joints

shall be sealed or topped out with the joint sealing filler specified, leaving a neat uniform strip of joint sealing filler slightly below the surface of the pavement.

Joints in concrete curbing that cannot be satisfactorily sawed shall be formed by means of steel templates or other approved joint forming dividers installed at the time the concrete is poured and at the location of the joint to be sawed

2.2 Contraction Joints. Transverse contraction joints shall be formed by sawing.

The contraction joints shall be sawed as soon as possible to the depth shown on the Plans without causing damage to the pavement or joint. Succeeding joints shall be sawed consecutively from beginning to end of the day's run and all transverse joints shall be sawed soon enough to prevent uncontrolled transverse cracking.

The sawed area shall be thoroughly clean and dry and be free from dust, chalk, contaminants, spalling, and filled with an approved joint sealing material.

Construction equipment and other vehicles which may cause damage to the pavement joints shall not be allowed on the pavement before the end of the curing period.

2.2.1 Skewed Contraction Joints. Skewed transverse contraction joints shall have a nominal 4-inch wide band surface skipped or blanked out from the transverse grooving equipment by mechanical or physical means.

Skewed transverse contraction joints shall be formed by sawing. The contraction joint shall be sawed as soon as possible to the depth shown on the Plans without causing damage to the pavement or joint. The sawed area shall be thoroughly cleaned and dry and be free from dust, chalk, contaminants, spalling and filled with an approved joint sealing material.

Construction equipment and other vehicles which may cause damage to the pavement joints shall not be allowed on the pavement before the end of the curing period.

Contraction joints shall be sawed consecutively from the beginning of the day's run.

2.3 Construction Joints. Unless otherwise directed, transverse construction joints shall be constructed when there is an interruption of more than 30 minutes, or as field conditions dictate in the concreting operations. No transverse joint shall be constructed within 10 feet of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed by the Engineer.

A rigid header shall be provided with holes or slots for dowel bars that shall be of the spacing and dimensions as for expansion joints and in no case shall the transfer load bar vary more than 1/8 inch from the planned horizontal or vertical position.

3. *Load Transfer Devices.* Approved load transfer devices shall be firmly held in the position indicated on the Plans. Dowels shall be held in position parallel to the surface and center line of the slab by an approved support and in no case shall the transfer load bar vary more than 1/8 inch from the planned horizontal or vertical position. Dowels for expansion joints shall be capped as shown on the Plans.

J. Final Strike off, Consolidation and Finishing.

1. *General.* The sequence of operations shall be the strike off and consolidation, floating and removal of laitance, straight-edging, and final surface finish.

The addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted.

2. *Finishing at Joints.*

2.1 The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated.

2.2 After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over, and beyond the joints causes segregation of concrete and of the joints, the finishing machine shall be stopped when the front screed is approximately 8

inches from the joint. Segregated concrete shall be removed from in front of and off the joint. The front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

3. *Machine Finishing*. The concrete shall be distributed or spread as soon as placed. As soon as the concrete has been placed, it shall be struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and to leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish.

   During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length.

   Vibrators for full width vibration of concrete paving slabs, shall meet the requirements in Subsection 414.03 B. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce pavement conforming to the Specifications.

4. *Hand Finishing*. Hand finishing methods will not be permitted except under the following conditions:

   In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade or in transit when the breakdown occurs.

   Narrow widths or areas of irregular dimensions where operation of the mechanical equipment is impractical may be finished by hand methods.

Concrete as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.

The screed for the surface shall be at least 2 feet longer than the maximum width of the slab to be struck off.

Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

In operation the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture reasonably true to grade and cross-section and free from porous areas.

5. *Floating.* After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal float.

   If necessary, long handled floats having blades not less than 5 feet in length and 6 inches in width may be used to smooth and fill in open textured areas in the pavement. Long handled floats shall not be used to float the entire surface of the pavement. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge 10 feet or more in length.

   Successive drags shall be lapped one-half the length of the blade.

6. *Straightedge Testing and Surface Correction.* After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a 10 foot straightedge. For this purpose, the Contractor shall furnish and use an accurate 10 foot straightedge. The straightedge shall be held in contact with the surface in successive positions parallel to the road center line and the whole area gone over from one side of the slab to the other as necessary. Advance along the road shall be in successive stages of not more than one-half the length of the straightedge. Any

depressions found shall be immediately filled with freshly-mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross-section.

7. Finishing.

7.1 Burlap Drag. The burlap drag shall be used prior to final finish of the pavement surface. The burlap or cotton fabric drag shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. For pavement 16 feet or more in width, the drag shall be mounted on a bridge which travels on the forms. The drag shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drag substituted.

7.2 Transverse Groove Final Finish. When final longitudinal texturing with the burlap drag is completed, the plastic pavement surface shall be mechanically transverse grooved and textured in a manner accepted by the Engineer with equipment meeting the requirements of Subsection 414.03 B. 3.

The grooves shall be perpendicular to the center line of the pavement, 0.08 to 0.125 inches wide, 0.125 to 0.250 inches deep, and approximately spaced at 0.50 to 1.0 inches. The machine shall automatically lift the roller or tines near the edge of pavement so that edge damage shall be held to a minimum. The overlap between grooving passes shall be less than 3 inches.

In those areas where mechanical grooving equipment cannot be operated, hand grooving methods will be permitted in a manner approved by the Engineer.

7.3 Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse

construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the Plans. A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

All joints shall be tested with a straightedge before the concrete has set, and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

K. Surface Tests. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 10-foot straightedge or other specified device. Areas showing high spots of more than 1/8 inch but not exceeding 1/2 inch in 10 feet shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10-foot straightedge. The surface of ground areas shall be re-textured to match the surface of the surrounding areas. Where the departure from correct cross-section exceeds 1/2 inch, the pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be not less than 10 feet in length, nor less than the full width of the lane involved. When it is necessary to remove and replace a section of payment, any remaining portion of the slab adjacent to the joints that is less than 10 feet in length, shall also be removed and replaced.

L. 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. In all cases in which curing requires the use of water, the curing shall have prior right to all water supply or supplies. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other

requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than one-half hour between stages of curing or during the curing period.

1. *Cotton or Burlap Mats.* The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighted down as to cause them to remain in intimate contact with the surface covered, and covering shall be maintained fully wetted and in position for 72 hours after the concrete has been placed unless otherwise specified.

2. *Impervious Membrane Method.* The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound meeting the requirements of Subsection 701.07 D. immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with jute or cotton mats, it may be applied upon removal of the mats. The curing compound shall not be applied during rainfall.

   Curing compound shall be applied under pressure at the rate of one gallon to not more than 200 square feet by mechanical sprayers meeting the requirements of Subsection 414.03 H. Provided, however, that when the temperature on the roadway is 100° F or above, the curing compound shall be applied at the rate of one gallon to not more than 150 square feet.

   At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. Hand-spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed.

   The curing compound shall be of such character that the film will harden within 4 hours after the application. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound.

Upon removal of side forms, the sides of the slabs, exposed shall be protected immediately to provide a curing treatment equal to that provided for the surface.

3. *White Polyethylene Sheeting.* The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 18 inches. The sheeting shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimensions that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed.

4. *Curing of Cold Weather.* The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

M. Removing Forms. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated above. Honeycombed areas shall be satisfactorily repaired.

N. Sealing Joints. The joints shall be of the type shown on the Plans. All joints shall be reasonably true to the line width and depth shown on the Plans. Joints in portland cement concrete pavement shall be thoroughly clean and dry prior to placement of backer rod and/or joint sealant. Cleaning shall be done by the hydroblast method, with a minimum nozzle pressure of 2,000 psi, and/or sandblasted. The method used will be determined by existing field conditions.

O. Protection of Pavement. The Contractor shall erect and maintain suitable barricades and employ watchmen as may be required to exclude traffic from newly constructed pavement for the period herein prescribed. When it is necessary to provide for traffic across the pavement, the Contractor shall at his expense, construct suitable and substantial crossings to bridge over the concrete, which will be adequate for the traffic and satisfactory to the Engineer. The Contractor shall protect the pavement against both public traffic and the traffic caused by his own employees and agents. All

ditches and drains shall be in such condition as to provide effective drainage. When berms of earth are placed along the shoulders, proper provisions shall be made for the surface drainage. Any part of the pavement damaged by traffic or other causes, occurring prior to its final acceptance, shall be repaired or replaced, by and at the expense of the Contractor, in a manner satisfactory to the Engineer.

P. Opening to Traffic. Traffic shall be excluded from the newly constructed pavement for a period of 14 days after the concrete is placed or longer if weather conditions make it advisable to extend this time. However, at the discretion of the Engineer, the pavement may be opened to traffic when specimen beams or cylinders made, cured and tested meet the strength requirements specified in Subsection 701.01 D.

Q. High-Early-Strength Concrete Pavement.

1. *General Requirements.* When high-early-strength concrete pavement is specified, it shall be made with high-early cement and meeting the other requirements of Section 701. In lieu of high-early-strength cement, and with written permission of the Engineer, the Contractor may use standard portland cement with a cement factor 25 percent in excess of that specified for portland cement concrete pavement. No additional compensation shall be allowed for the 25 percent additional cement if standard portland cement is used. When 25 percent of cement is added, the absolute volumes in the mix shall be adjusted to compensate for the additional cement. All other requirements hereinbefore specified for concrete pavement shall be applicable subject to the following modifications.

2. *Curing.* When high-early-strength concrete pavement is specified or used, the pavement shall be cured in the same manner as is provided for regular pavement.

3. *Opening to Traffic*. Traffic shall be excluded from the newly constructed pavement for a period of not less than 24 hours and for 72 hours if necessary, unless test beams or cylinders prepared meet strength requirements specified in Subsection 701.01 D before 72 hours.

R. Optional Use of a Slip-Form Paver. If the Contractor so elects, a slip-form paver may be used in lieu of the conventional paving train and stationary side forms.

When a slip-form paver is used, all requirements of placing pavement with rigid forms shall be complied with except as provided herein:

1. *Grade.* After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of a properly designed machine. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before concrete is placed. The grade shall be constructed sufficiently in advance of the placing of the concrete.

   If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete. When the foundation for the surfacing is stabilized with an admixture, the area under the pavement and the supporting area for the paving machine shall be within the specified tolerances for the foundation type before concrete is placed.

2. *Placing Concrete.* The concrete shall be placed with an approved slip-form paver designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibrations shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

   The slip-form paver shall be operated with a continuous forward movement and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide a uniform progress with stopping and starting of the paver held to a minimum.

   If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

3. *Finishing.* A tube float finishing machine shall be used immediately following the slip-form paver, in a manner approved by the Engineer.

4. *Tolerances.* Tolerances of the finished pavement shall meet the requirements of Subsection 414.04 T. except that for the outer 6 inches along the edges of the pavement, a maximum deviation of 1/4 inch from a 10-foot straightedge placed perpendicular to the center line of the roadway will be permitted. When auxiliary parallel lanes are constructed using a slip-form paver, there shall be no appreciable slump along edges of adjoining lanes. Any valleys or depressions that will not drain properly shall be corrected by the Contractor at his own expense to the satisfaction of the Engineer.

5. *Curing.* Unless otherwise specified, curing shall be done in accordance with one of the methods included in Subsection 414.04 M. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the payment.

6. *Joints.* All joints shall be constructed in accordance with Subsection 414.04 J.

7. *Protection Against Rain.* In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 2 inches and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain appears eminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

S. Tolerances.

1. *Surface.* The surface tolerance shall be in conformity with Section 401.

2. *Width and Thickness.* The width shall be in reasonably close conformity with the dimensions shown on the Plans or established by the Engineer. The thickness of the pavement will be determined by the average caliper measurement of cores tested in accordance with AASHTO T 148.

T. Acceptance of Pavement. Pavement slabs may be rejected because of unsound concrete, uncontrolled cracking, malfunctioning of the sawed joints, spalling, honeycombing, surface irregularities, insufficient thickness, or for any deficiencies commonly associated with poor quality pavements. Rejected slabs shall be removed and replaced with new pavement conforming to these requirements. The removal and replacement shall be at least one lane in width and ten feet in length. Where the linear extent of removal falls within ten feet of a transverse joint, the removal limits shall be extended to the joint.

414.05 METHOD OF MEASUREMENT.

A. Portland Cement Concrete Pavement. The yardage to be paid for under this item shall be the number of square yards of concrete pavement of the type shown on the Plans or in the Proposal, completed and accepted, measured complete in place. The width for measurement will be the width from outside to outside of the completed pavement, but not to exceed the width as shown on the Plans or as directed by the Engineer. The length will be the actual length measured along the riding surface on the center line of the road, and shall exclude the length occupied by bridges, approach slabs, and all other exceptions. Reinforcing steel, load transfer devices, joint fillers and joint sealers will not be measured for payment.

B. Approach Slabs. The yardage to be paid for under this item will be measured as provided above for portland cement concrete pavement.

414.06 BASIS OF PAYMENT. The accepted quantities of concrete pavement, and approach slabs, measured as provided above, will be paid for at the contract unit price for:

(A)	Portland Cement Concrete Pavement	Sq. Yd.
(B)	High-Early-Strength Concrete Pavement	Sq. Yd.
(C)	Approach Slabs	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

No additional compensation will be allowed when the Contractor, at his option, uses high-early-strength portland cement in lieu of standard portland cement.

417.00 COLD MILLING PAVEMENT

417.01 DESCRIPTION. This work shall consist of cold milling and removing existing pavement surfaces below the present grade to a depth shown on the plans, removing ridges, ruts and other imperfections as determined by the Engineer. The milling operation shall produce a plane surface that will provide a smooth riding surface for traffic.

417.03 EQUIPMENT. The Contractor shall provide a power-operated milling machine capable of planing a minimum depth of one and one-half inches in a single pass. The equipment shall be self-propelled with sufficient power, traction and stability to maintain accurate depth of cut and slope. The equipment shall be capable of accurately and automatically establishing profile grades along each edge of the machine by referencing the existing pavement by means of a ski, or matching shoe or from an independent grade control, and shall have an automatic system for controlling cross slope at a given rate. The machine shall be equipped with an integral loading means to remove the material being cut from the pavement surface and to discharge the cuttings into a truck, all in a single operation.

417.04 CONSTRUCTION METHODS. The existing pavement shall be uniformly milled to provide a uniform texture, true to line, grade and cross-section, it shall have no deviations in excess of 3/16 inch in ten feet. Any portion of the planed surface not meeting this requirement shall be corrected in a manner approved by the Engineer.

The machine shall make as many passes as necessary to remove irregularities and to profile the surface to the depth and cross-slope shown on the Plans.

Cold milling shall be done in a manner that will not create undue traffic hazards.

The milling operation shall be performed in each lane in such a manner that the milled lanes are evened up as near as practical at the end of each day's operation so as to eliminate the hazard of an exposed vertical edge when traffic is carried through construction.

All materials removed shall become the property of the Contractor and shall be disposed of by him in accordance with Section 104.06 unless otherwise specified on the Plans.

417.05 METHOD OF MEASUREMENT. Cold milling pavement will be measured by the square yard of surface area.

417.06 BASIS OF PAYMENT. Accepted quantities of cold milling pavement, measured as provided above, will be paid for at the contract unit price for:

Cold Milling Pavement	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

419.00 CONCRETE JOINT REHABILITATION

419.01 DESCRIPTION. This work shall consist of sawing, cleaning and sealing contraction joints in existing portland cement concrete pavement in reasonably close conformity with the details shown on the Plans or as approved by the Engineer.

419.02. MATERIALS. Materials shall meet the requirements of Subsection 701.08 the type joint filler or sealer shown on the Plans or designated in the Proposal.

419.03. EQUIPMENT. All necessary equipment shall be furnished by the Contractor in accordance with the requirements of Subsection 108.06. The minimum requirements for construction equipment as required to complete the work are specified herein.

A. Concrete Saw. Sawing equipment adequate in size and power to complete the sawing of concrete joints to the required dimensions.

B. High Pressure Water Pumping System. High pressure water pumping system capable of delivering sufficient pressure and volume of water to thoroughly flush concrete slurry from sawed joints.

C. Sand Blasting Unit. Compressed air pressure type sand blasting equipment of proper size and capacity to clean joint surfaces as specified. The unit shall be equipped with suitable traps for removal of all free water and oil from the compressed air.

D. Air Compressors. Air compressors capable of delivering compressed air having a pressure in excess of 90 psi and equipped with suitable traps for removal of all free water and oil from the compressed air.

E. Extrusion Pump. Air powered extrusion pumps as required for applying joint sealer with an output capable of delivering a sufficient volume of material to the joint.

F. Injection Tool. A mechanical injection device as required for applying the sealer into the joint.

419.04 CONSTRUCTION METHODS.

A. Sawing Joints. The existing contraction joints shall be cut to the width and depth shown on the Plans. Sawing shall be done in such a manner as to produce a new joint having a cut face on both sides and be uniform in width along its full length.

B. Flushing Joints. Within 5 minutes after sawing, the resulting slurry shall be

removed from the joint and immediate area by flushing with a high pressure water system and other equipment necessary to thoroughly remove the slurry.

C. Cleaning Joint Faces.

1. *General.* The cut faces of the joints shall be thoroughly cleaned of all foreign materials, as may be required for proper installation and bonding of the joint sealer or filler, including old sealant or any residue from water flushing operations, by sandblasting as required. The use of portable hand saws will not be permitted for cleaning joint faces.

   The cut faces of the joint shall be thoroughly air dried for a minimum of 48 hours after flushing with water. Blow drying of the joints with compressed air will not be permitted.

2. *Sandblasting*. After complete drying, the joint shall be sandblasted. The sandblaster nozzle shall be attached to a mechanical aiming device so as to direct the sandblast at approximately a 45 degree angle and at a maximum of 2 inches from the faces of the joint. Both joint faces shall receive sandblasting.

   After sandblasting the joints shall be blown out using filtered oil free and moisture free air at a minimum of 90 psi and 120 cfm. Blowing out of the joint shall be accomplished by using a blow tube which will fit into the joint.

   After blowing, the joint shall be checked for any residual dust or coating. If any is found the sandblasting and blowing operations shall be repeated until the joint is cleaned. The cleaned joints shall be sealed the same day as cleaned. Joints left open overnight shall be recleaned prior to sealing.

3. *Joint Contamination.* In the event the open joints prepared for installation of joint sealing materials become contaminated by traffic, or the result of weather conditions, they shall be recleaned as specified above or as approved by the Engineer.

D. Bond Breaker Rod. When shown on the plans or recommended by the sealant manufacturer, a bond breaker rod shall be installed prior to application of the joint sealant. The bond breaker rod shall be of the type recommended by the manufacturer of the sealant material. The bond breaker rod shall be installed in a manner that will produce the dimensions (width and depth) described on the Plans.

E. Sealing Joints.

1. *Approval of Joints for Sealing*. The Department's inspectors will examine

joints prepared for sealing just prior to installation of the joint filler or sealer. Joints will not be approved for sealing if contaminated or not adequately dry as required for bonding of sealing materials.

2. *Installation of Joint Sealers and Fillers.*

   2.1. General. A representative of the joint filler and/or joint sealer manufacturer shall be on the job site at the beginning of the joint sealing operation to demonstrate to the Contractor and to the Department's inspectors the manufacturer's acceptable standards for installation of the joint sealant materials.

3. *Application of Joint Sealers.*

   3.1. Joint Sealers. The joint sealer shall be applied using a mechanical injection tool approved by the Engineer. Application of the joint sealer will not be permitted when the joint temperature is less than 40° F. Joints shall not be sealed unless they are thoroughly clean and dry. Sealers to fill the joint shall be injected into the joint and applied in a manner which causes it to bond to the joint face surfaces. The surfaces of sealers requiring tooling shall be tooled using an approved mechanical device to produce a slightly concave surface approximately 0.25 to 0.50 inch below the pavement surface. Tooling shall be accomplished before a skin forms on the surface of the sealer. The use of soap or oil as a tooling aid will not be permitted. Tooling will not be required if the sealer is self-leveling.

4. *Bonding Failures.* Failure of the sealant to bond to sawed surfaces of the concrete joint will be cause for rejection and repair shall be at the Contractor's expense.

F. Traffic. Traffic shall not be allowed on the fresh applied sealant until it becomes tack free.

419.05 METHOD OF MEASUREMENT. Concrete joint rehabilitation will be measured by the linear foot after the joint sealant is in place.

419.06 BASIS OF PAYMENT. The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

Concrete Joint Rehabilitation	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

420.00 FABRIC REINFORCEMENT FOR ASPHALT CONCRETE PAVEMENT

420.01 DESCRIPTION. This work shall consist of the application of reinforcement fabric for plant mix asphalt concrete pavement in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Engineer.

420.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Reinforcement Fabric	712.01
Asphalt Cement	708.03

420.03 EQUIPMENT.

A. General. Equipment and tools necessary for performing all parts of the work shall be furnished by the Contractor in conformance with Subsection 108.06.

B. Distributors. Distributors shall meet the requirements of Subsection 401.03. Distributor units shall also be equipped with a hand spray with a single nozzle and positive shut-off valve.

C. Fabric Laydown Equipment. Mechanical laydown equipment shall be capable of handling full or partial rolls of fabric and shall be capable of laying the fabric smoothly without excessive wrinkles and/or folds. When manual laydown is required, a length of standard one-inch pipe, together with suitable roll tension devices shall be used for proper roll handling.

D. Miscellaneous Equipment. Miscellaneous equipment shall include stiff bristle brooms to smooth the fabric, scissors or blades to cut the fabric, and brushes as required for use in applying asphalt binder to fabric overlap at spliced joints.

420.04 CONSTRUCTION METHODS.

A. Surface Preparation. The surface on which the fabric is to be placed shall be free of dirt, dust, water, oil or other foreign matter.

B. Application of Bituminous Binder. Bituminous binder material shall be heated and uniform spray applied over the area to be fabric covered. Laps shall be mopped between layers of fabric. The longitudinal lap may be sprayed with the distributor.

The minimum application temperature of the bituminous binder shall not be less than 290° F. If the fabric is over-sprayed, the maximum application temperature shall not exceed 325° F. to avoid damage to the fabric. The

bituminous binder shall be applied at the rate of 0.20 to 0.35 gal./sq. yd. (actual application rates will be based on asphalt retention tests for the fabric used) as established by the Engineer. Application of the bituminous material shall be accomplished with an asphalt distributor. Areas not accessible to the distributor shall be hand-sprayed. The distributor shall be started and stopped over paper or roofing felt to provide neat cutoff lines. The width of binder application shall be two to six inches wider than the fabric width. Care shall be exercised in the application of the binder to avoid spills or excessive application to cause flushing of the bituminous material.

C. Placement of Reinforcement Fabric. The fabric shall be placed after the bituminous binder has been applied and before the binder has cooled and lost tackiness. The fabric shall be unrolled and placed into the binder with the unfused (fuzzy) side down with a minimum of wrinkles. Every effort shall be made to lay the fabric as smoothly as possible. The fabric shall be broomed to remove air bubbles and maximize fabric contact with the pavement surface. Wrinkles shall be cut and laid out flat. If misalignment of the fabric occurs the fabric shall be cut, realigned and jointed as directed by the Engineer. Overlap of fabric at joints shall be between 4 and 6 inches. Transverse joints shall be shingled in the direction of paving to prevent edge pick up by the paver. Additional binder shall be applied to joints at the rate specified by the Engineer. Transverse joints shall be mopped, brushed or hand-sprayed. The longitudinal joints shall be sprayed with the distributor. The reinforcement fabric shall be embedded into the bituminous binder and bonded to the pavement. Self-propelled pneumatic tired rollers may be used if deemed necessary by the Engineer. Fabric not overlaid the same day shall be blotted with clean apparently dry sand before being turned to traffic. Sand for blotting will be included in other items for payment.

D. Weather Limitations. Asphalt binder shall not be applied for installation of the fabric when the air temperature is less than 50° F unless otherwise approved by the Engineer.

E. Tack Coat. Tack coat, if required for the pavement overlay shall be applied in accordance with Section 407. The bituminous material type, grade, rate of application and temperature shall be approved by the Engineer. Cut-back asphalt or emulsified asphalt containing petroleum distillate additives shall not be used.

F. Pavement Overlay. Placement of the asphalt concrete pavement overlay should closely follow fabric lay down unless otherwise permitted by the Engineer. Any damage or disbonding of the fabric reinforcement membrane caused by traffic or wet weather conditions due to unnecessary delay or negligence of the Contractor shall be repaired at his own expense. In the event excess binder bleeds through the fabric before the overlay is placed, the excess material shall be blotted by spreading sand on the affected area as directed by the Engineer. The temperature of the paving mix at time of

placement on the reinforcement fabric membrane shall not exceed 325° F to prevent damage to the fabric. The turning of pavers or other vehicles should be gradual and kept to a minimum to avoid damage to the fabric. Should equipment tires pick up the fabric or the paver cause movement of the membrane during paving operations asphalt paving mix may be broadcast ahead of trucks and the paver to prevent damage. Any damage to the reinforcement membrane due to equipment shall be repaired by the Contractor at his expense.

420.05 METHOD OF MEASUREMENT.

A. Fabric reinforcement will be measured by the square yard in place.

B. Bituminous binder will be measured by the gallon in accordance with Subsection 109.01 A.

420.06 BASIS OF PAYMENT. The accepted quantities of fabric reinforcement and bituminous binder, measured as provided above, will be paid for at the contract unit price for:

(A)	Fabric Reinforcement	Sq. Yd.
(B)	Bituminous Binder	Gal.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

425.00 DIAMOND GRINDING CONCRETE PAVEMENT

425.01 DESCRIPTION. This work shall consist of grinding portland cement concrete pavement to restore drainage and riding characteristics to the pavement surface. This work shall be accomplished in accordance with these Specifications and in reasonably close conformity to the details shown on the Plans.

425.03 EQUIPMENT. The grinding equipment shall be a power-driven, self-propelled machine that is specifically designed to smooth and texture portland cement concrete pavement with diamond blades. The effective wheel base of the machine shall not be less than 12 feet. It shall have a set of pivoting tandem bogey wheels at the front of the machine and the rear wheels shall be arranged to travel in the track of the fresh cut pavement. The center of the grinding head shall be no further than 3 feet forward from the center of the back wheels.

The equipment shall be of a size that will cut or plane at least 3 feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the work area. Equipment that causes excessive ravels, aggregate fractures, spalls or disturbance of the transverse and longitudinal joints or cracks will not be permitted.

Other equipment may be considered in accordance with Subsection 108.06.

425.04 CONSTRUCTION.

A. Grinding Pavement. The Plans will designate the areas of pavement surfaces to be ground. Grinding shall be performed in the longitudinal direction so that grinding begins and ends at lines normal to the pavement centerline. The entire area designated on the Plans shall be ground until the pavement surfaces of adjacent sides of transverse joints and cracks are in the same plane. Extra depth grinding to eliminate minor depressions in the pavement to obtain 100% texturing will not be required.

The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface. Grinding shall be accomplished in a manner that eliminates joint or crack faults, while providing positive lateral drainage by maintaining a constant cross-slope between the edges of grinding operations. Auxiliary or ramp lane grinding shall transition as required from the mainline edge to provide positive drainage and an acceptable riding surface.

1. Surface Texture and Grooving. The grinding process shall produce a pavement surface that is uniform in appearance with a longitudinal line type texture. The surface shall have grooves between 0.09 to 0.15 inches wide, spaced up to 0.125 inches apart. The peaks of the ridges shall be approximately 1/16 inch higher than the bottom of the grooves.

2. *Slurry Removal.* The Contractor shall provide positive means for removal of grinding slurry or residue by vacuum or other continuous methods. Slurry shall not be allowed to flow across lanes being used by traffic.

3. *Pavement Smoothness.*

3.1. Profiling Pavement Surface. All ground surfaces shall be profiled by the Contractor for smoothness using the profilograph specified on the Plans or in the Proposal. Profiles will be made 3 feet from and parallel to each edge of pavement and at the approximate location of each longitudinal joint for all pavement areas. Pavement so tested shall have a profile index of 5 inches per mile or less using a 0.2 inch blanking width. Individual high points in excess of 0.3 inch, as determined by measurements of the profilograph shall be reduced by grinding, until such high points as indicated by reruns of the profilograph do not exceed 0.3 inch.

After grinding has been completed to reduce individual high points in excess of 0.3 inch, additional grinding shall be performed as necessary to reduce the profile index to values specified above in any 0.1 mile section along any line parallel with the pavement edge.

Additional grinding shall be performed as necessary. All ground areas shall be neat rectangular areas of uniform surface appearance.

3.2 Straight Edge Tolerance. The surface may be straightedged, at locations to be determined by the Engineer, with a straightedge 10 feet long. When the straightedge is laid on finished pavement parallel to centerline or normal to the centerline, the maximum distance to the roadway surface from the bottom edge of the straightedge shall not exceed 1/8 inch at any point. Additional grinding will be required at the locations found in excess of the 1/8 inch tolerance.

B. Traffic Control. Traffic control shall be in accordance with the Manual on Uniform Traffic Control Devices. Overnight closure of traffic lanes for the sole purpose of grinding pavement will not be permitted.

425.05 METHOD OF MEASUREMENT. Diamond grinding concrete pavement will be measured by the square yard. The square yards measured will be the final textured surface area regardless of the number of passes required to achieve acceptable results. Minor areas of untextured pavement within the

designated areas to be textured will be included in the measurement.

425.06 BASIS OF PAYMENT. The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

Diamond Grinding Concrete Pavement Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete the work as specified.

500.00 INCIDENTAL STRUCTURES

501.00 EXCAVATION FOR STRUCTURES

501.01 DESCRIPTION. This work shall consist of excavation and backfill or disposal of all materials required for the construction of bridges, box culverts, and other minor structures in accordance with these Specifications and in reasonably close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

This work shall also include removal of existing structures, unless provided for as a separate item. The clearing of the right-of-way, construction and removal of any necessary cofferdams, and pumping and incidentals as may be required for the proper execution of the work.

501.04 CONSTRUCTION METHODS.

A. Clearing and Preservation of Channel. The right-of-way shall be cleared in accordance with Section 201 for the full length of the bridge unless otherwise specified on the Plans.

Creek and river banks shall be kept in their natural state as much as possible. Banks up or downstream shall not be excavated or cut except as shown on the Plans or with written approval of the Bridge Engineer. Work roads shall be located in locations approved in writing by the Engineer. The Contractor shall restore all bank cuts and work roads to their original shape, density and condition in a manner approved by the Engineer.

Excavation or dredging shall not be made without prior approval of the Engineer outside of caissons, cribs, cofferdams, steel piling or sheeting, and the natural stream bed adjacent to the structure shall not be disturbed.

When approved excavation or dredging is made before caissons, cribs, or cofferdams are in place, the Contractor shall, without extra charge, backfill and compact all such excavation outside the structure in accordance with Section 202 to the original ground surface. Excavation in the stream bed shall be backfilled to the original ground line. Compaction in accordance with Section 202 will not be required. Material deposited within the stream area from foundation or other excavation or from filling of cofferdams shall be removed and the stream area restored to its natural condition.

B. Removal of Existing Structures. Removal of existing structures when shown on the Plans shall be in accordance with Subsection 619.04 B.

C. Cofferdams. Cofferdams for foundation construction shall be designed and constructed to be as watertight as is necessary for the proper performance of the work which must be done inside them. Cofferdams shall be of sufficient

size to allow pumping from outside the concrete forms so that all concrete is placed in the dry. A clay or concrete puddle wall may be required between the base forms and outside cofferdam, if necessary, to protect the base concrete from wash while bases are being placed.
Timber braces shall not extend into the concrete and structural members used for bracing shall not be left in the concrete.

Round pier bases of equal stability may be considered where square or rectangular bases are indicated on the Plans. Plans for round bases must be submitted to and approved by the Bridge Engineer before construction is started.

D. Treatment of Foundation Materials. Solid rock or other hard foundation material shall be excavated to a depth shown on the Plans or as directed by the Engineer and all loose and disintegrated material shall be removed. The final surface shall be entirely level or in level steps as shown on the Plans or directed by the Engineer.

When the footing is to rest on the material other than rock, the final finishing of the bearing surface shall be made immediately prior to placing concrete.

E. Placing Concrete for Foundations. Concrete shall not be placed in foundations until the Engineer has approved the depth and character of the foundation. All concrete shall be placed in the dry. Concrete for pier, abutment and retaining wall footings shall be placed against the solid rock or other approved foundation material. Quantities in such footing shall be measured and paid to the dimensions shown on the Plans. Additional concrete required to fill any excavation outside the neat lines shown on the Plans shall be at the Contractor's expense.

F. Soundings. Soundings to determine the depth and characteristics of foundation material may be made at the locations of structures. Boring logs if shown on the Plans were made for the purpose of selection of foundation types used in the design. The interpretation and confirmation of the boring information is the responsibility of the Contractor.

G. Pumping. Pumping will not be permitted during the placing of concrete or for at least 12 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other effective means. This period may be extended at the direction of the Engineer. Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

H. Box Culvert Excavation. This work includes box culverts in the bridge classification. Poor foundation material below the normal designed elevation shall be removed as directed by the Engineer. Material removed below designed elevation shall be replaced with material approved by the Engineer.

Unless otherwise directed, outlets shall be opened for the effective width of the structure before constructing footings of box culverts.

I. Abutments, Wings, and Retaining Wall Excavation. Excavation adjacent to abutments, wings, and retaining walls shall be vertical or broken by stepping before backfilling.

J. Backfilling. Backfill and embankment shall be placed and compacted in accordance with Subsection 202.04 C.

Backfill shall not be placed against cantilever abutments, retaining walls, or other structures or portions of structures where the embankment is placed on one side only for a period of 14 days after the walls are in place. This period may be decreased when test beams meet the minimum strength requirements specified in Subsection 701.01 D. In the case of a rigid frame bridge or a bridge where the abutments are designed to be integral with the superstructure, the abutments shall not be backfilled until the superstructure is in place and forms supporting girders and deck are removed.

Embankment shall not be placed around any supporting form. Backfill above the flow line around concrete boxes shall not be placed in less than 7 days after the last concrete is placed in the section of the structure.

Rollers, vibrators, or other approved compactors shall be operated parallel to the outside lines of barrels and wing walls of cross drains. Any areas inaccessible to rolling equipment shall be compacted with mechanical tampers.

The excavated areas around piers shall be uniformly backfilled and compacted to the elevation of the original surface or as established by the Engineer.

K. Disposal of Surplus. Excess material shall not be placed in the bed of the stream. Areas affected by the Contractor's operation shall be cleaned up in accordance with Subsection 104.08. Obstructions that may collect drift, induce scour, or endanger the work shall be removed as directed by the Engineer.

L. Variation in Footing Elevations. The elevations of the bottom of footings, as shown on the Plans, will be considered as approximate only. The Engineer may order in writing such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

508.00 CONCRETE CULVERTS, HEADWALLS AND RETAINING WALLS

508.01 DESCRIPTION. This work shall consist of constructing concrete culverts, headwalls and retaining walls in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.

Precast concrete box culverts in lieu of cast-in-place concrete box culverts will be considered by the Engineer if requested by the Contractor.

508.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Portland Cement Concrete	701
Reinforcing Steel	723

Precast concrete box sections for culverts shall meet the requirements of AASHTO M 259 or M 273.

Joint materials shall meet the requirements specified under Subsection 726.02 A.

508.04 CONSTRUCTION METHODS.

A. General. The construction methods shall conform to requirements of these specifications under the several items entering the work with specific reference to Sections 509, 510, and 511, and in addition shall meet the following requirements.

Cutoff walls shall be constructed as required by the Engineer and may be varied from the Standard Plans to insure protection against undermining.

Before any concrete is placed in the walls, the footing shall be carefully cleaned of all chips, sawdust, dirt and other extraneous materials, and the concrete surface wetted and thoroughly grouted with neat cement paste immediately ahead of the concrete placement.

In the construction of box culverts more than 4 feet in height, care shall be exercised that the concrete in the walls shall be placed and allowed to set before the top slab is placed. Each wing shall be completed as a monolith. A header shall be installed in the forms if the top slab and curb are not to be completed at the time the walls are concreted.

B. Excavation and Backfill. Excavation and backfill shall be in accordance with Section 501.

C. Forms. Forms shall be in accordance with Section 509.

D. Curing. Curing shall be in accordance with Subsection 509.04 H.

E. Finish. The exposed surface of all wings, curbs, rails and retaining walls shall be given a concrete surface finish as provided under Subsection 509.04 O. of these Specifications. A second concrete surface will be required when the first finish is rough, not uniform in color, has poor chamfer lines, or in any respect defective.

F. Bedding. Bedding for precast concrete box culverts shall be a minimum depth of 4 inches below the precast box sections unless otherwise specified on the Plans. Bedding material shall meet the requirements for Class B Bedding in accordance with Subsection 613 C.

G. Laying Precast Sections. Precast concrete box sections shall not be laid unless the foundation is in a condition satisfactory to the Engineer. Precast sections shall not be dropped onto the bedding material, but shall be lowered and placed into its final position by hoisting equipment adequate to handle the section without damage to the section or the bedding material. Damaged sections shall be replaced by the Contractor at his expense. The inside of the barrel shall be clean and free of debris when the sections are lowered into place.

The conduit laying shall begin at the downstream end of the culvert. The sections shall be laid reasonably true to the established line and grade. After the precast culvert has been inspected and approved, it shall be backfilled, with care being taken in placing the backfill material so as to prevent displacement or damage of the sections.

H. Joining Precast Sections. The precast sections shall be joined as required in Subsection 613.04 E.

I. Box Culvert End Sections. End sections for all concrete box culverts shall be cast-in-place. End sections include wingwalls, curbs, end of barrels, curtain walls, and aprons. When precast sections are used for skewed structures, the wings shown on the Plans for cast-in-place concrete box culverts will be used at the same skewed relationship to the culvert walls as shown for the cast-in-place culvert. Curbs and curtain walls shall be built perpendicular to the barrels of precast sections for skews between 90° and 60°.

J. Contractor's Drawings for Special Precast Box Sections, Special End Sections, Transition Sections and Stub-ins.

Prior to construction of precast concrete box culverts requiring stub-ins of storm sewers, junctions with other structures, transitions in box dimensions, end sections for skews less than 60° or design loads or sizes not covered by AASHTO M 259 or M 273, the Contractor shall furnish fully engineered and sealed plans of the proposed construction to the Engineer for approval. Plans

shall show complete details of reinforcing steel and concrete dimensions.

508.05 METHOD OF MEASUREMENT. The quantities which constitute the completed and accepted structure will be measured for payment according to the Plans and Specifications for the several pay items as provided under Sections 509 and 511 of these Specifications, which shall include full compensation for all materials, falsework, labor, equipment, and incidentals necessary to complete the work as specified.

Payment for precast concrete box culverts will be made based on unit prices bid for the items and quantities of a cast-in-place box of the length required as determined by field measurements for the construction.

509.00 STRUCTURAL CONCRETE

509.01 DESCRIPTION. This work shall consist of furnishing and placing portland cement concrete for structures and incidental construction in accordance with these Specifications and in reasonably close conformity with the lines, grades and dimensions as shown on the Plans or established by the Engineer.

509.02 MATERIALS.

A. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Portland Cement Concrete	701
Elastomeric Bearing Pads	733.06
Concrete Surface Finish for Structures	737
Curing Materials	701

B. ***High Early Strength Concrete.*** High early strength concrete shall meet the requirements as provided in Subsection 701.01 A. It shall be used for structures or portions of structures only when shown on the Plans or approved by the Engineer.

509.03 EQUIPMENT.

A. ***General.*** Equipment and tools necessary for handling materials and performing all parts of the work shall meet the requirements of Subsection 414.03.

509.04. CONSTRUCTION METHODS.

A. ***Handling, Measuring, and Batching.*** Handling, measuring and batching materials shall be in accordance with Subsection 414.04 D.

B. ***Mixing.*** The mixing of concrete shall be in accordance with Subsection 414.04 E.

C. ***Limitation of Mixing.*** The limitations of mixing concrete shall be in accordance with Subsection 414.04 F., except that the maximum temperature of the concrete shall not exceed 85^OF at the time of placement.

D. ***Forms.*** Forms shall be so designed and constructed that they will hold reasonably true to lines and grades as shown on the Plans and may be removed without injuring the concrete.

The material to be used in the forms for exposed surface shall be sized and dressed lumber, masonite, plywood or equal, or metal in which all bolt and rivet heads are countersunk, so that in any case a plain, smooth surface is

obtained. Undressed lumber may be used for backing or other unexposed surfaces.

The forms shall be built reasonably true to line and grade and braced in a substantial and unyielding manner. They shall be mortar tight. All corners, except at tops of footings or bases, shall be chamfered. Chamfer or molding strips shall be finished lumber, cut with true edges, and shall not be warped, cracked or frayed. No two pieces of chamfer strips of unequal width shall be used in the same chamfer line. Chamfer shall be held true to line and kept securely nailed to forms while placing concrete.

Form lumber for all curbs on bridges and culverts shall have a nominal thickness of 2 inches or more. Studding on all forms shall be spaced so that no bulge or deflection is apparent between the studs.

Form lumber which is to be used a second time shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete. Any bulging, warping or offset in adjacent boards shall be remedied.

All dimensions shall be carefully checked by the Contractor after the forms are erected and before any concrete is placed. The Contractor will be held responsible for the accuracy of all construction. The interior surfaces of the forms shall be adequately oiled or greased to insure the non-adhesion of mortar.

E. Handling, Placing and Vibrating Concrete.

1. *General.* In preparation for the placing of concrete, all saw dust, chips, and other debris shall be removed from the interior of forms. Struts, stays and braces serving temporarily to hold the forms in correct shape and alignment pending the placing of concrete at their locations shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. All temporary wood members shall be removed from the forms and not buried in the concrete.

   When vibrating concrete containing epoxy-coated reinforcing steel, the vibrator shall be equipped with a sheath designed to prevent damage to the epoxy coating.

   Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The Engineer may order the discontinuance of any type of conveyance or method of placing if the concrete is not being satisfactorily placed.

   Open troughs and chutes shall be mortar tight. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths

that change the direction of movement.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than 5 feet, it shall be deposited through approved sheet metal chutes, pipes, or flexible tubing. As far as practicable, the pipes shall maintain an even flow of concrete during the placing and their lower ends shall be kept level with the newly placed concrete. After the initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcing bars which project.

Concrete during and immediately after depositing shall be thoroughly consolidated by mechanical vibration, subject to the following provisions:

The vibration for Class A and AA concrete shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.

Vibrators shall be of a type and design approved by the Engineer. The manufacturer's rated capacity shall be not less than 4,000 impulses per minute.

The intensity of vibration shall be such as to visibly affect a mass of concrete of one inch slump over a radius of at least 18 inches.

The Contractor shall provide a sufficient number of vibrators to properly consolidate each batch of concrete immediately after it is placed in the forms.

Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms.

Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

The provisions of this article shall apply to the filler concrete for steel grid floor, except that the vibrator shall be applied to the steel.

The provisions of this article shall apply to precast piling, concrete cribbing and other precast members except that, if approved by the Engineer, the manufacturer's methods of consolidation may be used.

Concrete shall be placed in horizontal layers no more than 12 inches thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer before it has taken initial set.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of the laitance and other objectionable material to a sufficient depth to expose sound concrete. Where a feather edge might be produced at a construction joint, as in the sloped top surface of a wingwall, inset form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than 6 inches in the succeeding layer. Work shall not be discontinued within 18 inches of the top of any face, unless provision has been made for a coping less than 18 inches thick, in which case, if permitted by the Engineer, the construction joint may be made at the underside of the coping.

Immediately following the discontinuance of placing concrete, all accumulation of mortar splashed upon the exposed reinforcing steel and surfaces of the forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. Care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcing steel.

2. *Reinforced Concrete Boxes.* In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. Provisions shall be made for bonding the sidewalls to the culvert base, by means of raised longitudinal keys so constructed as to prevent the percolation of water through the construction joint.

   Before concrete is placed in the side walls, the culvert footings shall be thoroughly cleaned and the surface carefully chipped and roughened in

accordance with the method of bonding construction joints as specified herein.

In the construction of box culverts 4 feet or less in height, the sidewalls and top slab may be constructed as a monolith. When this method of construction is used, any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

In the construction of box culverts more than 4 feet in height, the concrete in the walls shall be placed and allowed to set before the top slab is placed. Appropriate keys shall be left in the sidewalls for anchoring the cover slab.

3. *Columns.* Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least two hours before the caps are placed.

   Concrete shall not be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the column. The load of the superstructure shall not be allowed to come upon the columns until they have been in place at least five days, unless otherwise permitted by the Engineer.

4. *Pneumatic Placing.* Pneumatic placing of concrete will be permitted only if specified.

5. *Pumping.* Placement of concrete by pumping will be permitted provided the equipment is so arranged that vibrations will not damage freshly placed concrete.

   Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. Aluminum pipe shall not be used. The operation of the pump shall be such that a continuous stream of concrete without air pockets is delivered.

F. Placing Concrete Under Adverse Weather Conditions. Concrete for structures shall not be placed on frozen ground nor shall it be mixed or placed while the atmospheric temperature is below 35° F, unless adequate means are employed to heat the aggregates and water, and satisfactory provisions have been made for protecting the work.

Concrete slab shall not be placed on frozen ground, nor shall concrete be mixed or placed when the atmospheric temperature is below 35° F, or when conditions indicate that the temperature may fall to 35° F within 24 hours, except with the written permission of the Engineer and only after such precautionary measures for the protection of the concrete have been taken as

the Engineer may direct.

Concrete shall be effectively protected from freezing or frost for a period of 5 days after placing.

Concrete for structures shall not be mixed or placed while the atmospheric temperature is above 100° F unless adequate means are employed to cool the aggregate and water and satisfactory provisions have been made for protecting the work. In any case, the temperature of the concrete placed shall not exceed 90° F.

Concrete placement shall be stopped when rainfall is sufficient to cause damage to the work.

G. Placing Concrete under Water. Concrete shall be deposited in water only with the permission of the Engineer and under his supervision. When depositing in water is allowed, the concrete shall be carefully placed in the space in which it is to remain in a compact mass by means of a tremie or a bottom dumping bucket that does not permit the concrete to fall through the water. Concrete placed under water shall be deposited in one continuous operation and shall be allowed to set for a period of at least 48 hours before the caisson is dewatered. After dewatering, the laitance and soft concrete shall be cut away and the top surface cleaned. Concrete shall not be placed in running water, and forms which are not reasonably watertight shall not be used for holding concrete deposited under water. The concrete shall not be disturbed after being deposited.

Ten percent of additional cement shall be added to all concrete placed under water. No allowance will be made to the Contractor for additional cement required for placing concrete under water. The water pressure shall be equal inside and outside the forms before any concrete is placed under water. The quantity of mixing water shall be the minimum amount to permit the passage of concrete through the tremie or it shall not have a slump in excess of 2 inches when placed with a dump bottom bucket.

When a tremie is used, it shall have a diameter of not less than 10 inches and shall be of sufficient tightness at joints to prevent loss of mortar. Equipment for supporting a tremie shall be adequate to raise, lower or change the position of the tremie laterally when it is entirely full of concrete. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than 1/3 cu. yd. It shall open in two parts at the

center of the bottom perimeter; the trip being so arranged that it will function properly. It shall be tested for tripping with a load before concreting. The empty bucket shall be lowered to the bottom of the footing and the load line marked before the first batch is placed. The bucket shall be slowly and carefully lowered until it rests upon the concrete already placed. It shall then be raised very slowly during the discharge in order to maintain, as nearly as possible, still water at the point of discharge and avoid agitating the mixture.

H. Joints. Whenever the work of placing concrete is delayed until the concrete shall have taken its initial set, the point of stopping shall be deemed a construction joint. So far as possible, the location of construction joints shall be planned in advance, and the placing of concrete carried continuously from joint to joint. These joints shall be perpendicular to the principal lines of stress.

Where dowels, reinforcing bars, or other adequate methods are not shown on the Plans, keys shall be made by placing water-soaked beveled timbers of a size shown on the details, or as directed by the Engineer. The key material shall be removed when the concrete has set. In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of laitance or other soft material with stiff wire brushes, and if deemed necessary by the Engineer, shall be roughened by a steel tool.

Construction joints shall be made only where located on the Plans or shown in the placing schedule, unless otherwise approved by the Engineer. Shear keys or continuous reinforcement shall be used to transmit shear or bond the two sections together.

In parapets, railings, and other light work superimposed on heavy work, the expansion joints shall be placed as shown on the Plans.

In order to maintain the proper alignment of the different parts of the work, they shall be provided with keys at approximately 1/3 of the area of the cross-sections of the wall or with the equivalent thereof in dowels.

I. Curing Concrete.

1. *General.* All concrete shall be cured as provided in these Specifications for the various parts of structures. The approved method of cure and minimum curing time shall be as follows:

ITEM	CURE TIME* (MINIMUM)	METHOD
Piers	3 Days	A,B,C,D
Columns	5 Days	A,B,C,D
Abutments	3 Days	A,B,C,D
Retaining Walls	3 Days	A,B,C,D
Wing Walls	3 Days	A,B,C,D
Parapets	3 Days	A,B,C,D,E
Rails	3 Days	A,B,C,D,E
Reinforced Concrete Box	3 Days	A,B,C,D
Bridge Floors	6 Days	E,F**
Slabs & Girders	5 Days	A,B,C,D
Curbs	3 Days	A,B,C,D
Sidewalks	3 Days	A,B,C,D
*During unfavorable weather conditions where the temperature does not exceed 50° F, the cure time may be extended at the discretion of the Engineer.		
**Both E & F required on bridge floors.		

The approved methods for curing shall be:

(A) Curing with an approved polyethylene burlap.
(B) Curing with three layers of wet burlap.
(C) Curing with wetted cotton mats as specified under Subsection 414.04 M.
(D) Curing with an approved membrane compound (Red) as specified below and in Subsection 701.07.
(E) Linseed oil emulsion curing.
(F) Water curing.

Curing compound shall be applied under pressure, by means of a spray nozzle, in such a manner as to cover the entire exposed surface thoroughly and completely with a uniform film. Sufficient pressure shall be applied to the spray machine to force the compound to leave the nozzle as a fine mist. The application of curing compound shall be close to the finishing at all times and all finished concrete shall be sprayed immediately after the superficial water, if any, has subsided.

Formed surfaces shall be coated with curing compound as soon as practicable after removal of the forms.

Curing compound shall be applied on concrete for sidewalks, curbs and floors, other than concrete bridge floors, as soon as possible after finishing. On surfaces requiring a surface finish or surfaces poured against forms, the curing materials which adversely affect the bond on surface finish shall not be applied.

If hair checking develops before the curing compound can be applied, the procedure set forth above shall be modified in that initial curing with wet burlap shall be performed as specified for the particular type of work under construction.

If discontinuities, pinholes, or abrasions in the membrane exist, a second coat shall be applied to the affected areas. Walking on the cured surface will not be permitted for 24 hours after application. If any abrasions occur within 24 hours, they shall be corrected by the use of additional compound.

Rate of Application.

The sealing compound shall not be applied at a coverage rate lighter than specified below:

Steel trowel finish	225 sq. ft. per gallon
Rough float finish	200 sq. ft. per gallon

Whenever the atmospheric temperature is 100° F or more, the Engineer may require an additional coat at a rate of approximately 270 square feet per gallon, if he deems the additional material essential to obtain adequate water retention. When required, the second coat shall be applied 30 minutes after the first.

When the desired results are not obtained by this method, the membrane method shall be discontinued and the curing shall be by other methods specified in the Specifications.

1.1 Linseed Oil Emulsion Curing. Linseed oil emulsion shall be applied under pressure, by means of an atomizing type spray nozzle, in such a manner as to cover the entire exposed surface uniformly at the rate of not less than one gallon per 175 square feet. Sufficient pressure shall be applied by the spray machine to force the compound to leave the nozzle as a fine mist. Care shall be exercised when spraying linseed oil emulsion to prevent the emulsion from coating exposed reinforcing steel.

Linseed oil emulsion shall not be applied when the temperature of the emulsion is less than 35° F or more than 95° F.

Any container of linseed oil emulsion that exhibits separation, segregation or skimming of surface shall not be used.

The estimated wind velocity at the time of application should be noted and the rate of application adjusted to assure the yield of one gallon of emulsion for each 175 sq. ft. covered.

The oil emulsion shall be applied to the fresh concrete immediately after finishing.

The linseed oil shall be applied to the sides of parapets and other formed surfaces immediately following the removal of forms. Caution shall be exercised in applying linseed oil emulsion to surfaces to be finished. The Contractor shall furnish evidence that the proposed finish is compatible with linseed oil emulsion cured surfaces.

All surfaces cured with linseed oil emulsion shall be protected from damage for a period of 72 hours after application. Walkways shall be provided for workmen and any materials or equipment placed on mats.

1.2 Water Curing. Floors shall be covered with wet cotton mats as soon as the condition of the concrete surface will permit. The cotton mats shall be kept wet continuously from the time the first mat is placed until the curing period has expired.

Curbs and parapets shall be covered with wet burlap as soon as finishing is completed. The curb and parapet shall be kept continuously wet from the time the first burlap is placed until the curing period has expired.

Water used for curing shall meet the requirements for concrete mixing water.

J. Removal of Forms. In order to make possible the obtaining of a satisfactory surface finish, forms on ornamental work, railing, parapets and vertical surfaces which do not carry loads and which require a special concrete surface finish shall be removed as soon as practicable.

Form removal shall be governed by the following table:

ITEM	SPECIFIED FORM REMOVAL TIME	MINIMUM FORM REMOVAL TIME*
Vertical Walls:		
Columns	12 hours	
Piers	12 hours	
Abutments	12 hours	
Retaining Walls up to 6 feet	12 hours	
Retaining Walls over 6 feet	24 hours	
Wingwalls	12 hours	
Concrete Girder Bridges:		
Floors between girders	14 days	10 days
Main Slab	21 days	14 days
Girders	21 days	14 days
Prestress Concrete, Steel Beam & Truss: Floors	14 days	10 days
Reinforced Concrete Boxes:		
Span 8 ft. or less	14 days	7 days
Span 8 ft. to 10 ft.	14 days	10 days
Span 10 ft. & over	21 days	14 days
Supporting Forms:		
Pier Caps	14 days	10 days
Web Walls	14 days	10 days
Bridge Floors:		
Open to traffic	21 days	10 days
*Specimens shall be made, cured and tested as provided in Subsection 701.01 D. In unfavorable weather or during a period of time the temperature does not exceed 50° F, the specified time may be increased at the discretion of the Engineer.		

When H.E.S. concrete is used, in no case shall forms under parts of structures carrying loads be removed in less time than shown.

After removal of forms, supports and centering, concrete may be subjected to not more than the design load of the structure.

As soon as the forms are removed, all rough places, holes, and porous spots shall be filled, and all bolts, wires or other appliances used to hold the forms and which pass through the concrete shall be cut off flush with the surface. For all finished surfaces, all wires shall be cut off ¼ inch below the surface and depression filled with cement mortar at once. This shall be left rough for several hours and then rubbed smooth with the surface.

Honeycomb shall be repaired as soon as the forms are taken off by removing any aggregate that is loose or that is not thoroughly bonded to concrete mass, washing the surface with clean water, using a wire brush to remove any loose

particles, and applying a thin coating of neat cement mortar.

Patched areas shall be dressed flush with the surrounding area.

Small cavities shall be neatly pointed up with cement mortar of the same mix as used in the body of the work, immediately after removing forms. Care shall be taken to remove any thin surfaces or edges and expose the whole cavity before pointing up.

K. Defective Work. Any defective work discovered after the forms have been stripped shall be removed immediately and replaced. If the surface of the concrete is bulged, uneven, or shows excess honeycombing or settlement, which cannot be repaired satisfactorily, the entire section shall be removed and replaced. No additional compensation will be allowed for this work.

L. Drainage and Weep Holes. Drainage openings and weep holes shall be constructed in the manner and where indicated on the Plans or directed by the Engineer.

M. Placing Pipes and Conduits. Pipes and conduits for utility service lines which are to be encased in the concrete shall be placed by the Contractor during construction.

N. Placing Anchors, Bolts, Grillages, etc. The Contractor shall place all anchors, bolts, grillages, etc., securely and accurately in the locations shown on the Plans or as otherwise required.

O. Waterproofing. Reinforced retaining walls, abutments, earth filled arches, etc., shall be waterproofed whenever shown on the Plans or directed by the Engineer. This waterproofing shall conform to Sections 606 or 607, depending upon the type specified.

P. Finishing. Unless otherwise specified on the Plans, a special finish conforming to one of the following methods shall be applied after penetrating water repellent treatment of concrete surfaces, when specified. Before the surface finish is applied, the surface shall be inspected by the Engineer to assure compliance with Subsection 509.04 I. The finish coat shall be uniformly textured and colored in a manner approved by the Engineer.

Option I. Heavy cement base mortar mixed with an acrylic bonding agent.

Option II. Paint type spray finish.

The special finish shall consist of one or more applications of the materials specified for Option I or Option II. The intent of this Specification is to attain a durable finish reasonably uniform in appearance as to texture and color, the

color to be somewhat lighter than the natural color of concrete unless otherwise specified on the Plans.

The Engineer shall be informed in writing of the option selected by the Contractor and materials approved prior to the beginning of the finishing operation.

Test Panel: At the beginning of the first finishing operation, a test panel or area shall be prepared showing surface texture and method of application and shall be approved by the Engineer. This area shall be maintained throughout the duration of the project as a standard for comparison purposes.

Before the surface finish is applied, when using the heavy cement base mortar material option, the surface shall be thoroughly washed with clean water applied with a jet spray. The application of the surface finish shall be applied with an approved plaster type spray gun or by the brush and float method, as recommended by the manufacturer. No application is to be made when the atmospheric temperature is 40° F or below or when the temperature is expected to drop to freezing within 12 hours. Curing shall be done in the same manner as required for curing concrete. Application of the special surface finish shall not be started until all other work which might mar or deface the surface finish has been completed.

Under Option II, the following conditions shall be met:

Samples: At the time of original request for approval of the surface finish, the manufacturer shall submit a one-gallon sample of the material.

Application: At the time of application of spray finish, concrete surfaces shall be free of moisture as determined by both sight and touch and in a condition consistent with the manufacturer's recommendations.

Surfaces shall be protected by paper, cloth, or other means from spatter of the sprayed material. Any concrete areas which are not intended to be covered by the spray finish and which are stained or spattered by the spray shall be cleaned by wire brushing, sandblasting, or other methods satisfactory to the Engineer.

The spray finish shall be applied at a rate of 45 + 5 square feet per gallon with heavy duty spray equipment (4:1 ration or larger) capable of maintaining a constant pressure as necessary for proper application.

The completed finish shall be tightly bonded to the structure and present a uniform appearance and texture. If necessary, additional coats shall be applied to produce the desired surface texture and uniformity. Upon failure to adhere positively to the structure without chipping or cracking or to attain the desired surface appearance, the surface shall be refinished to the satisfaction

of the Engineer at no additional cost to the City.

Q. Concrete Surface Finish. All surfaces of piers and abutments exposed to the traveling public shall receive a concrete surface finish in accordance with Subsection 509.04 P. All other surfaces exposed to the public shall receive a concrete surface finish.

The surfaces of piers to receive a surface finish shall be made a smooth and uniform texture by face lining the forms or by the use of steel forms. Rubbing of the surfaces will not be required unless honeycombed areas, form marks or other defects occur. In case these defects occur, the areas immediately affected will require rubbing. Such rubbing shall extend over a sufficient area around the blemished portions to blend the rubbed area into the surrounding unfinished surface without causing an unsightly appearance, but this shall not be construed to require rubbing of large areas of unblemished surfaces to gain absolute uniformity of color and texture on the entire surface of the piers.

No compensation will be allowed for the extra work or materials involved in eliminating these defects.

Special care shall be given the concrete surfaces that are exposed to the traveling public. Concrete handrails, posts and curbs on regular structures and all of the exposed surfaces of the substructure and all of the exposed surfaces of the substructure on grade separation structures shall be finished to a uniform color and texture. Care shall be taken in the finishing operations to maintain sharp or well-defined corners on chamfer lines. A second or final finish will generally be required. The final finish must produce neat lines, uniform color and smooth finish.

509.05 METHOD OF MEASUREMENT. Structural concrete will be measured by the cubic yard in accordance with the dimensions shown on the Plans or directed by the Engineer. Concrete for small structures will be measured by the cubic yard when the total volume of concrete in the whole structure does not exceed ten cubic yards.

509.06 BASIS OF PAYMENT. Accepted quantities of structural concrete will be paid for at the contract unit price per cubic yard for:

(A)	Class AA Concrete	Cu. Yd.
(B)	Class A Concrete	Cu. Yd.
(C)	Class A Concrete for Small Structures	Cu. Yd.
(D)	Class B Concrete	Cu. Yd.
(E)	Class C Concrete	Cu. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

511.00 REINFORCING STEEL

511.01 DESCRIPTION. This work shall consist of furnishing and placing reinforcing steel in accordance with these Specifications and in conformity with the Plans.

All reinforcement shall consist of deformed bars, epoxy coated deformed bars, or cold drawn wire mesh as specified.

Deformed bars shall be of an approved deformed type such that a mechanical bond will be provided between the concrete and steel at frequent intervals. The size shall be such that the minimum net sectional area of the bar shall be equal to the section of a plain bar of the nominal size indicated.

511.02 MATERIALS. Materials shall meet the requirements of Section 723.

Reinforcing steel bars of structural grade 60 shall be furnished when shown on the Plans and specified. When the grade is not specified, grade 40 or grade 60 may be used and will be measured and paid for at the lowest grade required.

Spiral ties and other reinforcing, designated on the plans in W (wire) sizes, shall be cold drawn wire.

Bar List. The bar list and bending schedule are made for the purpose of arriving at an estimate of quantities. The Contractor shall verify the quantity, size and shape of the bar reinforcement against the structure drawings and make the necessary corrections, if any, before ordering. Errors in the bar list and bending schedule shall not be cause for adjustment of the contract unit price.

511.04 CONSTRUCTION METHODS. Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be substantially free from dirt, detrimental scale, paint, oil or other foreign substance.

Thin powdery rust and tight rust that does not reduce the effective cross-section is not considered detrimental and need not be removed.

Epoxy-coated reinforcing bars sheared and/or cut ends shall be promptly coated or repaired before visible oxidation occurs with coating materials meeting the requirements of AASHTO M 284.

Unless otherwise permitted, all reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on the Plans and in a manner approved by the Engineer. Should the Engineer approve the application of the heat for field bending reinforcing bars, precautions shall be taken to assure that the physical properties of the steel will not be materially altered.

All reinforcing steel shall be accurately placed within the tolerances specified herein. During the placing of concrete, reinforcing steel shall be firmly held by approved supports in the position shown on the Plans. Reinforcing bars shall be fastened at alternate intersections with wire ties unless this results in ties being more than 12 inches apart in which case each intersection shall be tied. Spot welding of reinforcing steel will not be permitted. Spacing of parallel bars is shown center to center. Bar bends are out to out and distance from face of concrete to reinforcing steel is clear distance. In the plane of the steel parallel to the nearest surface of concrete, individual bar spacing shall not vary from Plan placement by more than 1/6 of the spacing between bars, and the average over ten spaces shall not vary more than 1/20 of the specified spacing. Perpendicular to the nearest surface of concrete, bars shall not vary from Plan placement by more than 1/4 inch in slabs and walls up to and including 8 inches in total thickness, and for slabs and walls over 8 inches in total thickness, the bars shall not vary more than 1/2 inch from Plan placement. The placement of deck reinforcement in bridge floors shall not deviate more than ¼ inch from Plan placement in the vertical direction.

Approved metal bar supports of adequate strength, of proper depth and in sufficient number shall be used for supporting the bars in slabs, beams, and girders. Both low and high approved metal chairs shall be used in I-Beam, truss and girder floors.

The placing, wiring and supporting reinforcement in each section of the work shall be approved by the Engineer before any concrete is deposited in the section.

All reinforcement shall be furnished in the full lengths indicated on the Plans. Splicing of bars, except where shown on the Plans, will not be permitted without written approval of the Engineer. Splices shall be staggered when possible.

Unless otherwise shown on the Plans, bar splices in the bottom of beams and girders, and in walls, columns and haunches shall be lapped as given in the table below for other bars. Bar splices near the top of beams and girders having more than 12 inches of concrete under the bars shall be lapped as given in the following table for top bars:

REQUIRED LENGTH OF LAP IN INCHES								
SIZE	**No. 4**	**No. 5**	**No. 6**	**No. 7**	**No. 8**	**No. 9**	**No. 10**	**No. 11**
Top Bars	15	19	24	32	42	54	68	83
Other Bars	12	13	17	23	30	38	49	60

The required length for lap splices given in the table is based on Grade 40 Reinforcing Steel. If Grade 60 Reinforcing Steel is specified the required length for lap splices shall be increased by 50 percent. No more than ½ of the bars should be lap spliced within a required lap length.

Bars larger than No. 11 bars shall not be lap spliced but shall be weld spliced in accordance with current AWS Specifications or spliced with other positive mechanical methods. The splice methods or devices shall be approved by the

Engineer prior to use.

The minimum spacing, center to center, of parallel bars shall be 2½ times the diameter, but in no case shall the clear distance between the bars be less than 1½ times the maximum size of the coarse aggregate.

The minimum covering, measured from the surface of the concrete to the face of any reinforcing bar, shall be not less than 2 inches or as otherwise shown on the Plans. In the footings of abutments and retaining walls and in piers the minimum covering shall be 3 inches.

When epoxy coated bars are used, tie wires shall be plastic coated. Chairs, supports and clips shall be one of the following:

1. Steel, fully coated with epoxy or plastic.
2. Galvanized steel, with cradle and upper 3 inches of the chair, support or clip coated with epoxy or plastic.

The plastic or epoxy coating on accessories shall be of sufficient thickness to prevent physical damage to the coated reinforcing during installation. The coating will be inspected and approved by the Engineer prior to use.

511.05 METHOD OF MEASUREMENT. Deformed bars, epoxy coated deformed bars, cold drawn wire and wire mesh will be measured by the pound, based on the theoretical number of pounds complete in place as shown on the Plans or placed as ordered.

The quantities of materials furnished and placed shall be based upon the calculated weights of the reinforcing steel actually placed in accordance with these Specifications. The weights calculated shall be based upon the following table:

DEFORMED BAR WEIGHTS	
BAR DESIGNATION NO.	**NOMINAL LB/FT**
¼	0.167
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14S	7.650
18S	13.600

No allowance will be made for clips, metal spacers, ties, wire, etc., or other material

used for fastening or holding reinforcement or forms in place, except that wire hoops used in reinforced concrete columns and encased in I-beams or similar construction, when included in the bar list shown on the Plans, will be classified as reinforcing steel and will be paid for at the contract unit price per pound for reinforcing steel.

Epoxy coated reinforcing steel will be measured by the pound, based on the theoretical number of pounds calculated on the nominal weight before application of the epoxy coating materials. No allowance will be made for the epoxy coating material required by the manufacturer or applicator as specified above.

511.06 BASIS OF PAYMENT. Accepted quantities of reinforcing steel and wire mesh, as measured above, will be paid for at the contract unit price per pound for:

(A)	Reinforcing Steel	Lb.
(B)	Epoxy Coated Reinforcing steel	Lb.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

514.00 TIMBER, CONCRETE AND STEEL PILES

514.01 DESCRIPTION. This work shall consist of furnishing and driving timber, precast concrete and steel piles of the kind and dimension designated. It shall also include cutting off or building up concrete and steel piling when required. Piling shall conform to and be driven in accordance with these Specifications and at the location, manner and to the elevation, penetration and bearing shown on the Plans or as directed by the Engineer. When test piles are required, the pile lengths shown on the Plans are for estimating purposes only and the actual lengths to be furnished for the types of piles specified will be determined after driving test piles.

514.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Portland Cement Concrete	701.01
Reinforcing Steel	723
Structural Steel	724
Casting for Pile Shoes	725.05
Timber Piles	728
Paint	730.05
Timber Preservative & Treatment	731

514.03 EQUIPMENT FOR DRIVING PILES.

A. Timber Piles. Timber piles shall be driven with a steam, air or diesel pile hammer, unless otherwise provided on the Plans or in the Proposal. The hammer shall develop an energy per blow at each full stroke of the piston of not less than 7,250 foot-pounds for a single acting hammer or 6,000 foot-pounds for a double acting hammer, operating at not less than 80 percent of the manufacturer's rated capacity.

When the use of a gravity hammer is permitted, it shall weigh not less than 2,400 pounds and the height of drop shall not exceed 15 feet, but in no case shall the weight of the hammer be less than the combined weight of driving head and pile.

Water jets or pilot holes may be required to secure the penetration shown on the Plans or as directed by the Engineer.

B. Concrete and Steel Piles. Concrete and steel piles shall be driven with a steam, air or diesel pile hammer, unless otherwise provided on the Plans or in the Proposal. The hammer shall have sufficient energy to produce a penetration of the pile, of one inch in ten blows at the driving resistance required on the Plans, when calculated in accordance with the formula in Subsection 514.04 without any reduction for driver efficiency.

If necessary to obtain the required penetration without damage to piles, pilot

holes having a diameter not greater than 2 inches less than the least dimension of the body of the pile may be drilled or a pump and equipment sufficient to furnish 500 gallons per minute or 100 pounds per square inch at two 3/4 inch nozzles. When the jets are used, they shall be removed and the piles shall be driven a minimum of 5 feet by the hammer to secure the final penetration. This procedure may be changed at the direction of the Engineer if the desired results are not obtained.

Vibrating hammers and the use of pile followers will not be used except when specifically authorized and under conditions specified by the Bridge Engineer.

Unless otherwise specified, piling will be driven with rigid or swinging leads of sufficient size and strength to control the pile at all times.

514.04 CONSTRUCTION METHODS.

A. Driving Resistance. The calculated driving resistance for piles shall be determined by the following formulas:

P(2WH) / (S1.0) for gravity hammers
P(2WH) / (S0.1) for single-acting steam or air hammers.
P(2H(WAp)) / (S0.1) for double-acting steam or air hammers.
P(2E) / (S0.15) for free-fall diesel hammers.

Where:

E=foot pounds of energy per blow (Manufacturer's rating for hammer)
P=driving resistance in pounds
W=weight in pounds of striking parts of hammer
H=height of fall in feet
A=area of piston in square inches
p=steam pressure in pounds per square inch
S=the average penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam hammers.

The above formulas are applicable only when:

1. The hammer has a free fall.
2. The head of the pile is free from broken concrete broom or crushed wood fiber.
3. The penetration is at a reasonably quick and uniform rate.
4. There is no excessive bounce after the blow. Twice the height of the bounce shall be deducted from H to determine its true value in the formulas.
5. The hammer shall be operated at the maximum efficiency

attainable at all times.

The bearing capacity of timber piles, as determined by the foregoing formulas, shall be considered effective only when they are less than the crushing strength of the piles. In general, timber piles shall be required to develop a bearing capacity of not less than the maximum bearing required on the Plans and not more than 40 tons. Should the bearing capacity of timber piles as computed by either of the above formulas be in excess of 40 tons, pilot holes or jetting shall be used, if required by the Engineer, to secure a satisfactory penetration without damage to the pile. The character of the soil penetrated, conditions of driving, sizes and lengths of the piles involved and the computed load per pile shall be given due consideration in determining the reliability of driven piles.

In case water jets are used in connection with the driving, the bearing capacity shall be determined by the above formulas from the results of driving after the jets have been withdrawn or a load test may be applied.

B. Loading Tests. When required, the size and/or number of pile will be determined by actual loading tests. In general, unless otherwise specified, these tests will be made in accordance with ASTM Specification D 1143 Quick Load Test Method, paragraph 5.6.

C. Test Piles. Test piles shall be driven when shown on the Plans and at the locations and of lengths as specified. In general, the specified length of test piles will be greater than the assumed length of regular piles in order to provide for variation in soil conditions. The equipment used for driving test piles shall be identical to that which the Contractor proposes to use on the regular or permanent piling and shall conform to the requirements of these Specifications.

Test piles shall be driven to one foot above the grade shown on the Plans for permanent piles or practical refusal (1/2 inch ten blows). If piles have not attained Plan minimum bearing capacity, they will be allowed to set up for 24 hours. If bearing value is not attained when driving is resumed, no more than ½ the remaining length will be driven and the set-up procedure repeated. Test piles driven to grade shall have at least the minimum bearing capacity called for on the Plans. Concrete test piles driven to plan grade and not having the bearing required, shall be driven until the required bearing is obtained. Build up of concrete test piles will be measured for payment as specified for splices and build up under reinforced concrete piling. Splices and build up for steel test piles, when required, will be measured for payment in the manner specified for steel piling.

A record of driving of test piles, showing the type and weight of hammer used, the length of test pile, fall of hammer, penetration in ground and distance of pile tip below cutoff elevation will be required. In addition, the bearing

capacity at 5 foot intervals will be required throughout the driving and the intervals shall be decreased as the driving becomes harder until the readings for bearing capacity shall be one foot intervals on the last five feet of driving. The Contractor shall not order piling to be used in the permanent structure until test pile data has been reviewed and permanent pile lengths are authorized by the Engineer.

Concrete test piles shall meet the requirements of Subsection 514.04 H.

D. Required Bearing Capacity. Piling shall be driven to the penetration shown on the Plans or to a greater depth if necessary to obtain the required bearing. Piling shall not be driven after practical refusal (1/2 inch in ten blows) or 120 tons bearing has been obtained. If necessary to obtain satisfactory penetration, jetting or other methods shall be used.

E. Preparation and Driving. The heads of all concrete piles, and the heads of timber piles when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design, preferably having a plywood or other similar approved material cushion next to the pile head and fitting into a casting which in turn supports a timber shock block. The minimum thickness of the cushion shall be 4 inches and be replaced as necessary to provide an effective cushion.

Piling should be driven to the position shown on the Plans with a permissible variation of not more than 1/4 inch per foot from the vertical or from the batter as shown. Piles for trestle bents shall be so driven that the cap may be placed in its proper location and in event the cap is reinforced concrete, no pile shall be nearer than 4 inches from any edge of the cap. Any increase in size of cap to meet this edge distance requirement will be at the Contractor's expense. Foundation piles out of the position shown on the Plans more than 6 inches after driving shall be evaluated for structural adequacy by the Bridge Engineer.

In general, starting holes for piles shall not be drilled more than 20 percent of the total pile length below the ground surface, unless otherwise shown on the Plans or directed by the Engineer. Cushions and leads shall be so arranged that a full square blow is delivered to the pile heads. Care shall be taken to keep piling leads vertical while driving, unless battered piles are specified. Pulling or imposing lateral loads while driving will not be permitted.

F. Unsatisfactory Piles. Piles that have been broken, split, or otherwise damaged to the extent that in the opinion of the Engineer they are not suitable to leave in the finished structure shall be removed immediately and replaced by sound ones at the Contractor's expense. In removing piles, jets shall be used in conjunction with jacks or other devices for pulling in an effort to remove the whole pile. All piles raised (heaved) more than 1/2 inch during the driving process, shall be re-driven to the required resistance.

G. Timber Piles. Piles shall be pointed. When necessary, piles shall be shod with metal shoes. The piles shall be carefully shaped to secure an even and uniform bearing on the shoes. Collars and bands to protect the piles against brooming and splitting shall be provided when necessary. When the area of the pile heads are greater than the face of the hammer, suitable caps shall be provided to distribute the blow of the hammer throughout the cross-section of the piles. The top of piles shall be sawed off in a true plane as shown on the Plans and at the elevation set by the Engineer.

After making cutoffs, creosoted piles supporting concrete caps shall be treated with three applications of hot creosote oil. They shall then be covered with a piece of three-ply asphalt roofing felt having a diameter of not less than 24 inches. This shall be closely and securely tacked around and to the top of piles before concrete is placed in caps.

Piles supporting timber caps or grillage work shall be given three coats of hot creosote oil. They shall then be covered with a coat of hot tar pitch over which shall be placed a sheet of galvanized iron or a covering may be built up of alternate layers of hot tar pitch and three-ply roofing felt, using four layers of tar and three of roofing felt. Either covering shall measure at least 6 inches more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large headed nails or secured by binding with galvanized wire.

Metal shoes shall be used when specified on the Plans, they shall be fastened to the pile and have the dimensions shown on the Plans. When shoes are used they shall be used on the timber test piles.

H. Concrete Piles.

1. *Class of Concrete.* Class AA concrete shall be used for precast concrete piles. Class AA high early strength concrete may be used when Class AA concrete is specified on the Plans.

2. *Reinforcement.* Reinforcement for precast concrete piles and test piles shall consist of longitudinal bars in combination with lateral reinforcement in the form of hoops or spirals. It shall be of the size and spacing as shown on the Plans. It shall be rigidly wired or fastened at all intersections and held in true position in the forms. Reinforcement shall be placed at a clear distance from the face of the pile of not less than 2 inches and when the piles are for use in salt water or alkali soils this clear distance shall not be less than three inches.

3. *Form Work.* Forms for precast concrete piles shall conform to the general requirements for concrete form work. Forms shall be accessible for tamping and consolidation of the concrete. Under good weather curing

conditions, side forms may be removed at any time within 48 hours subsequent to placing concrete, but the entire pile shall remain supported for at least 5 days and shall not be subject to any handling stress until the concrete has set for at least 7 days and for a longer period in cold weather, the additional time to be determined by the Engineer.

4. *Casting.* Piling may be cast either in a vertical or horizontal position. When vertical forms are used, special care shall be exercised to consolidate the concrete around the reinforcing and to avoid the formation of stone pockets. When horizontal forms are used, the piles may be cast either separately or in tiers. If cast in tiers, the tiers shall be separated by suitable material carefully placed.

   Concrete in the upper tier shall not be placed until test beams or test cylinders meet strength requirements as provided in Section 701.

   Not more than two tiers shall be used unless the additional tiers are supported independently.

   If alternate piles are cast in tiers, the intermediate piles shall not be cast until 2 days after the casting of the adjacent piles.

   Concrete shall be placed continuous in each pile and shall be carefully consolidated with special care being exercised to avoid horizontal and diagonal cleavage planes and to see that the reinforcement is properly embedded in the concrete.

   As soon as the forms are removed, concrete piles shall be carefully examined and pointed with 1:2 mortar, filling up all cavities or irregularities. Trestle piling exposed to view shall be finished above ground line in accordance with the provisions of Section 509. Foundation piling that portion of trestle piling which will be below the ground surface and piles for use in salt water or alkali soils shall not be finished except by pointing as above set forth.

5. *Curing.* As soon as the top surface of piles have been finished, they shall be cured with one of the following methods.

   5.1 Covering with wet burlap as soon as finishing is completed. The following day the piles shall be covered with 2 inches of sand and kept wet for an additional 5 days. Piles must be kept wet continuously from the time the first burlap is placed until curing time has expired.

   5.2 Covered with wetted cotton mats as specified in Subsection 414.04 M.

   5.3 Cured with an approved membrane curing compound as

specified in Section 701.

5.4 Cured with an approved polyethylene burlap for 6 days.

5.5 The side forms on concrete piles may be left in place for at least 6 days or if removed before the 6 days have elapsed, the surfaces shall be cured for the remaining time by one of the methods specified herein. Surfaces that require a concrete surface finish shall be shrouded with wet burlap or wet mats from the time the forms are removed until the 6-day curing period has elapsed.

6. *Handling Piling.* Removal of forms, curing, storing, transporting and handling precast concrete piles shall be done in such a manner as to avoid excessive bending stresses, cracking, spalling or other damage.

Piling which has been cracked or otherwise damaged in handling, storage, or transportation to the extent that they would not be suitable for use in the structure shall be replaced at the Contractor's expense.

Concrete piling cast in cold weather shall conform to the requirements of Section 414.

Concrete piles, including test piles, made of Class AA or high early strength concrete may be driven when test beams or test cylinders made, cured and tested in accordance with Subsection 701.01 D. indicate a strength of 600 pounds per square inch when tested with the third point method or 700 pounds per square inch when tested by the midpoint method or test cylinders have a compressive strength of not less than 4000 pounds per square inch. In no case shall concrete piles be driven in less than 7 days after casting.

7. *Build Up.* Extensions, splices or build up on concrete piles should be avoided, but when necessary, they shall be made as follows:

After the driving is completed, the concrete at the end of the pile shall be cut away, leaving the reinforcing steel exposed for a length of 40 diameters. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the piles shall be securely fastened to the projecting steel and the necessary form work shall be placed, care being taken to prevent leakage along the pile. The concrete shall be of the same quality as that used originally in the pile. Just prior to placing concrete, the top of the pile shall be thoroughly wetted and covered with a thin coating of neat cement. The forms shall remain in place not less than 7 days and shall then be carefully removed and the entire exposed surface of the pile finished as herein specified. Built-up piles may be further driven when a modulus of rupture of test beams has been attained, as provided in Subsection 701.01 D., but in no

case in less than 7 days after casting.

I. ***Steel Piling.*** Steel piling lengths and weight shall be as shown on the Plans. The steel shall comply with the requirements of Section 506. When steel piles extend above the ground surface or water surface they shall be protected by painting as specified in Section 506. The paint shall be applied from low water to top of pile and in dry river beds from 2 feet below the ground line to top of the pile. Field paint shall not be applied until the bent is completed in place. When untested steel piling is received on the job site, the Contractor shall furnish, at his expense, enough extra length from each heat number for testing.

Piling shall be cut off at the required elevation in a neat and workmanlike manner. If capping is required, the connection shall be as shown on the Plans.

514.05 METHOD OF MEASUREMENT.

A. ***Test Piles.*** Test piles whether of timber, concrete or steel will be measured by the actual number of piles driven as shown on the Plans or directed by the Engineer.

B. ***Untreated Timber Piling.*** The number of linear feet of untreated timber piling measured for payment shall be the actual number of feet remaining in the finished structure. Cutoffs measured for payment will be the difference in length between the piles of approved length placed in the leads and the actual number of feet remaining in the finished structure. Cutoffs, in excess of one foot, which are necessitated by damaged pile heads will not be measured for payment.

C. ***Treated Timber Piling.*** The method of measurement for treated timber piling shall be as specified for untreated timber piling in Subsection 514.05 B.

D. ***Reinforced Concrete Piling.*** The number of linear feet of reinforced concrete piling measured for payment shall be the actual number of feet remaining in the finished structure. Cutoffs and buildups measured for payment will be the difference in length between the piles of approved length placed in the leads and the actual number of feet remaining in the finished structure. An additional length of up to 2 feet for each pile cut off will be measured for payment as reinforced concrete piling. For cutoffs of 2 feet or less, the reinforcing steel shall not be cut off but shall be bent into the adjacent concrete. Splices measured for payment will be the length of pile cut back for making build-ups. No measurement will be made of lengths cut back or splices made which were necessitated by damage to piling.

E. ***Steel Piling.*** The number of linear feet of steel piling measured for payment shall be the actual number of feet remaining in the finished structure. Cutoffs measured for payment will be the actual length of pile cut off but will

not include any length in excess of plan length. Those lengths of piling paid for as cutoffs shall become the property of the Contractor. Where cutoffs are used in the project, that length will be deducted from the length of cutoffs measured for payment. Where steel piling buildups are required over Plan length one piling splice per pile, when made, will be measured for payment. When Plan length of pile exceeds 50 feet, one splice per pile, when furnished, may be measured for payment to attain plan length.

514.06 BASIS OF PAYMENT. Piling measured as provided above will be paid for at the contract unit price per linear foot, which shall include the furnishing of all necessary pilot holes, jetting, material, equipment, and labor necessary for the satisfactory driving of such piles.

A. Test Piles. Test piles whether of timber, concrete or steel will be paid for at the contract unit price per pile complete in place. When metal shoes are specified for timber piles or tip reinforcing plates and pile head bearing assemblies are specified for steel piling in the finished structure, they shall also be used on the test piles and all cost of same will be included in the price bid per test pile complete in place. Right is reserved to increase or decrease the number of test piles. In case of such variation, the unit price shall prevail for the exact number of test piles used.

(A) Test Piles Ea.

Cutoffs of test piles will not be measured for payment.

B. Untreated Timber. Cutoffs, measured as provided above, will be paid for at 50 percent of the contract unit price per linear foot for untreated piling and shall become the property of the Department.

(B) Untreated Timber Piling Lin. Ft.

C. Treated Timber Piling. Cutoffs, measured as provided above, will be paid for at 60 percent of the contract unit price per linear foot for treated piling and shall become the property of the Department.

(C) Treated Timber Piling Lin. Ft.

D. Reinforced Concrete Piling. Reinforced concrete piling, measured as provided above, will be paid for at the contract unit price per linear foot, which shall include the furnishing of all necessary pilot holes, jetting, material, equipment and labor necessary for the satisfactory driving of such piles. Cutoffs, measured as provided above, will be paid for at 75 percent of the contract unit price per linear foot for reinforced concrete piles. Splices, measured as provided above, will be paid for at 1 1/2 times the length of splice multiplied by the contract unit price per linear foot for reinforced concrete piles.

(D) Reinforced Concrete Piling Lin. Ft.

The length of build-ups, when re-driving is not required, will be paid for at the contract unit price per linear foot for reinforced concrete piling. Build-ups of reinforced concrete piling, when re-driving is required, will be paid for at 1 1/2 times the contract unit price per linear foot for reinforced concrete piling.

E. Steel Piling. Cutoffs, measured as provided in method of measurement, will be paid for at 60 percent of the bid price per linear foot for steel piling. Splices will be paid for as provided herein. Piling splices, when necessitated by the construction, shall be measured as provided in paragraph 514.05 E. and shall be paid for at 2 times the contract unit price for one linear foot of the pile specified.

(E) Steel Piling Lin. Ft.

F. Metal Pile Shoes. Metal pile shoes, except for test piles, will be paid for at the contract unit price for each metal pile shoe, which shall include furnishing of all material, equipment and labor incidental to this item.

(F) Metal Pile Shoes Ea.

G. Loading Tests. When loading tests are specified on piling, they will be paid for on a lump sum basis.

(G) Loading Tests Lump Sum

515.00 PENETRATING WATER REPELLENT TREATMENT OF CONCRETE SURFACES

515.01 DESCRIPTION. This work shall consist of furnishing necessary labor, materials, and equipment to treat concrete surfaces with a penetrating water repellent treatment solution including surface preparation and application as shown on the Plans, and in accordance with these Specifications.

515.02 MATERIALS. The penetrating water repellent treatment solution shall meet the requirements of Subsection 701.12.

515.03 EQUIPMENT.

A. General. All necessary equipment shall be furnished by the Contractor in accordance with the requirement of Subsection 108.06. Minimum requirements for construction equipment required for surface preparation and application of the penetrating water repellent treatment solution are specified herein.

B. Equipment Required for Sand Blasting Methods of Surface Preparation.

1. Sand Blasting Unit. Compressed air pressure type sand blasting equipment of proper size and capacity to clean concrete surfaces as specified.

C. Equipment Required for Water Washing Methods of Surface Preparation.

1. Hot Water Pressure Washer. Hot water pressure system for cleaning concrete surfaces as specified, utilizing 160° F water temperature at 1,800 pounds per square inch minimum nozzle pressure.

2. Hydroblast Washer. High pressure cold water washer unit for cleaning concrete surfaces as specified, using 7,000 pounds per square inch minimum nozzle pressure.

3. Steam Cleaning Unit. Steam jet cleaning equipment for preparing concrete surfaces as specified, utilizing 320° F water temperature under 305 pounds per square inch operating pressure.

D. Equipment for Application of Treatment Solution.

1. Spray Equipment. Low pressure airless type spray equipment with 15 to 40 pounds per square inch application pressure.

515.04 CONSTRUCTION METHODS.

A. General. Concrete surfaces may be cleaned by utilizing either sand blasting or water washing equipment as specified. The use of other methods and equipment for surface preparation equal to or exceeding the minimum requirements specified for sand blasting or water washing methods may be approved for use under the requirements of Subsection 108.06.

B. Surface Preparation. All concrete surfaces prepared for treatment shall be thoroughly cleaned prior to application of the penetrating water repellent treatment solution. The method of cleaning shall remove all traces of curing compound, laitance, dirt, dust, salt, oil, asphalt or other foreign materials.

Surface preparation may include the application of pretreatment cleaning agents prior to the use of water washing cleansing methods.

If necessary, solvents and hand tools shall be used as required to remove bonded materials detrimental to treatment of the concrete surface.

When water washing methods of cleaning are utilized the addition of detergents may be used to reduce surface tension of the cleaning water. The addition of such detergents may be used in proportions of 2 percent or less by weight.

The cleaning process shall not cause any undue damage to the concrete surface, remove or alter the existing surface finish, or expose the coarse aggregate of the concrete. The method of cleaning shall be performed in such a manner as to provide a reasonably uniform appearing surface color.

When water washing methods of cleaning are employed all concrete surfaces shall be free of any standing water or excess moisture at the time of treatment which may restrain surface penetration of the water repellent treatment solution.

Concrete surfaces prepared for treatment shall be approved by the Engineer.

C. Weather Limitations. The penetrating water repellent treatment solution shall not be applied when the air or concrete surface temperature is less than 40° F, or otherwise below or above the manufacturer's recommended application temperature range. The solution shall not be sprayed when blowing winds or other conditions prevent proper application.

D. Application. The penetrating water repellent treatment solution shall be used as supplied by the manufacturer and not diluted or altered in any way. The solution shall be sprayed onto concrete surfaces prior to concrete surface finish specified by Subsection 509.04 O. at the manufacturer's recommended rate of coverage as approved for use under these

Specifications unless otherwise specified.

Surface treatment of new concrete prior to 28 days curing will not be permitted.

E. Traffic. Traffic shall be kept off treated surfaces until the solution has completely penetrated and is surface dry.

515.05 METHOD OF MEASUREMENT. The penetrating water repellent treatment will be measured by the square yard of treated concrete surface area.

515.06 BASIS OF PAYMENT. Accepted quantities of penetrating water repellent treatment will be paid for at the contract unit price for:

Penetrating Water Repellent Surface Treatment	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

516.00 DRILLED SHAFT FOUNDATIONS

516.01 DESCRIPTION. This work shall consist of the construction of foundations of reinforced concrete shafts with or without bell type concrete footings. Concrete shafts shall be placed in drilled excavation when the shafts are without bell type footing and in drilled and under reamed excavation when shafts are with bell type footings. Such foundations shall be constructed in accordance with these Specifications and in reasonably close conformity with the details and governing dimensions shown on the Plans or established by the Engineer.

516.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Portland Cement Concrete	701.01
Reinforcing Steel	723.01 & 723.02

All concrete shall be Class AA unless otherwise shown on the Plans.

The slump of the drilled shaft concrete shall be 6 inches + 1 inch. The maximum water cement ratio specified in Subsection 701.01 shall not be increased. An approved water reducing agent may be used to obtain desired workability.

An approved set retarding agent will be required in all concrete when the casing method is used.

When the prevailing maximum temperature is 75° F or above, an approved water reducing agent or an approved set retarding agent will be required in all drilled shaft concrete.

The temperature of concrete to be placed in the drilled shaft shall not exceed 85° F.

The materials in the inner casing of the Double Casing Method shall meet the requirements of AASHTO M 36.

516.04 CONSTRUCTION METHODS.

A. General. The methods covered by this Specification are the dry method, the casing method, and the double casing method.

The Contractor shall perform the excavation required for the shafts and bell footings, through whatever materials encountered, to the dimension and elevations shown on the Plans or required by the site conditions.

Shafts and bells may be excavated either by hand or by mechanical methods. Blasting may be used only with the permission of the Engineer and shall be controlled to avoid disturbance to the formations below or outside the limits of the proposed shaft.

The drilled shaft must be installed so that the axis of the shaft at the top is no more than 3 inches from its plan location. Drilled shafts must be plumb to within one percent of the total length of the shaft. The diameter of the stem of the drilled shaft must be no less than one inch smaller than plan dimension. The bearing area of the bell must be as large as that shown on the Plans.

When the plans require drilled shafts in abutments, the embankment at the bridge ends shall be completed to grade and thoroughly compacted prior to drilling.

Material excavated from shafts and bells, including drilling mud, and not used in the backfill around the compacted pier or abutment shall be disposed of in a manner approved by the Engineer and shall not be placed in a stream channel or otherwise impair the efficiency or appearance of the bridge or other parts of the work.

Any excavation for the shaft or bells beyond the lines required by the plans shall be filled with Class AA concrete at the Contractor's expense.

If the elevation of the top of shaft is below ground level at the time of concrete placement, an oversize surface casing from ground elevation to a point below the top of the shaft will be required to control caving of any substance into freshly placed concrete. This provision will apply to the dry method, the casing method and the double casing method if the top of the outer casing, as well as the top of the inner casing, is below ground level.

It is the responsibility of the Contractor to report to the Engineer any significant deviation from subsurface conditions as shown on the Plans, thereby allowing redesign of foundations as necessary. An example of a significant deviation would be finding the bearing stratum at a lower elevation than shown on the Plans.

In order that the Engineer may judge the adequacy of a proposed foundation, the Contractor shall take cores to such cores will not be required to exceed 5 feet below the foundation base elevation. It is the intent of this provision that cores shall be made at the time the excavation in each foundation is approximately complete.

At any time when a person is in the hole, the Contractor shall make provisions for pumping fresh air to the workmen and protecting against possible collapse of the excavation by adequate casing.

The Contractor shall provide suitable access and lighting for the Engineer to inspect the completed foundation excavation and check the dimensions and alignment of the shaft and bell excavation.

Any required lighting shall be electric. Any mechanical equipment used within the excavation shall be operated by air or electricity. The use of gasoline driven engines within the excavation for any purpose will not be permitted. Prior to placing concrete, excessive loose material shall be removed from the bottom of the excavation; excessive loose material is defined as more than one inch of loose material.

B. Obstructions. Obstructions when encountered will be measured for payment. An obstruction is defined as an extremely hard ledge or boulder, or any other natural or man-made object such as metal that cannot be drilled through or under reamed by use of normal drilling techniques and tools. Normal tools are defined to be an auger with or without rock bits that is the full size of the shaft being drilled, and a full size under reamer. Other techniques and tools, such as blasting within the shaft, drilling at least three additional smaller shafts within the planned shaft, or excavating the shaft or bell by hand, shall only be used with the permission of the Engineer. A hard material in which the shaft is founded will be considered an obstruction if it cannot be drilled by normal drilling techniques and tools as defined above.

C. Reinforcing Steel. The reinforcing steel cage shall be completely assembled, and immediately prior to concrete placement it shall be placed as a unit.

The clearance between the edge of the drilled shaft and the reinforcing steel shall be 3 inches.

Where spiral reinforcing is used, it shall be tied to the longitudinal bars at a spacing not to exceed 12 inches on centers, unless otherwise shown on the Plans, to provide a rigid unit.

The minimum length of steel required for lap with the column steel, as shown on the Plans, shall be maintained. Dowel bars may be used if the proper lap length is provided both into the shaft and into the column.

The cage shall be supported from the top by some positive method to minimize its slumping downward during concrete placement and/or extraction of the casing. The support shall be concentric with the cage to prevent racking and distortion of the steel. For shafts built using the Casing Method, a minimum of 1/2 of the vertical bars shall be supported from the top.

The elevation of the top of the steel cage shall be carefully checked before and after casing extraction. Generally any upward movement of the steel not exceeding 2 inches, or any downward movement thereof not exceeding 6 inches per 20 feet of shaft length will be acceptable. Any upward movement of the concrete or displacement of the steel beyond the above limits will be cause for rejection.

When additional length of shaft requires reinforcing to be spliced, the added

length required in the splice will be paid for at the contract price for reinforcing steel under Subsection 511.06.

D. Drilled Shafts.

1. *Dry Method.* The excavation shall be made without the use of water, drilling mud, or casing, except for possibly a surface casing. Unless obstructions are encountered, the excavation shall be completed in a continuous operation and the concrete shall be placed without undue delay.

   In uncased shafts, concrete spacer blocks or steel chairs shall be used at sufficient intervals to insure concentric spacing of the entire length of the cage. In cased shafts, concrete spacer blocks shall not be used. Metal chair type spacers or bent pieces of steel bars shall be placed at sufficient intervals around the steel cage to insure concentric spacing inside the casing.

2. *Casing Method.* Where caving conditions are encountered or where excess water begins seeping into the excavation, no further drilling will be allowed until the Contractor selects a method to prevent ground movement and/or water flow. The Contractor may elect to place a temporary casing by appropriate means or advance the excavation by stabilizing the hole by use of a fluid of the appropriate density.

   Temporary casing, when employed, shall be of metal and of ample strength to withstand handling stresses and the external pressure of the caving soil and/or water, and it shall be water-tight. When necessary, the Contractor shall prepare the bottom of the casing with cutting teeth to facilitate seating in the founding stratum. The casing shall be smooth, well oiled, and shall extend approximately to the top of the shaft. Normally the casing shall extend above the ground surface. Casing shall not be employed in a hole with a nominal diameter less than 18 inches. The outside diameter of the casing shall not be less than the specified diameter of the drilled shaft. Casing shall not be left in the ground except by permission of the Engineer and if left in ground, it shall be adequately backfilled with concrete grout or sand as specified by the Engineer.

   When a stratum of soil is encountered that will not cave or admit a significant flow of water and where the excavation is to be completed, the bottom of the casing will be sealed in that formation so as not to admit fluid. The excavation will be completed according to plan in the stratum specified.

   The Contractor will be permitted to backfill around the upper portions of the casing with pea size gravel or other granular material, but space shall

be provided to allow for escape of muck, slurry, or water displaced from outside the casing by the concrete.

If an oversize casing is used, no extra compensation will be allowed for the concrete required to fill the oversize casing.

The elapsed time from the beginning of concrete placement in the cased portion of the shaft until extraction of the casing is begun shall not exceed one hour unless additional time is approved by the Engineer before concrete placement is begun.

Under normal operations, the removal of the casing shall not be started until the level of the concrete approaches the top of the drilled shaft. Under no circumstances shall removal of the casing begin until the level of the concrete is higher than the level of fluid, such as drilling mud or water, outside the casing. Throughout removal of the casing the level of the concrete must be maintained above the level of the fluid outside the casing. Movement of casing for short pulls of a few inches, rotating, exerting downward pressure, and tapping it to facilitate extraction will be permitted. Under normal conditions, the casing will be removed in a continuous operation while maintaining the head of concrete. Casing extraction shall be at a slow, uniform rate and the pull shall be vertical.

3. *Double Casing Method.* This method is to be used when severe groundwater problems or unstable soil conditions are encountered.

   The temporary outer casing shall be as specified in Subsection 516.40 D. 2. except that it shall be 6 inches larger in diameter than the drilled shaft. The outer casing shall be driven into the founding stratum for sealing off water.

   After the outer casing is in place, the foundation excavation shall be completed to the plan diameter of the drilled shaft.

   A permanent inner casing, the same diameter as the drilled shaft diameter, shall be set into the founding stratum and braced at the top. The inner casing shall be a round corrugated galvanized steel pipe with 3 x 1 inch corrugations, and shall be of sufficient gauge to maintain the round shape and withstand the pressure of the concrete.

   After the complete drilled shaft concrete is poured, the outer casing may be removed provided initial set of the concrete has not taken place. If initial set has taken place, the outer casing shall not be removed for 12 hours. The inner casing shall remain in place.

E. Concrete. The work shall be performed in accordance with the provisions of Section 509 and in conformance with the requirements herein.

At the time the concrete is placed, the excavation shall be free from accumulated seepage water unless an underwater pour is authorized by the Engineer.
Concrete shall be placed as soon as possible after all excavation is complete and reinforcing steel placed, and shall be of such workability that vibrating or rodding will not be required.

After concrete placement is completed, the top surface shall be cured and any construction joint area shall be treated as prescribed in Section 509.

Placing of drilled shaft concrete underwater shall be done only with permission of the Engineer in strict conformance with the procedures outlined below for underwater pour. Underwater pour shall not be permitted with the dry method of shaft construction.

1. *Concrete Poured in the Dry.* All drilled shaft concrete placed in the dry shall be placed through a suitable rigid tremie or by pumping through a suitable rigid tube to prevent segregation of materials. The tremie shall consist of a suitable rigid tube with a diameter of no more than 14 inches or less than 10 inches. It shall be constructed and supported so that it can be moved horizontally to cover the work area and moved vertically to control the concrete flow as the level of the concrete in the shaft is raised. The bottom of the tremie or pump pipe must remain below the top of the concrete at all times but shall not be left at the bottom of the hole during the entire pour.

   Placing of concrete by pumping will require that the portion of the tube inside the excavation meets all the requirements above, but only that portion of the pumping tube in contact in place will be required to be rigid.

2. *Concrete Poured Underwater.* If it becomes apparent that pumping and other dewatering methods are not adequate to dry the hole, the Engineer may authorize underwater placement of concrete. In this case, the water in the hole shall be permitted to seek its natural hydrostatic head to prevent any possibility of pressure washing of the concrete being placed.

   The tremie requirements and concrete placement procedure shall be the same as specified above for concrete poured in the dry except the tremie shall be watertight and shall be constructed so that the bottom can be sealed and then opened after it is in place and fully charged with concrete.

516.05 METHOD OF MEASUREMENT. Acceptable drilled shafts, complete in place, of the specified diameter will be measured by the linear foot as constructed to the dimensions shown on the Plans or approved by the Engineer from bottom to

top of shaft without regard to the method of construction.

Acceptable footing bells, complete in place, will be measured by the cubic yard as constructed to the dimensions shown on the Plans or approved by the Engineer.

The volume of footing bells will be measured outside the neat lines of the drilled shaft.

Corrugated galvanized steel pipe, in place as the permanent inner casing of a completed drilled shaft, will be measured by the linear foot as constructed to the dimensions shown on the Plans or approved by the Engineer.

Obstructions, as defined above in Subsection 516.04 B., shall be measured by the linear foot in the shaft where the obstruction occurs. No reduction shall be made in drilled shaft or footing bell measurements due to obstructions.

516.06 BASIS OF PAYMENT. Accepted quantities of drilled shafts, measured as provided above, will be paid for at the contract unit price for:

(A) Drilled Shafts Lin. Ft.

1. Payment for individual completed shaft lengths plus or minus one foot of plan length, will be made at the unit price bid per linear foot of the specified diameter of drilled shafts.

2. Payment for that portion of individual completed shaft length in excess of one foot more than the plan length shaft, will be made at a unit price equal to 125 percent of the unit price bid per linear foot of the specified diameter of drilled shafts.

3. When individual completed shaft lengths are more than one foot less than the plan length, the Contractor will be paid an amount equal to 25 percent of the unit price bid per linear foot of the specified diameter of drilled shafts for each foot of the reduction in length from plan length.

4. Obstructions as measured above shall be paid for at 200 percent of the unit price bid for linear foot of drilled shaft of the size specified.

Accepted quantities of footing bells, measured as provided above, will be paid for at the contract unit price for:

(B) Footing Bells Cu. Yd.

The foregoing unit prices shall be full compensation for making all excavations using normal drilling techniques and tools; for doing any necessary pumping; for furnishing, placing, and removing any temporary casings; for furnishing and placing all concrete and reinforcing steel; for all backfilling; and for furnishing all

tools, materials, labor, equipment, and incidentals necessary to complete the work. When the bottom of any drilled shaft is ordered to be placed at an elevation below plan grade and a splice of reinforcement is required, no payment will be made for the extra reinforcing required, but it shall be considered subsidiary to the price bid per foot of shaft. However, the added reinforcing in the lap splice will be paid for at the contract price for reinforcing steel. No extra payment will be made for temporary casings left in place.

Accepted quantities of corrugated galvanized steel pipe, measured as provided above, will be paid for at the contract unit price for:

(C) Corrugated Galvanized Steel Pipe Lin. Ft.

which shall be full compensation for furnishing and placing the pipe.

529.00 LOW STRENGTH BACKFILL MATERIAL

529.01 DESCRIPTION. This work shall consist of the placement of a flowable mixture of portland cement, fly ash and sand, termed CLSM (controlled low strength material) for backfilling bridge abutments, street repairs, culverts, concrete reinforced boxes, or other identified structures in close conformity with the lines, grades, dimensions and details shown on the Plans or established by the Engineer. Before any CLSM is poured, the Engineer shall verify that the CLSM trial mix satisfied the strength requirement as stated in this Specification.

529.02 MATERIALS.

A. Portland Cement. Portland cement shall conform to the requirements of Subsection 701.02 of the Standard Specifications.

B. Fly Ash. Fly Ash shall conform to ASTM Designation C-618, Class "C" or Class "F" mineral chemical composition and physical requirements. Alternate materials may be used for fly ash provided the alternate material meets the approval of the Engineer.

C. Fine Aggregate (Sand). Fine aggregate shall conform to the requirements of Subsection 701.05 A. of the Standard Specifications.

D. Water. All water shall conform to the requirements of Subsection 701.04 of the Standard Specifications.

529.03 MORTAR MIX.

A. Mix Proportioning. The initial trial mixture shall consist of the following approximate quantities of materials per cubic yard.

CLSM	
Cement	50 lbs.
Fly Ash	250 lbs.
Sand (SSD)*	2,910 lbs.
Water	500 lbs.
*(-saturated – surface – dry)	

The Contractor shall submit a proposed mix with trial batch test data for the Engineer's acceptance. The Engineer may require trial batches. Adjustments of the proportions may be made by the Contractor, providing the total absolute volume of the materials is maintained. During the progress of the work no change shall be made in the batch proportions of the ingredients without the approval of the Engineer. The Contractor may use air entrainment.

The batch proportions accepted by the Engineer apply only for materials from the same source and having the same characteristics as the materials used in

the mix design. Materials from any other source shall be used only with the approval of the Engineer.

Should a change in sources of materials be made, a new mix design formula shall be established by the Contractor before the new material is used. When unsatisfactory results or other conditions make it necessary, the Contractor shall establish a new mix design formula to get the desired results.

B. Mix Adjustment. To expedite consolidation of the mortar, it will be necessary for bleed water to appear on the surface immediately after the CLSM levels off. A delay in bleeding indicates there are too many fines in the mixture, so the fly ash quantity shall be reduced in increments of 50 pounds until mixture is bleeding freely. Approximately 60 pounds of sand shall be added to replace each 50 pound increment of fly ash to maintain the original yield.

529.04 CONSTRUCTION METHODS.

A. Mixing equipment. Sufficient mixing capacity of mixers shall be provided to permit the mortar to be placed without interruption.

B. Placing CLSM. CLSM shall be discharged from the mixer by any reasonable means into the space to be filled. The fill material shall be brought up uniformly to the fill line shown on the Plans or as directed by the Engineer. Placing of material over controlled low strength material (CLSM) may commence as soon as the surface water is gone or as directed.

C. Sampling. The standard test specimen shall be the 4x8 inches cylinder for strength tests and an open-ended 3x6 inches cylinder for the flow test. Four test specimens shall be made for the strength tests. Samples for strength tests shall not be rodded and cylinders shall be allowed to stand undisturbed for at least 14 days before being shipped to the lab. Single use cardboard cylinder molds, split forms, or polystyrene molds are recommended for easier removal of the sample. Extrusion shall not be used to remove samples from the cylinders.

D. Testing. Laboratory tests for CLSM Flowability, strength and uniformity shall be made prior to placement. These laboratory tests shall consist of the following.

1. *Flow Test or Slump Test.* Flow test shall consist of filling a 3x6 inches open-ended cylinder to the top with the CLSM mixture. If necessary, strike off the top of the cylinder so that the mixture is level. Pull the cylinder straight up and measure the approximate diameter of the CLSM mixture. In order to provide ample flowability, the diameter of the material spread shall be a minimum of 8 inches.

2. *Strength Tests.* All strength tests shall be made by the lab. The

compressive strength testing shall follow the procedure set forth in AASHTO T-106 with modifications in regard to the cylinder size and rodding requirements. The cylinders size shall be 4x8 inches. Samples shall not be rodded. The maximum acceptable strength for CLSM trial batches is 350 psi and the recommended minimum is 130 psi. Compressive strength is based on the average of three cylinders at 28 days.

3. *Test for Unit Weight.* Test for unit weight shall conform to AASHTO T-121.

529.05 METHOD OF MEASUREMENT. The quantities which constitute the completed and accepted structure will be measured for payment by the cubic yard as constructed to the dimensions shown on the Plans or approved by the Engineer.

529.06 BASIS OF PAYMENT. Accepted quantities of CLSM, measured as provided above, shall be paid for at the Contract unit price for:

Low Strength Backfill Material C.Y.

which shall be full compensation for all materials, equipment, labor, and incidentals required to complete the work as specified.

600.00 GENERAL CONSTRUCTION

601.00 RIPRAP

601.01 DESCRIPTION. This work shall consist of furnishing and placing riprap protection of the type specified at the locations and in reasonably close conformity with the lines and dimensions shown on the Plans or established by the Engineer. The types of riprap are as follows:

Type I	Plain Riprap
Type I-A	Plain Riprap with Filter Blanket
Type II	Special Plain Riprap
Type II-A	Special Plain Riprap with Filter Blanket
Type III	Laid Up Riprap
Type IV	Grouted Riprap

601.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Portland Cement	701.02
Fine Aggregate	701.05
Stone for Riprap	713.02
Filter Blanket	713.03
Filter Fabric	712.04

601.04 CONSTRUCTION METHODS.

A. General. The slopes, ditches, and areas to be protected shall be shaped and dressed to the lines and grades shown on the Plans. Where Type III or Type IV construction is specified, the base shall be compacted in accordance with Subsection 501.04 before the riprap is placed.

B. Filter Blanket. Filter blanket, when specified, shall be placed in one or two layers as indicated on the Plans. When material is stockpiled at the jobsite, it shall be in accordance with Subsection 106.07. Each layer shall be spread uniformly on the prepared base, in a satisfactory manner, to the neat lines indicated. Damage to the surface of the filter blanket during placing of the blanket shall be repaired before proceeding with the work. Compaction of the filter blanket will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

C. Filter Fabric. Filter fabric, when specified, shall be placed to conform to Plan details. Areas on which filter fabric is to be placed shall have a uniform slope, be reasonably smooth, free from mounds and windrows, and free of any debris or projections which could damage the filter fabric to be placed on it.

The material shall be loosely laid (not stretched). Adjacent strips shall overlap by a minimum of 2 feet. The fabric shall be supported at all times to the extent necessary to prevent displacement of the fabric from its intended position. All methods of fabric support and all methods of holding the fabric in place shall be approved by the Engineer. Laps in filter fabric shall be made in conformance with Section 602.04 B. Any filter fabric damage or displacement before fabric placement, during fabric placement, or during riprap placement shall be replaced or repaired to the satisfaction of the Engineer at the Contractor's expense.

During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays, temperature greater than 140° F, mud, dirt, dust and debris. To the extent possible, the filter fabric shall be maintained wrapped in a heavy duty protective covering.

The work shall be scheduled so that the covering of the filter fabric is accomplished within 30 days after placement or otherwise protected. Failure to comply with this requirement shall require replacement of the fabric.

D. Types I, I-A, II and II-A. The areas to be protected shall be dressed approximately to the lines and grades shown on the Plans prior to placing riprap or the filter blanket, when a filter blanket is specified.

Plain riprap and special plain riprap, graded so that the smaller stone is uniformly distributed throughout the mass, may be dumped over the area designated until the required depth is attained. Hand or machine placing will be required as is necessary to deposit the stones to the general lines and to the thickness shown on the Plans.

E. Type III. The foundation for riprap shall be excavated below probable scour or the elevation shown on the Plans, and no stone shall be laid or concrete placed until the footing is approved by the Engineer.

The stones shall be placed with their beds at the approximate angle to the slopes as indicated on the Plans. They shall be laid in close contact and so as to break joints, and the individual stones shall be thoroughly keyed into the wall. Spaces between stones shall be filled with spalls securely rammed into place. The finished wall shall present an even, tight and reasonably plain surface of the contour required. Points of stones projecting beyond the surface of the wall shall be broken off.

F. Type IV. The foundation for riprap shall be excavated below probable scour or to the elevation shown on the Plans, and no stone shall be laid or concrete placed until the footing is approved by the Engineer.

The stones shall be placed with their beds at the approximate angle to the slopes, as indicated on the Plans. They shall be laid in the close contact and so

as to break joints, and the individual stones shall be thoroughly keyed into the wall. Care shall be taken during placing to keep earth or sand from filling the spaces between the stones. After the stones are in place, they shall be thoroughly wetted immediately prior to placing grout. The spaces between the stones shall be completely filled with grout from bottom to top and the surface swept with a stiff broom. No riprap shall be grouted in freezing weather and in hot, dry weather the work shall be protected from the sun and kept moist for at least 3 days after grouting.

Grout for grouted riprap shall consist of one part of portland cement and 3 parts fine aggregate by volume, thoroughly mixed with water to produce grout having the proper consistency. Re-tempering of grout will not be permitted.

601.05 METHOD OF MEASUREMENT.

Type I and Type I-A. Plain riprap or plain riprap and filter blanket will be measured separately by the cubic yard determined by multiplying the specified thickness of each type of material by the actual area of the surfaces on which each material is acceptably placed, or by the ton.

Type II and Type II-A. Special plain riprap or special plain riprap and filter blanket will be measured separately by the cubic yard determined by multiplying the specified thickness of each type of material by the actual area of the surfaces on which each material is acceptably placed, or by the ton.

Type III. Laid up riprap will be measured by the square yard. This measurement covers the whole face area, regardless of thickness and including additional thickness at base of walls.

Type IV. Grouted riprap will be measured by the square yard. This measurement covers the whole face area, regardless of thickness, including additional thickness at the base of walls.

Scales for weighing shall meet the requirement of Subsection 109.01.

Filter Fabric. Filter fabric complete in place will be measured by the square yard as constructed to the dimension shown on the Plans or approved by the Engineer.

601.06 BASIS OF PAYMENT. Accepted riprap, measured as provided above, will be paid for at the contract unit price for:

(A)	Type I	Plain Riprap	Cu.Yd. or Ton
(A-1)	Type I-A	Plain Riprap	Cu.Yd. or Ton
(A-2)	Type I-A	Filter Blanket	Cu.Yd. or Ton
(B)	Type II	Special Plain Riprap	Cu.Yd. or Ton
(B-1)	Type II-A	Special Plain Riprap	Cu.Yd. or Ton

(B-2)	Type II-A	Filter Blanket	Cu.Yd. or Ton
(C)	Type III	Laid Up Riprap	Sq. Yd.
(D)	Type IV	Grouted Riprap	Sq. Yd.
(E)		Filter Fabric (Riprap)	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

602.00 GABIONS

602.01 DESCRIPTION. This work shall consist of furnishing and placing rock filled wire mesh baskets (Gabions) and filter fabric in accordance with these Specifications and in reasonably close conformity with the lines, grades dimensions and details shown on the Plans or established by the Engineer.

602.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Filter Sand	703.04 B.
Filter Fabric (Gabions)	712.02
Stone for Gabions	713.04.2.
Wire Baskets	732.09

602.04 CONSTRUCTION METHODS.

A. Gabions. Gabions shall be constructed in various lengths and heights shown on the Plans. The lengths shall be multiples of 2, 3, or 4 of the base width. The heights shall be equal to all of, 1/2 of, or 1/3 of the base width. The base width shall not be less than 36 inches. Gabions furnished shall be of uniform width.

Gabions may be rotated 90°, if called for on the Plans, so that the side height becomes the base.

Gabions shall be placed to conform to Plan details; otherwise, the gabions shall be installed according to the manufacturer's recommendations. The gabions shall be placed on a smooth foundation. Each row or tier of gabion baskets shall be reasonably straight and conforming to proper alignment and grade before baskets are filled. Final line and grade shall be approved by the Engineer.

Each gabion unit shall be assembled by binding together all vertical edges with wire ties on approximately 6 inch spacing or by a continuous piece of connecting wire stitched around the vertical edges with a coil about every 4 inches.

All gabion units shall be tied together to each adjacent unit along all contacting edges in order to form a continuous connecting structure. Wire ties or connecting wire shall be used to join the units together in the same manner as described for assembling each unit.

A standard fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment of the baskets during placement of the rock. If, while being stretched, any openings in or between gabions appear, the openings shall be repaired before further placement of the rock.

Rock fill shall be placed in close contact in the unit so that maximum fill is obtained. The units may be filled by machine with sufficient hand work to accomplish requirements of these Specifications. The rock fill shall be placed in three equal lifts. After each the first and second lift, half the connecting wires shall be placed; half of these connecting wires placed at each elevation shall be at a 90° angle to the other half of the connecting wires. Internal tie wires shall be uniformly spaced and securely fastened in each cell of the structure. Alternate placing of rocks and connection wires shall be performed until the gabion is filled. After the gabion has been filled, the lid shall be bent over until it meets the side and the edges. The lid shall then be secured to the sides, ends and diaphragms with wire ties or connecting wire in the manner described above for assembling each unit.

B. Filter Fabric. Filter fabric shall be placed for filtration and prevention of piping erosion.

Unless otherwise shown on the Plans the filter fabric shall be placed behind gabion walls and beneath gabion slope protection. The filter fabric shall be placed to conform to Plan details.

Areas on which filter fabric is to be placed shall have a uniform slope, be reasonably smooth, free from mounds and windrows, and free of any debris or projections which could damage the filter fabric to be placed on it.

The material shall be loosely laid (not stretched). Adjacent strips shall overlap by a minimum of 2 feet. The fabric shall be supported from the top at all times to the extent necessary to prevent displacement of the fabric from its intended position; the configuration of the gabion may require repositioning of the filter cloth several times during gabion construction. Other methods of holding the filter fabric in place may also be used such as securing pins, staples, or wires, but the primary support of the fabric shall be from the top. All methods of fabric support and all methods of holding the fabric in place shall be approved by the Engineer.

Vertical fabric laps shall be staggered at least 5 feet. Laps shall be made with the uphill layer on top. Full rolls shall be used whenever possible in order to minimize the number of vertical laps. When a gabion is placed adjacent to a stream, the fabric shall be placed so that the upstream strip of fabric will overlap the downstream strip.

If the configuration of the gabions requires that the gabion be placed on the filter fabric, then the rock fill shall be placed, not dropped, in the baskets to avoid damage to the filter fabric. Any filter fabric damaged or displaced before fabric placement, during fabric replacement, or during rock fill placement shall be replaced or repaired to the satisfaction of the Engineer at the Contractor's expense.

During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 140° F, mud, dirt, dust and debris. To the extent possible, the filter fabric shall be maintained wrapped in a heavy duty protective covering.

The work shall be scheduled so that the covering of the filter fabric is accomplished within 30 days after placement or otherwise protected. Failure to comply with this requirement shall require replacement of the fabric.

C. Filter Sand. Filter sand will not be required unless specified on the Plans. When filter sand is required, it shall be placed in accordance with the lines, dimensions and locations designated. Care shall be taken during placement of the filter sand not to damage or displace the plastic filter fabric.

D. Backfilling. Backfill behind gabions shall be placed and compacted in accordance with Subsection 202.04 C. of the Specifications.

602.05 METHOD OF MEASUREMENT. Acceptable gabions, complete in place, will be measured by the cubic yard as constructed to the dimensions shown on the Plans or approved by the Engineer.

Acceptable filter fabric, complete in place, will be measured by the square yard as constructed to the dimensions shown on the Plans or approved by the Engineer.

Rock fill for gabions will be included in the price bid per cubic yard of gabions.

Filter sand when required on the Plans will be included in the price of gabions.

Unless otherwise shown on the Plans, there will be no payment for backfilling behind gabions. If no payment for backfilling is allowed on the Plans, all cost of backfilling shall be included in the price of gabions.

602.06 BASIS OF PAYMENT. Accepted quantities of gabions, measured as provided above, will be paid for at the contract unit price for:

(A)	Gabions	Cu. Yd.
(B)	Filter Fabric (Gabions)	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

609.00 INTEGRAL CURB, COMBINED CURB AND GUTTER AND HEADER CURBING

609.01 DESCRIPTION. This work shall consist of the construction of integral curb, combined curb and gutter, header curbing, in accordance with these Specifications and in reasonably close conformity with the lines, grades and dimensions shown on the Plans or established by the Engineer.

609.02 MATERIALS. Concrete for integral curb, combined curb and gutter or header curbing shall be Class A concrete meeting the requirement of Section 701.

Sealing materials for concrete curbs shall conform to Subsection 701.08. Materials for sealing new concrete pavements and for most joint rehabilitation applications shall be in accordance with Subsection 701.08 E.; materials for sealing joints in integral concrete curb and combined curb and gutter shall be in accordance with Subsection 701.08 D., unless otherwise approved by the Engineer.

609.03 EQUIPMENT. A self-propelled or towed curb machine may be used when approved by the Engineer. The curb machine shall be capable of extruding a uniformly textured material to the shape and density specified and placing it in reasonably close conformity to the established line and grade.

609.04 CONSTRUCTION METHODS.

A. **Excavation.** Excavation shall be made to the required depth, and the base upon which the curb is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material which shall be thoroughly compacted.

B. ***Forms.*** Forms shall be of wood, metal or other suitable material, straight, free from warp and of such construction that there will be no interference to the inspection of grade or alignment. All forms shall extend for the entire depth of the curb or curb and gutter and shall be braced and secured sufficiently so that no deflection from alignment or grade will occur during the placing of the concrete or asphalt.

Fastening hardwood strips to the bottom of the forms not to exceed 2 inches in built-up thickness for special curb sections to provide the specified thickness may be permitted. The material and method of fastening the built-up section to the form shall be approved by the Engineer prior to use.

Forms shall be sufficiently tight as to prevent leakage. Forms shall be clean and oiled or wetted before placing concrete.

C. ***Placing Concrete.*** Checking forms, and placing and vibrating concrete shall be in accordance with Subsection 414.04.

D. Surface Finish. As soon as the curb concrete has set sufficiently to retain its shape without support, the final surface finish shall be obtained by uniformly brushing the surface in a manner approved by the Engineer.

The edges of all formed concrete joints, including edges at expansion and contraction joints or planes of weakness joints, shall be neatly edged to the required radius.

E. Joints. All joints in curbs shall be perpendicular to the sub-grade at right angles to the longitudinal axis of the curb. Expansion and contraction joints shall be constructed at the same location as similar joints in the paving slab.

Expansion joints shall be pre-molded expansion joint filler and shall be of the thickness and placed at the locations shown on the Plans or as approved by the Engineer. Joints shall be placed in the curb, gutter, or combined curb and gutter opposite the joints in the pavement.

Contraction joints in curb and gutter, when used in conjunction with asphalt surfacing, shall be sawed as specified in Subsection 609.04 H. and sealed with the same material specified for sealing expansion joints.

F. Curb Openings. Where curb is to be omitted for driveways, or other cause, either all or only the top portion of the separate curb may be omitted as shown on the Plans or approved. In general, only the curb will be left off of combined curb and gutter. Where the bottom portion of separate curb or the gutter of combined curb and gutter is left in place, the concrete shall be constructed slightly higher at the back of the curb line than at the front as shown on the Plans or as approved. Such curb shall be considered as regular curb.

G. Curing. Concrete curbs or combined curb and gutter shall be cured in accordance with Section 414.

H. Extruded Method. When the extruded method is used to construct combined curb and gutter, the extrusion machine shall be operated on a string or wire line, rails or forms set at uniform depth below the predetermined finished top of curb grade.

Concrete shall be uniformly fed to the machine and shall be of such consistency that after extrusion the concrete will maintain the shape of the section without support. The finished curb or curb and gutter shall present a well-compacted mass with a surface free from voids and honeycomb and reasonably true to established shape, line and grade. Any additional surface finishing required shall be performed immediately after extrusion. Tolerances shall meet the requirements of Subsection 414.04 S.

Joints shall be constructed at the same locations as required when form

construction is being used. Weakened joints, spaced at 20 foot intervals, shall be made by sawing unless other methods are approved by the Engineer.

I. Backfill. The back side of the curbs shall be backfilled with approved earth and thoroughly compacted in layers not exceeding 6 inches in depth and neatly graded as shown on the Plans or as approved by the Engineer. Care shall be taken not to damage the concrete in placing or compacting the backfill; any damage will be repaired at the Contractor's expense.

609.05 METHOD OF MEASUREMENT. Curbing will be measured by the linear foot along the front face of the curb for (a) concrete curb; (b) combined curb and gutter; and (c) concrete header curbing.

609.06 BASIS OF PAYMENT. The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

(A)	Concrete Curb	Lin. Ft.
(B)	Combined Curt and Gutter	Lin. Ft.
(C)	Concrete Header Curbing	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

610.00 CONCRETE SIDEWALKS, DRIVEWAYS AND DIVIDING STRIP

610.01 DESCRIPTION. This work shall consist of the construction of concrete sidewalks, driveways and dividing strips in accordance with these Specifications and in reasonably close conformity with the lines, grades and typical cross-sections shown on the Plans or established by the Engineer.

610.02 MATERIALS. Material shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Portland Cement Concrete, Class A	701.01

610.04 CONSTRUCTION METHODS.

A. Concrete Construction. All forming, placing and finishing shall be in accordance with Subsection 414.04. A sawed joint shall be made to connect the old and new pavements.

1. *Expansion Joints.* Expansion joints shall be of the dimensions specified and shall be filled with the type of pre-molded expansion joint filler noted. The sidewalk shall be divided into sections by dummy joints formed by a jointing tool or other acceptable means as approved by the Engineer. These dummy joints shall extend into the concrete for at least 1/3 of the depth and shall be approximately 1/8 inch wide.

2. *Construction Joints.* Construction joints shall be formed around all appurtenances such as manholes, utility poles, etc., extending into and through the sidewalk, driveway, or dividing strip. Pre-molded expansion joint filler ¼ inch thick shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between the concrete and any fixed structure such as a building or bridge. This expansion joint material shall extend for the full depth of the concrete.

3. *Curing.* Concrete shall be cured for at least 72 hours. Curing shall be by means of moist burlap or mats or by other approved methods. During the curing period all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Engineer may direct.

B. Backfill. The sides of sidewalks and driveways shall be backfilled as soon as the forms have been removed and the required pointing up of honeycombed areas completed. The backfill shall be of approved earth, thoroughly compacted in layers not exceeding 6 inches in depth as shown on the Plans or in a manner approved by the Engineer. Care shall be taken not to damage the concrete material in placing or compacting the backfill.

Where the general elevation of the adjacent ground surface is lower than the top of the sidewalk or driveway, the minimum width of the backfill shall be 2 feet.

C. Protection from Traffic. Sidewalks, driveways and dividing strip shall be protected from traffic using substantial barricades for a period of 7 days, unless otherwise permitted or ordered by the Engineer.

D. Remove Relay or Extend Brick or Stone Sidewalks. Where existing brick or stone sidewalks are to be re-laid or extended, the sub-grade shall be prepared as specified for concrete sidewalks, provided that a sand cushion 1-1/2 inches in depth shall be prepared, having a uniform flat surface at the proper sub-grade elevation. All old bricks shall be satisfactorily cleaned before re-laying. The brick or stone shall be laid close together in a manner to match the existing walk and shall be uniformly tamped firmly into the sand cushion. The top surface of the walk shall be smooth and at the proper grade. All joints shall be filled with concrete sand by spreading an excess over the surface and sweeping it into the joints. The top surface of the brick shall be cleaned. The sides of the walk shall be backfilled as specified for concrete walks.

610.05 METHOD OF MEASUREMENT. Concrete sidewalks, driveways and dividing strip will be measured by the square yard. Removing, re-laying, or extending of brick or stone sidewalks will be measured by the square yard.

610.06 BASIS OF PAYMENT. The accepted quantities, measured as provided above, will be paid for at the contract unit price for:

(A)	Concrete Sidewalk	Sq. Yd.
(B)	Concrete Driveway	Sq. Yd.
	(High Early Strength)	Sq. Yd.
(C)	Concrete Dividing Strip	Sq. Yd.
(D)	Remove and Relay Brick or Stone Sidewalk	Sq. Yd.
(E)	Brick or Stone Sidewalk	Sq. Yd.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Reinforcement, if used, excavation, backfill, expansion joint material, rolled curb on driveways and other related miscellaneous items will not be paid for separately, but the cost thereof shall be included in the cost of other items.

611.00 MANHOLES, DROP OR CURB INLETS, AND JUNCTION BOXES

611.01 DESCRIPTION. This work shall consist of the construction of manholes, drop or curb inlets, including special curbs, junction boxes or similar structures in accordance with the Plans and these Specifications, and in reasonably close conformity with the lines, grades and elevations shown on the Plans or established by the Engineer.

The option of furnishing precast concrete units in lieu of brick masonry or cast-in-place concrete structures may be considered by the Engineer if requested in writing by the Contractor.

611.02 MATERIALS.

A. General. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Portland Cement	701.02
Mortar Sand	701.05
Clay or Concrete Brick	714
Reinforcing Steel	723.01 & 723.02
Structural Steel	724
Steel Castings	725.03
Iron Castings	725.04
Precast Manholes	726

Portland cement concrete shall be Class A and shall meet the requirements of Subsection 701.01.

Clay or concrete brick or precast concrete units shall not be used in the construction or rebuilding of sanitary sewer manholes.

All precast structures with slab tops which may be subject to traffic, shall meet H-20 loading requirements.

Concrete for precast units shall be Class A concrete. The coarse aggregate shall conform to Subsection 701.06. Coarse aggregate for thin section concrete, No. 7 (1/2 in. - No. 4) size. Alternate material shall be concrete referenced in AASHTO M 199 (ASTM C 478).

Reinforcing steel for precast concrete units shall conform to the requirement of Subsections 723.01, 723.02 and 723.03.

Alternate material shall be steel referenced in AASHTO M 199 (ASTM C 478).

B. Portland Cement Mortar. The mortar for use with brick masonry shall be composed of one part portland cement and two parts mortar sand by volume, mixed with sufficient water to form a plastic consistency. The use of hydrated

lime not to exceed 10 percent by volume of the amount of cement will be permitted, but when used shall be added to the cement first and in proportioning the mortar will be considered as cement.

C. Accessories. Accessories, such as bolts, rivets, spacers, small I-beams, channels, and plates used for assembling or supporting frames, gratings, or covers shall be of first quality standard commercial material free from defects which may affect their value for the service intended.

D. Pipe Materials. Pipe required for construction of manholes, inlets or junction boxes shall conform to the requirements of the type of improvement under construction. Sanitary sewer pipe shall conform to Section 615, drainage pipe to Section 613, and etc.

611.03 EQUIPMENT. Specialized equipment required for off-loading, handling and placement must be demonstrably capable of safely handling the largest single unit and/or subassemblies. Lift holes or lift rings shall be provided in each unit at the manufacturer's discretion and all lift devices and/or connection points shall provide safe handling above ground and in the inlet excavation.

611.04 CONSTRUCTION METHODS.

A. Concrete. In the construction of concrete bottoms for manholes and inlets, the concrete shall be rounded to the dimensions and shape, the surface shall be troweled until a uniform, smooth and impervious hard fanned finish is obtained.

All exposed concrete edges shall have a minimum 1/2 inch chamfer, or an approved rounded edging. Unless otherwise specified, all exposed concrete or brick surfaces shall be finished in accordance with Subsection 509.04 P.

B. Concrete Brick. Brick masonry in circular or curved walls which have a radius of less than 2 feet, shall have every fifth course stretchers, and the remainder, headers, and the thickness of joints shall not exceed 1/4 inch vertical on the inside face, or 3/8 inch horizontal. Brick masonry in straight walls and in walls where the radius of curvature is 2 feet or greater, shall have every fifth course headers, and the remainder, stretchers, and all joints shall have a thickness not exceeding 3/8 inch. Vertical joints in adjacent courses shall be broken approximately half the length or width of the brick, as the case may be.

All brick shall be laid in a full bed of mortar and all joints shall be shoved joints, completely filled with mortar. Buttered joints will not be permitted. The joints on the inside face or exposed face of the masonry shall be rubbed full and cut as the brick work is built up. The masonry shall be built up in level courses, reasonably true to line, grade and dimension. Bats shall be used only when necessary to close joints, or around irregular openings. All brick shall

be thoroughly wet down immediately before being placed. All work shall be completed and finished in a careful, workmanlike manner. Old brick masonry shall be thoroughly cleaned and wetted before joining new masonry thereto. Where a mortar coating is required, it shall have the minimum thickness shown on the Plans, shall be applied while the brick masonry is clean and damp and shall be troweled and re-troweled until a uniform, smooth and relatively impervious surface is obtained.

C. Pipe Connections. Inlet and outlet pipe shall be of the size indicated on the Plans. The end of the pipe shall be flush with the inside of the wall and shall be tightly sealed in the wall with mortar throughout the circumference of the pipe. The mortar shall be pressed in and troweled off flush with the face of the wall.

D. Special Curb. Curbs adjacent to inlets shall be the same kind of concrete as that used in the regular curb, or where no regular curb is being built, shall be Class A concrete. The forms for the curb opening shall be accurately shaped to the dimensions specified on the Plans and securely held in true position. They shall remain in place not less than 3 days under favorable curing conditions and as much longer as approved by the Engineer under unfavorable conditions.

E. Reinforcing Steel. All reinforcing steel shall be placed in accordance with Section 511.

F. Castings, Grating and Drop Inlet Gratings and Special Frames.

All castings, gratings or special frames or supports shall be accurately and rigidly assembled and carefully placed as shown on the Plans. The frames of all manhole frames and covers, and inlet frames and gratings shall be bedded in a substantial layer of mortar, shall have a full bearing, and shall be set to the exact grade required. Unless otherwise shown on the Plans, the top of such casting shall be flush with the surrounding surface.

Exposed surfaces of special structural steel frames and supports shall be painted as provided in Section 506 except that the second field coat may be from the same paint as the first but with the addition of lamp black paste at the rate of 1½ pounds per gallon.

G. Excavation and Backfill. Excavation and backfill shall be in accordance with Subsection 615.04 B. and F.

H. Precast Units. Precast concrete units shall be bedded on a 4 inch minimum thick solid foundation of clean uniformly graded material. No clay balls or cement clumps will be allowed. The units shall be anchored securely to prevent lateral or vertical movement. Inlet excavation shall be backfilled and thoroughly compacted as soon after placement as is practicable.

Entrance and exit conduits shall be placed with their flowlines as shown on the Plans. Under no circumstances will the elevation or angle be altered to facilitate ease of installation or to make use of an existing blockout.

Precast concrete inlet units (main boxes and additional opening boxes) may be set flush or slightly below the sub-grade to allow free travel of the paving equipment. If precast concrete inlet assemblies are set at or below sub-grade elevation, a leveling course shall be used to bring the inlet assembly to final working grade. A formed and poured concrete collar pinned to the inlet box and additional opening boxes shall be used. A rich mortar collar, formed or puddled, is not acceptable as a leveling course. All precast concrete units shall provide a watertight connection between subassemblies and at each entrance or exit conduit blockout.

If a unit is delivered with a blockout placed in error, or if the Plans are altered to render a blockout unnecessary, the hole shall be cleaned and filled with an approved concrete patch. The patch may be from a previous blockout hole securely grouted in place or poured and/or placed using a dry-mix high strength concrete.

Gasket material used between subassemblies, or between the inlet unit and entrance or exit conduits, shall be of approved adhesive materials.

When precast units are used, all joints and the base shall be properly sealed to prevent the passage of water. To prevent the passage of water wall joints shall be sealed in accordance with Subsection 613.04 E. with the following exception: joints shall be made with a single natural rubber or neoprene gasket or "O" ring, in accordance with the manufacturer's recommendations.

I. Drop Manhole Connections. The pipe shall be of the size indicated on the plans. All drop connections shall be constructed as outside drop connections. Where drop connections will be made to existing sewer works the work shall include removal of pipe, manhole walls, etc., and performance of any incidental work to complete installation.

Each drop connection shall consist of the necessary pipe, fittings, and materials to provide a complete connection. All materials shall conform with requirements specified in Section 615. No additional payment will be made for excavation, backfill, pipe, fittings, or incidental materials.

611.05 METHOD OF MEASUREMENT. The accepted items of this Section will be measured for payment in the following manner:

A. Manholes. Manholes, except special manholes, that do not exceed 6 feet in depth, as measured from the bottom of the frame cover casting to the flow line of the outlet lead will be measured for payment as manhole and shall

include the walls and the concrete bottom.

B. Additional Depth in Manholes. Manholes, except special manholes, exceeding 6 feet in depth will be measured as set out above, and the depth in excess of 6 feet will be measured by the vertical foot of wall and classified for payment as additional depth in manhole.

C. Frames, Covers and Grates. Frames, covers and grates for manholes and junction boxes will not be measured but shall be included in price bid for each structure.

Cost of support beams for installation in junction boxes shall be included in above measured items. They shall not be measured separately.

Cost of T handles for locking manhole covers when specified shall be included in measurement for the above items. Two handles will be furnished for up to and including 20 locking manhole covers and one for every 20 thereafter.

D. Inlets. Inlets will be measured by each unit. Units for inlet boxes, single or double, and additional curb opening boxes will be measured complete in place by inlet per each unit specified by configuration.

E. Drop Manhole Connections. Drop connections shall be measured by each unit. No measurement of height will be considered or made. All pipe, concrete, and miscellaneous materials required to make a complete drop connection will be included and will not be measured for payment.

F. Frames and Grates for Inlets. Frames and grates for inlets will not be measured by each inlet frame and grate, inlet frame or inlet grate, complete in place and accepted shall be included in price bid for each structure.

Cost of support beams and/or support beams with riser plates shall be included in above-measured items. They shall not be measured separately. Bolts and nuts necessary for installation as shown on the Plans shall not be measured separately; their cost shall be included in the above-measured items.

G. Cast Steel Grate. For use with special frames, cast steel grates will not be measured for payment.

H. Special Structural Steel Frames. Special structural steel frames will be measured by each such frame, complete in place, if so provided on the Plans or in the proposal. Painting will not be measured as a separate item, but the cost of same shall be included in the price bid for the structural steel frame.

I. Junction Boxes. Junction boxes will be measured by the each.

611.06 BASIS OF PAYMENT. Accepted quantities, measured as provided above, will be paid for at the contract unit price for:

(A)	Manhole	Ea.
(B)	Additional Depth in Manhole	Vert. Ft.
(E)	Inlet	Ea.
(F)	Drop Manhole Connections	Ea.
(I)	Special Structural Steel Frames	Ea.
(J)	Junction Boxes	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Excavation and backfill will not be measured for payment, but the cost of same will be included in the unit price or prices bid for various pay items.

Reinforcing steel will be included as part of the cost of the structure complete and will not be measured as a pay item.

612.00 ADJUSTMENT OF EXISTING STRUCTURES

612.01 DESCRIPTION. This work shall consist of the necessary adjustment, alterations, relocating or resetting to the required grade and alignment of existing structures, equipment or appurtenances which are not to be removed or abandoned and which are not the property of a private company, firm, or corporation required to move their own property, in accordance with these Specifications and in reasonably close conformity with the lines, grades, elevations and dimensions shown on the Plans or approved by the Engineer.

When specified on the Plans or shown in the Proposal, this work shall include refurbishing and resetting existing electrical equipment taken from storage.

612.02 MATERIALS. Materials for use in this work, including the existing item to be adjusted or reset and any new material necessary, shall be specified on the Plans, or if not specified, shall be of the same grade of material as specified elsewhere in these Specifications or for a similar type work or of a material equivalent to that in the structure being adjusted.

612.04 CONSTRUCTION METHODS.

A. General. The materials and workmanship necessary in raising, lowering or otherwise adjusting or resetting existing structures shall conform to the requirements of the Plans and Specifications for the class of work involved, or as approved by the Engineer. Existing structures shall be rebuilt in accordance with the Plans and Specifications. The final adjustment to grade shall be completed after the final surface course has been placed if the structure is in the pavement.

The Contractor shall guard against damage or breakage to any portion of the structure or appurtenance to be altered, removed or reset. Any damage or breakage due to the Contractor's failure to properly protect such structure or appurtenances shall be repaired or replaced at the Contractor's expense.

Items to be reset from storage shall be transported from the storage site and reset as shown on the Plans. The Contractor shall repair or replace any items damaged as a result of his failure to properly transport, adjust or reset the structure or appurtenance. If the Plans specify an existing item to be modified, cleaned, repaired or otherwise made ready for reuse, this work shall be in accordance with the Plan requirements, prior to being reset at the planned location.

B. Manholes. Where the tops of the manholes are to be lowered to a new grade, the walls shall be removed and rebuilt to an elevation far enough below the new grade so that the maximum batter of the walls does not exceed 4 inches per foot.

Where manholes are to be built up a distance of one foot or less to a new grade, the walls may be carried up vertically. Where the walls are to be built up a distance exceeding one foot, the existing walls shall first be removed to the bottom of the batter section of the walls, or to such elevation that the inside diameter of the manhole is not less than 3.5 feet. The manhole shall then be rebuilt in conformity with the size and shape requirements for new manholes.

C. Catch Basins, Inlets, Manholes. Where inlets, catch basins, manholes or similar structures are to be revised to grade or rebuilt, the work shall be done in conformity with the requirements for new construction of this class of work as provided elsewhere in these Specifications.

D. Valve Boxes, Meter Boxes. Care shall be taken in removing and resetting to grade, valve boxes, meter boxes, etc., to avoid breaking and any breakage shall be replaced by the Contractor at his expense.

E. Fire Hydrants, Valves, Water Meters, Waterlines, Manholes and Etc. Where adjustment or relocation of waterlines and appurtenances is to be done by the City, the Contractor shall be responsible for coordinating the arrangements with the City for lowering or relocating of all waterlines and the resetting of water valves, meters, manholes, and fire hydrants. When the alteration is part of the work to be performed by the Contractor as a part of his contract, such work shall be done in conformity with the requirements of the City and in accordance with the requirements of these Specifications for new work of this type.

F. Traffic Signal or Highway Lighting Systems. When the adjustment or relocation of traffic signal or highway lighting systems require new concrete footing or other concrete appurtenances, these concrete structures shall be in accordance with the details shown on the Plans and shall be paid for in other items of work, unless otherwise specified.

Items to be reused such as signal heads, luminaries, and etc., shall be inspected for damage, thoroughly cleaned and re-lamped with a new lamp of the original size and type before reinstalling the item.

Materials that are not reusable, such as wiring, connectors, fuses, conduit, and etc., shall be disposed of in a manner approved by the Engineer. All additional new materials necessary to complete the installation as specified and make the system operational shall be furnished by the Contractor and paid for in other items of work.

After adjusting and/or resetting the items specified in this work and after the electrical connections have been completed, the traffic signal or highway lighting system shall be energized and tested in a manner approved by the Engineer. Any item that fails to function as specified shall be corrected, by the

Contractor, to the satisfaction of the Engineer.

G. Pipe Sewers. Pipe sewers and appurtenances which are to be removed and re-laid shall be re-laid in conformity with the requirements for new sewers.

H. Waterlines. Waterlines and appurtenances which are to be removed and re-laid, or to be lowered shall be re-laid in conformity with the requirements for new waterlines.

612.05 METHOD OF MEASUREMENT. Structures to be adjusted and/or reset, or re-laid will be measured by each unit of the type and size specified or on the lump sum basis, if stipulated, complete with all necessary accessories and operationally tested.

612.06 BASIS OF PAYMENT. The accepted quantities of items, measured as provided above, will be paid for at the contract unit price for:

(A)	Manholes Adjust to Grade	Ea.
(B)	Manholes Rebuilt	Ea.
(C)	Catch Basins Adjust to Grade	Ea.
(D)	Catch Basins Rebuilt	Ea.
(E)	Inlets Adjust to Grade	Ea.
(F)	Inlets Rebuilt	Ea.
(G)	Valve Boxes Adjust to Grade	Ea.
(H)	Meter Boxes Adjust to Grade	Ea.
(I)	Lampholes Adjust to Grade	Ea.
(J)	Fire Hydrant Reset	Ea.
(K)	Valves Reset	Ea.
(L)	Water Meters Reset	Ea.
(M)	Waterline Lowered	Lin. Ft.
(N)	Waterline Removed and Re-laid	Lin. Ft.
(O)	Remove & Relocate Traffic Signal (Specific Item)	Lump Sum
(P)	Reset Light Poles (Specific Item)	Ea.
(Q)	Electric Cable Re-laid	Lin. Ft.
(R)	Electric Cable Conduit Re-laid	Lin. Ft.
(S)	Pipe Sewer Removed and Re-laid	Lin. Ft.
(T)	Remove and Reset Manhole Frame and Cover	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Valve boxes, meter boxes, etc., in connection with valves or meters to be reset will be considered as part of the valve or meter and will not be paid for as a separate item.

Valves in waterlines or fire hydrant leads will not be considered as a separate pay item, but the cost of resetting same shall be included in the contract unit price for the waterline or lead.

When the valve is under pavement, adjustment of valve box will be a separate pay item.

Extensions to fire hydrant leads, when separately classified for payment, will be paid for as set out for the new waterlines under Section 616, otherwise cost of pipe for extending lead shall be included in the contract unit price for fire hydrants reset.

613.00 DRAINAGE CONDUITS

613.01 DESCRIPTION. This work shall consist of the construction of pipe conduits of the type shown on the Plans in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer. Included are pipe underdrains 4 inches in diameter or greater and all other pipe with an inside diameter of 12 inches or greater used in storm drains and culverts or drainage conduits not defined as bridges.

613.02 MATERIALS. Drainage conduit shall be of the kind specified on the Plans and shall meet the requirements of Section 726. The class of reinforced concrete pipe and the sheet thicknesses of the corrugated steel and corrugated aluminum pipe for various diameters and heights of fill above the top of pipes shall be as shown on the Plans. When the class of reinforced concrete culvert pipe is not specified it shall be Class III.

All reinforced concrete culvert pipe to be installed under paving shall be "O" ring joint pipe.

When not specified on the Plans, the kind of pipe will be optional with the Contractor, but the same kind of pipe shall be used throughout any one project, unless otherwise approved in writing by the Engineer.

Joint filler and cover materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Joint Filler	726.02 A.
Cover Material For Pipe Underdrains	703.04

The type, size, class and quantity of pipe to be installed by jacking shall be as specified on the Plans.

613.04 CONSTRUCTION METHODS.

A. General. The construction of all pipe conduit shall begin at the outlet or the low point in the line. When the construction involves the building of main or sub-main drainage conduit having one or more laterals or tributaries, the construction of tributary lines will not be started until the main or sub-main drainage conduit has been completed to the point where the tributary or laterals discharge into it.

The installation practices shall be adhered to as shown on the Plans. Any conduit cracked or deformed prior to final acceptance shall be replaced by the Contractor at his expense.

During the construction, adequate provisions for drainage of the system shall be made by the Contractor.

The connection of storm drain appurtenances to other storm drain appurtenances shall be made in accordance with the Plans or in a manner approved by the Engineer. The work shall be done in a workmanlike manner in such a way as not to damage any of the structures involved. Storm drain conduit shall not project beyond the inside wall line of other sewers or of sewer appurtenances. The grade line shown on the Plans or established by the Engineer is the elevation of the invert or flow line of the drain. The center line and grade line shall be accurately established in the trench at intervals not more than 25 feet. If the Contractor elects to use a laser device to establish line and grade, the interval may be increased to 50 feet, except that the first interval shall be set at 25 feet when laying out of a manhole or appurtenance.

Dead ends of all conduits or drains, wyes, tees, etc., shall be closed with approved stoppers securely cemented in place. When work is stopped temporarily on storm drains 24 inches in diameter and smaller, the end of the pipe shall be closed to prevent trash or debris from entering the pipe. Such stoppers should not be watertight.

B. Excavation. Except by special permission from the Engineer, the amount of trench excavated at any time shall not exceed the amount in which pipe conduit can be set and the trench backfilled in 2 calendar days. Where conduits are to be placed in embankment fill, the trench excavation shall be made after the embankment has been completed to a height specified on the Plans above the design flowline grade for those conduits.

The width of trench excavation at the bottom of the trench shall be held to a minimum or as shown on the plans. Trench excavation shall be of constant width for at least 2 feet above the top of the conduit.

Bell holes or recesses for bells of the pipe shall be excavated at every joint and shall be of sufficient size and depth to relieve the bell of all load, permitting the barrel to be firmly bedded throughout its length and to provide ample space for forming the joint. Filling and ramming earth or other material beneath the pipe to raise it to grade will not be permitted. Where a concrete cradle or refill is shown on the Plans or required by the Engineer, it shall be placed in conformity with the Plans and Specifications and shall consist of Class A concrete meeting the requirements of Section 701.

The completed trench bottom shall be firm for its full length and width. Where required, in the case of cross drains, the trench shall have a longitudinal camber of the magnitude specified.

C. Bedding. When bedding is not specified on the Plans the bedding used shall be Class B except for pipe underdrains. Classes of bedding are as follows:

1. *Class A.* Class A bedding shall consist of a continuous concrete cradle conforming to the Plan details.

2. *Class B.* Class B bedding shall consist of bedding the conduit to the depth shown on the Plans. The bedding material shall be shaped to fit the conduit for at least 15 percent of its total height with a cushion of bedding material a minimum of 4 inches deep below the conduit.

   The bedding material shall be standard bedding material of sand, stone screenings or selected sandy soil, all of which passes the 3/8 inch sieve with not more than 15 percent passing the No. 200 sieve.

3. *Class C*. Class C bedding shall consist of bedding the conduit to a depth of not less than 10 percent of its total height. The bed shall be shaped to fit the conduit and shall have recesses shaped to receive the bell.

4. *Underdrain Bedding.* A bedding layer of granular backfill material meeting the requirement of Subsection 703.04 shall be compacted in the bottom of the trench for its full width and length as shown on standard drawings for pipe underdrain.

D. Laying Pipe. Pipe conduit shall not be laid unless the foundation is in a condition satisfactory to the Engineer. The laying of pipe in a wet trench shall be done only when and as approved by the Engineer. The spigot end of the pipe shall be laid in the direction of the flow. No buckling in or laying pipe downgrade will be permitted. Pipe shall not be dropped to the bottom of the trench, but shall be lowered and placed in its final position by hoisting equipment adequate to handle the pipe without damage to the pipe or trench. Damaged pipe shall be replaced by the Contractor at his expense. The inside of the barrel shall be cleaned when the pipes are lowered into the trench.

The conduit laying shall begin at the downstream end of the conduit line. The lower segment of the conduit shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream.

Paved or partially lined conduit shall be laid so that the longitudinal center line of the paved segment coincides with the flow line. Elliptical and elliptically reinforced conduits shall be placed with the major axis within 5 degrees of a vertical plane through the longitudinal axis of the conduit.

Underdrain pipe shall be embedded firmly in the bedding material. The pipe shall be laid reasonably true to the established line and grade. Perforated (round holes or elongated slots) pipe shall be laid with perforations down. Pipe underdrain with a top of pipe identification shall be laid with the marker up in all installations.

Metal screens having 1/2 inch mesh size openings composed of either 0.062 or 0.041 inch diameter steel wire (after galvanization) meeting the requirements of ASTM A 740 shall be formed and securely fastened to the outlet end of the sub-drain pipe. End caps fabricated of the same base material as used in the pipe shall be shaped for a drive fit inside the dead end of the pipe or otherwise firmly attached thereto as approved by the Engineer.

After the pipe has been inspected and approved, it shall be carefully covered with cover material and/or backfill material as shown on current standard drawings, taking care in placing cover materials to prevent displacement or damage to the pipe. Regular backfill materials, excavated from the trench if suitable, may be used over non-perforated pipe underdrain unless the Engineer directs that granular cover material shall be used. When dumping from trucks or bucket machinery which causes deformation or misalignment in the installed pipeline, alternate methods such as small windrows on the trench edge and careful blading of small amounts of cover material into the trench may be utilized.

The Contractor shall furnish and set a marker post at the outlet of all pipe underdrains. (See details on current standard drawings.) Costs are to be included in the contract unit price per linear foot of pipe underdrain.

E. Joining Pipe Conduit. Rigid conduits may be of bell, spigot, or tongue and groove design unless one type is specified. The method of joining conduit sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even.
Joints shall be made with mortar, cold applied mastic, rubber gaskets, or plastic joint material in accordance with the appropriate Specifications for the type of pipe being used. Joints shall be concentric, reasonably watertight and free from superfluous joint material on the inside of the pipe. Flexible conduit shall be joined by an approved external or internal coupling device (separate item), or by an approved twist-lock coupling system integrated into the wall of the conduit. Any coupling system shall firmly and solidly join the conduit to prevent separation during installation, handling, and backfilling operations. The performance under field conditions will determine the acceptability of the coupling system, and repeated releases of any system will be cause for rejection. The Engineer has the right of approval or rejection of any coupling system, regardless of its presence or absence on an approval list elsewhere.

F. Shop Elongating. When required on the Plans, the pipe shall be shop elongated in accordance with AASHTO M 36 to form an approximate ellipse with the vertical diameter approximately 5 percent greater than the nominal diameter of the corresponding round pipe.

G. Backfilling. Conduit shall be inspected before any backfill is placed. Any pipe found to be out of alignment, unduly settled, or damaged shall be taken up and re-laid or replaced. Inside joints shall be smooth and barrels clean before

backfilling. Standard bedding material shall be placed over all pipe except pipe underdrain to the depth shown on the Plans. Backfilling shall be placed and uniformly compacted in accordance with Subsection 615.04 F.

H. Jacking, Boring Pipe Conduit. Conduit of any nature shall not be placed by jacking, boring or pushing unless shown on the Plans or designated in the Contract. The Engineer will establish line and grade, and the limits, if any, of placement to be made by open trench methods of construction for each line of conduit where jacking or boring has been designated.

Unless otherwise specified, the methods and equipment used in jacking and boring conduit shall be optional with the Contractor, provided that the proposed method is approved by the Engineer. The Contractor shall investigate the area of placement and will be responsible not to interfere with existing underground utilities under the roadway or adjacent to the jacking operation. Care shall also be taken to keep the disturbed area of construction to a minimum.

Unless otherwise shown, conduits bored, pushed, or jacked shall be installed a minimum depth of 18 inches below the top of ground line or sub-grade, as applicable. Where conduit passes under a surfaced area, an "X" shall be cut in the curb or surfacing above the conduit crossings for future relocating purposes.

Where conduit is required to be installed under railroad embankments or under highways, streets, or other facilities construction, shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure.

Conduit to be placed through boring shall proceed from a pit provided for the boring equipment and workmen. The location of the pit shall meet the approval of the Engineer. The holes are to be bored mechanically. The boring shall be done using a pilot hole. By this method an approximate 2 inch pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored. Excavated material will be placed near the top of the working pit and disposed of as required. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Jetting will not be permitted.

The use of water or other fluids in connection with jacking operation will be permitted only under unusual conditions as determined by the Engineer and only on his written approval. The water or other lubricant used as the circulation medium authorized under these conditions must be applied without the use of undue pressure and retained as jacking progresses.

Conduit to be placed by jacking shall be of the size, type and class specified on the Plans, except that the strength of the conduit designated in the Contract is determined for not less than final loading, complete in place under the embankment. Additional reinforcement or strength of conduit required to withstand jacking pressure shall be the responsibility of the Contractor, and any such extra strength conduit required by the Contractor shall be at his expense.

Conduit larger than 2 inch inside diameter shall not be pushed or jacked under the highway, railroad or street without boring or otherwise removing the soil as the conduit is advanced. Conduit up to 36 inches inside diameter shall be constructed by a combined method of boring and jacking. The boring auger or bit shall have a smaller diameter than the specified diameter of the conduit to be jacked.

The conduit shall be jacked as the boring auger drills out the material. Excavation ahead of the conduit shall not exceed one foot.

Where conduit 60 inches inside diameter or greater is to be jacked for a distance greater than 32 feet, a pilot tunnel shall be constructed first to insure accuracy of grade and alignment. The dimensions and support of the pilot tunnel will be optional with the contractor, subject to the approval of the Engineer.

Supports for pilot tunnels shall be removed as jacking progresses. All costs involved in the performance of the work of constructing pilot tunnels shall be included in the contract unit price for jacking conduit.

If the grade of the conduit at the jacking end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking to prevent earth caving. Dewatering, if necessary, shall be continuous until the backfill is made.

Heavy duty jacks suitable for forcing the conduit through the embankment shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head, usually of timber, and suitable bracing between jacks and jacking head shall be provided so that pressure will be applied to the conduit uniformly around the ring of the conduit. A suitable jacking frame or back stop shall be provided. The conduit to be jacked shall be set on guides, properly braced together, to support the section(s) of conduit and to direct it in the proper line and grade. When sections of conduit are less than 6 ft. in length, two sections shall be carefully placed in the guide frame with joints so treated as to minimize the possibility of breakage. The whole jacking assembly shall be placed so as to line with the direction and grade of the conduit. In general, earth material shall be excavated just ahead of the conduit and the material removed through the conduit, and the conduit forced

through the embankment with jacks into the space thus provided.

The excavation for the underside of the conduit, for at least 1/3 of the circumference of the pipe, shall conform to the contour and grade of the conduit. Except as provided herein below, a clearance of not more than 2 inches may be provided for the upper half of the conduit. The clearance is to be tapered off to zero at the point where the excavation conforms to the contour of the conduit.

The Contractor may at his option provide a steel cutting edge around the head and for not less than the upper 2/3 of the conduit and extending a short distance beyond the end of the conduit. The steel cutting edge shall be so constructed, mounted and used as to insure that clearance between the outside of the conduit and the undisturbed earth will be not more than ½ inch. Excavation inside the pipe shall not exceed the outside diameter of the conduit, nor extend more than one foot beyond the lead edge of the cutting head, thus providing for final trimming by the cutting edge and eliminating any void space except that clearance permitted herein by the described steel cutting edge.

When jacking of the conduit is once begun, the operation shall be carried on without interruption, insofar as practicable, to prevent the conduit from becoming firmly set in the embankment.

Any evidence at any time of caving shall require that the operation be discontinued until provisions are made for eliminating such caving and the location of any cavity identified.

All cavities formed by caving or any voids resulting from excavation larger than the pipe diameter shall be filled with grout in a manner approved by the Engineer.

Any conduit damaged in jacking operations shall be removed and replaced by the Contractor at his expense.

I. Removing and Replacing Railway Track. The railway company shall remove trackage as required to permit the use of Contractor's excavation equipment. Before the start of trench excavation, the Contractor shall carefully set aside the ballast in a manner approved by the Engineer.

The Contractor shall immediately proceed with the trench excavation, Class B bedding and laying the pipe as shown on the Plans and in accordance with the Specifications.

Backfilling shall be in accordance with Subsection 613.04 G. except the standard bedding material and approved backfill material shall be placed in 4 inch layers (loose measurement) and compacted with approved mechanical

tampers in accordance with Subsection 202.04 C. Flooding the trench will not be permitted.

Upon satisfactory completion of the backfill the railway company shall restore its ballast, ties and tracks.

The railway company will be reimbursed for removing and replacing the necessary trackage ballast and ties in accordance with a force account agreement with the Department.

613.05 METHOD OF MEASUREMENT. Drainage conduit will be measured by the linear foot along the center line of the conduit actually laid. Conduit with sloped or skewed ends will be measured along the invert or as shown on the Plans.

End sections will be measured by the number of units installed.

Deductions will not be made for wye branches. On conduits 12 inches or less in diameter, no deductions will be made for standard manholes. Deductions will be made for special structures, unless otherwise shown on the Plans. On conduits larger than 12 inches in diameter, deductions will be made for all manholes and for all structures. Conduits which extend only through the wall of the structure will be measured to the actual end of the pipe except as provided above for measuring conduits 12 inches or less in diameter through standard manholes.

Earth backfill, sheeting, and shoring will not be measured for payment.

Unless otherwise provided, concrete cradles, if specified, will not be a separate pay item.

Standard bedding material when specifically noted on the plans as a pay item will be measured by the cubic yard of standard bedding material calculated on a theoretical basis with the weight as shown on the Plans above and below the design flowline, the width inside the vertical neat lines of the trench as defined in Subsection 613.04 B., the length as that measured for the drainage conduit and deducting the volume displaced by the conduit calculated from the nominal designated outside diameter of the pipe, pipe arch or elliptical pipe, or precast box conduit.

Pipe underdrain cover material, when specified by the plans as a pay item, will be measured by the cubic yard of pipe underdrain cover material placed and accepted and based on Plan width and established depth of the trench with no deduction for the volume of the underdrain pipe.

Joint filler for pipe will not be measured for payment, but the cost will be included in other bid items.

Trench excavation when specified as a pay item will be measured by the cubic yard calculated on a theoretical basis of the volume of material defined as follows:

The depth of the trench will be the average depth measured from the datum plane specified (below the conduit flowline as shown on the pipe or box installation standard drawings) to the finished sub-grade in cut areas. In fill areas the measurement will be from the datum plane to a distance 2 feet above the top of conduit. The Engineer shall establish an equitable measurement elevation in areas requiring both excavation and embankment in adjacent areas. Thickness of rigid conduit will be the actual measured thickness; thickness of flexible conduit will be the height of corrugation or wall thickness of the type of conduit used when calculating the dimension below the flow line for establishing the datum plane.

The length will be that measured for the drainage conduit.

The width will be measured inside the vertical neat lines of the trench defined in Subsection 613.04 B.

The conduit of the size and type as shown on the Plans and constructed by jacking as specified above will be measured by the linear foot along the center line of the conduit actually jacked in place and accepted.

613.06 BASIS OF PAYMENT. The accepted quantities of drainage conduit of the types and sizes specified, measured as provided above, will be paid for at the contract unit price for:

(A)	Non-Reinforced Concrete Pipe	Lin. Ft.
(B)	Reinforced Concrete Pipe, Round, Elliptical or Arch	Lin. Ft.
(CC)	Culvert End Treatment	Ea.
(D)	Corrugated Galvanized Steel Pipe, Round or Arch	Lin. Ft.
(G)	Galvanized Steel Culvert End Sections, Round or Arch	Lin. Ft.
(M)	Prefab. Culv. End Sec., Round or Arch	Ea.
(MM)	Sloped Concrete End Section	Ea.
(N)	Vitrified Clay Pipe	Lin. Ft.
(O)	PVC Pipe	Lin. Ft.
(P)	Perforated Pipe Underdrain	Lin. Ft.
(Q)	Non-Perforated Pipe Underdrain	Lin. Ft.
(R)	Pipe Underdrain Cover Material	Cu. Yd.
(S)	Trench Excavation	Cu. Yd.
(T)	Standard Bedding Material	Cu. Yd.
(U)	Jacked Conduit	Lin. Ft.
(V)	Cast Iron Pipe	Lin. Ft.
(W)	Corrugated Polyethylene Pipe	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

The Contractor shall inform the City of material or product that will be furnished to the project in accordance with Section 106.

615.00 SANITARY SEWER

615.01 DESCRIPTION. This work shall consist of the construction of sanitary sewer pipe conduits of the type shown on the Plans in accordance with these and other applicable Specifications and in reasonable close conformity with the lines and grades shown on the Plans or established by the Engineer. No person shall uncover, make any connections with, alter, or disturb any public sewer without first obtaining a permit or work order from the City Engineer.

615.02 MATERIALS. Materials shall be of the types, classes, sizes and dimensions shown on the plans and/or required by the specifications. All materials delivered to the job site shall be marked with the appropriate specification number and designation, such as AASHTO, ASTM, ANSI, NSF, AWWA, etc. Prior to the starting of work or at the time of a pre-work conference, material certifications shall be furnished in accordance with the specifications.

615.02.1 Ductile Iron Pipe. Ductile iron pipe shall conform to and be tested in accordance with the American Standard for Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids, AWWA Designation C 151, ANSI, A21.50, A21.51, Class 50, unless otherwise specified.

Ductile iron pipe fittings, shall comply with the specifications as listed:

Flanges:	ANSI A21.15, AWWA C115, Class 125
Bolts:	ASTM A307, Grade B, rounded ends projecting beyond face of nut.
Nuts:	ASTM A307, Grade B. hexagonal, ASA B18.2, heavy semi-finished pattern.
Flange Gaskets:	ASTM D1330, Grade I, red rubber ring type, 1/8" thick

Mechanical and push-on joints shall comply with ANSI/AWWA C111/A21.11, except they shall be made of Styrene Butadiene Rubber (SBR) for use in fresh water, salt water and sanitary sewage.

Flexible joint pipe shall comply with ANSI/AWWA C151/A21.51 and ANSI/AWWA C110/A21.10 and shall be American Flex-Lok boltless ball joint pipe or approved equal.

All ductile iron pipe and fittings shall have interior surfaces cement lined, according to ANSI/AWWA C104/A21.4. All surfaces of pipe and fittings shall be shop coated with a bituminous coating according to Manufacturer's Standard.

615.02.2 Polyvinyl Chloride Pipe. Polyvinyl sewer pipe shall conform to the requirements of A.S.T.M. D-3034 for Type PSM, PVC sewer pipe and fittings. PVC sewer pipe shall have the elastomeric gasket type joint providing a watertight seal. A solvent cement type joint will not be allowed.

Fittings shall correspond in all respect with the dimensions specified for pipe of the corresponding size. Wall thicknesses of molded and/or fabricated fittings shall be no less than the respective minimum thicknesses for the equivalent pipe size. No fittings shall have an ID dimension smaller than the base ID for the equivalent pipe size.

All PVC pipe shall have a minimum SDR of 35 unless otherwise noted on the plans or specifications.

The pipe shall be made and joined with an integral bell, bell and spigot rubber gasketed joint. Each integral bell joint shall consist of a formed bell complete with a single rubber gasket. Gaskets shall conform to ASTM F 477.

615.02.3 Vitrified Clay Pipe. Clay pipe and fittings shall conform to the specifications for extra strength in accordance with ASTM C700. All pipe and fittings shall be clearly marked with the name or trademark of the manufacturer, the location of the plant, and extra strength designation.

All clay pipe dimensions shall not vary from a true circle by more than 3 percent of nominal diameter. Pipe shall not deviate from straight by more than 1/16 inch per foot.

Clay pipe of sizes less than 18 inches in diameter shall have no blister exceeding 3 in., and no blister shall project more than 1/8 inch above the surface of the pipe. Pipe sizes over 18 inches shall have no blister exceeding 2 in. per foot of internal diameter, and no blister shall project more than 1/8 inch per foot of internal diameter above the surface of the pipe. All clay pipe shall have no broken blisters.

There shall be no fractures or cracks passing through the barrel or socket of the pipe. A single crack at the spigot end of the pipe not exceeding 75% of the depth of the socket may be permitted. Chips or fractures on the interior of the pipe shall not exceed 2 inches in length, 1 inch in width, and a depth of one fourth of the thickness of the barrel.

Clay pipe fittings shall correspond in all respect with the dimensions specified for pipe of the corresponding size. Dimensional tolerances of fittings shall be the same as for straight pipe. All fittings shall conform to the requirements for clay pipe described above and within these specifications.

615.02.4 Services. New or replacement services shall consist of an SDR 35 PVC wye, Bell X Spigot 45° bend, SDR 35X Schedule 40 adapter, Schedule 40 service line and Schedule 40 cap. All long services crossing under paving shall be sleeved in Schedule 40 PVC or other approved material.

615.02.5 Casting. The production of Gray Iron castings, materials, and production control processes shall conform to ASTM A48-84 or latest revision, Class

20, Class 30, or Class 35, when required. Casting shall also conform to Federal Specification RRF-621-D latest revision.

Materials and workmanship shall be tested, and free from strength defects, shrinks, or other distortions. Test results are periodically verified by an independent laboratory and equipment is calibrated on a regularly scheduled basis.

Certified Reports of test results will be provided when requested with the casting order. Reports will accompany the castings at the time of shipment from the manufacturer.

Round manhole frames and lids designed for traffic applications will have machined seating surfaces and non-rocking fit. Traffic ratings on castings are verified according to Proof Load Testing procedures as written in RRF-621-D using a 9 x 9 footprint. Load rating will be stated by the designation recommended by AASHTO Specifications. H-20 is heavy roadway traffic (16,000 lb wheel load). H-15 is medium duty traffic rating (12,000 lb wheel load). Non-traffic loads are held to a minimum 1000 lb Transverse Proof Load Test without permanent deformation.

The manufacturing processes for the castings will occur in the United States.

615.03 CONSTRUCTION METHODS.

A. General. All equipment necessary and required for the proper construction of sanitary sewer shall be on the project in first class working condition and approved by the Engineer before construction is permitted to start.

The Contractor shall provide appropriate hoisting equipment to handle the pipe while unloading and placing it in its final position without damage to the pipe.

The pipe shall be handled with care to prevent damage and shall not be thrown, dropped or dragged. Pipe bundles shall be stored so that the barrels are evenly supported. When handling pipe in cold weather, consideration shall be given to variation in the pipe's impact strength, and to dimensional changes that may allow movement of pipe within bundles.

The connection of sanitary sewers or sewer appurtenances to other sanitary sewers shall be made in accordance with the Plans. The work shall be done in a workmanlike manner in such a way as not to damage any of the structures involved. Sewer pipe shall not remain projecting beyond the inside wall line of other sewers or of sewer appurtenances.

Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers, watermains, home service connections for both sewer and water and other obstructions encountered in the progress of the work shall be furnished by the Contractor at no additional cost to the Owner unless otherwise indicated by the Plans or Specifications. During

construction adequate provisions for the continued sewerage of the system shall be made by the Contractor, at no additional cost to the City, unless otherwise shown on the Plans or by the Specifications.
Wherever existing utility structures or branch connections leading to main sewer or water mains or other conduits, duct, pipes or structures form obstructions to the grade and alignment of the sewer pipe to be laid, they shall be permanently supported, removed, relocated or reconstructed by the Contractor through cooperation with the owner of the utility, structure or obstruction involved. In those instances where their relocation or reconstruction is impracticable, a deviation from the line and grade will be ordered by the Engineer, and the change shall be made in the manner directed by the Engineer. The grade line shown on the Plans or supplemental drawings or as established by the Engineer is the elevation of the invert or flow line of the sewer. The grade line and alignment shall be accurately established and maintained.

The Contractor shall establish and use throughout sewer construction a method for establishing grade and alignment. The use of batterboards, laser devices or other acceptable means in a manner approved by the Engineer will be required.

Horizontal and vertical separation of sanitary sewers and water mains must be maintained as specified in the OSHD regulations.

Dead ends of all sewers, wyes, tees, etc., shall be closed with approved stoppers securely cemented in place. Tight fitting stoppers or bulkheads shall be securely placed in or across the end of all sanitary sewer lines when construction is stopped at the end of each day's work or for any other cause. These stoppers or bulkheads shall be watertight.

B. Excavation and Preparation of Trench. The trench shall be dug to the alignment and depth required and only so far in advance of pipe laying that can be safely maintained by the Contractor. The trench shall be so braced and drained so that workmen may work there safely and efficiently. It is essential that the discharge from pumps be led to natural drainage channels, drains or storm sewer.

The trench width might vary depending upon the depth of the trench and the nature of the excavated material, but in any case shall be of minimum width to permit the pipe to be laid and joined properly and the bedding and backfill to be placed and compacted to the required density. The normal width of trench shall be thirty (30) inches and for pipe eighteen (18) inches or larger no more than twelve (12) inches greater than the outside diameter of the pipe barrel. If approved by the Engineer, the trench walls may be backsloped from a point two (2) feet above the top of the pipe.

Whenever necessary, to prevent caving, excavations in sand, gravel, sandy soil, or other unstable material shall be adequately sheathed and braced. Where sheathing and bracing are used, the trench width shall be increased accordingly. Trench sheathing will be required on all ditches where necessary to prevent damage to utilities above or below ground. Trench sheathing shall remain in place until the pipe has been laid and the joint properly constructed and the backfill material thoroughly compacted to a depth over the pipe sufficient to protect any utility structures or adjacent paving, curb and gutter, sidewalks or trees which might be damaged by caving of the trench walls.

Excavation for pipe laying operations shall be conducted in a manner to cause the least interruption to traffic. Where traffic must cross open trenches, the Contractor shall provide suitable bridges at street intersections and driveways. Hydrants under pressure, valve boxes, curb stop boxes and other utility controls shall be left unobstructed and accessible during the construction period.

Adequate provisions shall be made for the flow of sewers, drains and water courses encountered during construction and the structures which may have been disturbed shall be satisfactorily restored upon completion of the work.

Trees, fences, poles and all other property shall be protected unless their removal is authorized by the Engineer and any property damages shall be satisfactorily restored by the Contractor.

All rock excavated from the trench having a diameter greater than eight (8) inches shall not be used as backfill but shall be disposed of as directed by the Engineer.

Where conditions are such that running or standing water occurs in the trench bottom or the soil in the trench bottom displays a "quick" tendency, the water shall be removed by pumps or suitable means as approved by the Engineer. No attempt shall be made to make joints under water and the trench must be kept dry until the pipe has been installed and backfill has been placed to a height of two (2) feet above the top of pipe or to a sufficient height to prevent pipe movement.

The trench bottom shall be constructed to provide a firm, stable and uniform support for the bedding material for the full length of the pipe. Where the bottom of the trench uncovered is soft, spongy, unstable and in the opinion of the Engineer cannot support the pipe, the trench shall be excavated and refilled to the proper grade with foundation gravel or rock and thoroughly compacted. Unless otherwise indicated by the plans or specifications, the cost of additional excavation and subsequent placement of foundation gravel or rock shall be included in the prices bid for other items of work. Foundation gravel or rock shall meet the specifications of Section 703.01, Type A or B aggregate, 1-1/2" maximum size unless otherwise indicated by the plans or

specifications. Recesses for the bells of pipe shall be provided at each joint to ensure proper joint assembly, alignment and pipe support. Any part of the trench bottom excavated below grade shall be backfilled to grade and shall be compacted in a manner approved by the Engineer.

When rock is encountered the rock shall be excavated to a depth of 6" below grade and the trench shall be backfilled to proper grade with pipe bedding material or an approved select soil. Where it becomes necessary to excavate beyond the limits of normal excavation in order to remove boulders or other interfering objects, the voids remaining shall be backfilled with an approved material.

The removal of boulders or other interfering objects or excavating an additional depth of rock removal and the backfilling and compaction caused by such removal shall be at the expense of the Contractor, and no payment for the cost of such work shall be made. The cost of such work shall be included in the prices bid for other items.

C. Bedding. Bedding shall be defined as that material supporting, surrounding and extending from the trench bottom to the springline of the pipe or as directed by the Plans and Specifications. Where it becomes necessary to remove boulders or other interfering objects for proper bedding placement, any void shall be filled with the bedding material designated.

Bedding material shall be placed upon a firm, stable and uniform trench bottom. Bedding material shall be placed so that the pipe is supported for the full length of the barrel with full bearing on the bottom segment of the pipe.

Except where otherwise specified, bedding material shall be gravel, crushed aggregate, native free-draining granular material, or other material approved by the Engineer. In cases where native free-draining granular material is suitable for use as bedding, the trench bottom may be excavated to a point above the invert grade and the trench bottom hand shaped so the bottom segment of the pipe is firmly supported on undisturbed material.

For all plastic pipe and fittings, the bedding material shall be composed of crushed rock conforming to Section 703.02, No. 1, Aggregate, 3/4" maximum size. The bedding shall have a minimum thickness of 4 inches and extend up to the springline of the pipe.

For all steel or cast iron pipe, special bedding will not be required. The trench bottom shall be shaped to provide firm and uniform bearing.

For all clay pipe and fittings, the bedding material shall be composed of crushed rock conforming to Section 703.02, No. 1, Aggregate, 3/4" maximum size. The bedding shall have a minimum thickness of 4 inches or 1/8 of the outside diameter of the pipe, whichever is greater, and shall extend up the

pipe to a depth equal to 1/6 of the outside diameter of the pipe.

D. Laying Pipe. Proper implements, tools and equipment satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe and fittings shall be carefully lowered into the trench, piece by piece, by means of a derrick, ropes or other suitable tools or equipment.

After the trench has been excavated to the proper grade, the first pipe at the outlet end of the sewer shall be bedded to the proper line and grade with the bell end upstream. The pipe shall be held in place by backfilling, as specified. All joints shall be installed in accordance with the pipe manufacturer's instructions.

Adapters, where required to join pipe of different materials, shall be equal to those manufactured by Can-Tex Industries or by Fernco Joint Sealer Company. When using vitrified clay pipe flex joints shall be used at all manholes.

All sanitary sewers on slopes of 10% or greater shall be anchored with concrete collars cast immediately downhill from bells and shall be spaced at no greater than 75 feet. No additional compensation shall be made to the Contractor for this work; cost shall be included in other items of work.

E. Joining Pipe Conduit. Joints shall be constructed in accordance with the Manufacturer’s recommendations.

Prior to making pipe joints, all surfaces of the portion of the pipe to be jointed shall be cleaned and dried. Trenches shall be kept water free during jointing and for a sufficient period thereafter to allow the joint to become fully set and completely resistant to water penetration. There shall be no realignment of the pipe after the joint is completed unless the pipe is removed and a completely new joint constructed.

F. Backfilling. Backfilling shall be considered as starting at the top of the bedding material. Backfilling shall be broken down into two (2) separate methods of operation; initial backfill and final backfill.

Initial backfill shall be that portion of backfill beginning at the top of bedding and extending to a distance of one (1) foot above the top of pipe. Initial backfill material may be material obtained from project excavations provided that all organic material, rubbish, debris and other objectionable material are first removed. Rocks greater than 2½ inches in any dimension shall not be permitted in the initial backfill. No special or mechanical compactive effort shall be required. Impact or free-fall compaction shall be considered sufficient for initial backfilling operations.

Final backfill shall be that portion of backfill beginning at the top of the initial backfill and extending to final grade elevations. The final backfill shall be placed so that compaction requirements can be met. Final backfill shall be mechanically compacted, water densified or naturally compacted, as allowed by the Plans and Specifications.

Unless specified otherwise, the final backfill shall be placed using special compaction (mechanical or water densified) under improved surfaces or shoulders of streets, and under roads, aprons, curbs, sidewalks, lawns and areas designated for those potential uses.

Under open fields, unimproved right-of-way or neutral grounds which are free of traffic, final backfill may be placed using natural compaction. Areas allowing natural compaction shall be only those areas identified by the Plans and Specifications.

Mechanically Compacted Backfill shall be considered those methods which incorporate tamping rollers, sheepsfoot rollers, pneumatic tire rollers, vibrating rollers or other mechanical tampers. Impact-type pavement breakers will not be permitted. All equipment shall be of a size and type approved by the Engineer.

Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under contract. The Contractor shall make his own determination in this regard.

Material for mechanically compacted backfill shall be placed in lifts which, prior to compaction, shall not exceed the thickness specified below for the various types of equipment:

1) Vibratory equipment, including vibratory plates, vibratory smooth-wheel rollers, and vibratory pneumatic tired rollers – maximum lift thickness of 2 feet.
2) Rolling equipment, including sheepsfoot (both vibratory and nonvibratory), grid, smooth-wheel (nonvibratory) and segmented wheels – maximum lift thickness of 1 foot.
3) Hand-directed mechanical tampers – maximum lift thickness of 6 inches.

Mechanically compacted backfill shall be placed in horizontal layers of thickness (not exceeding those specified above) compatible to the material being placed and the type of equipment being used. Each layer shall be evenly spread, moistened (or dried, if necessary), and then tamped or rolled until specified compaction has been attained.

Water Densified Backfill shall be considered those methods which incorporate water in the compaction effort.

As used in these specifications, flooding shall mean the inundation of backfill with water, puddled with poles or bars to ensure saturation of the backfill material for its full depth. Jetting shall be accomplished by use of a jet pipe to which a hose is attached, carrying a continuous supply of water under pressure.

Unless flooding is specified or otherwise authorized by the Engineer, all backfill to be densified by water shall be jetted.

The backfill shall be jetted in accordance with the following requirements:

1) The jet pipe shall consist of a minimum 1-1/2 inch diameter pipe to which a minimum 2 inch diameter hose is attached at the upper end. The jet shall be of sufficient length to project to within 2 feet of the bottom of the lift being densified.

2) The Contractor shall jet to within 2 feet of the bottom of the lift and apply water in a manner, quantity and at a rate sufficient to thoroughly saturate the thickness of the lift being densified. The jet pipe shall not be moved until the backfill has collapsed and the water has been forced to the surface.

3) The lift of backfill shall not exceed that which can be readily densified by jetting, but in no case shall the undensified lift exceed 15 feet.

4) Where the nature of the material excavated from the trench is generally unsuitable for densification with water, the Contractor may, at no cost to the City, import suitable material for jetting or densify the excavated material by other methods. The backfill shall be allowed to thoroughly drain until the surface of the backfill is in a firm and unyielding condition prior to commencement of any subsequent improvements. The Engineer may require the Contractor, at the Contractor's expense, to provide a sump and pump to remove any accumulated water.

5) The Contractor shall make his own determination that jetting will not result in damage and any resulting damage shall be repaired at the Contractor's expense.

Natural Compaction shall be considered those methods requiring no additional compactive effort after initial placement of backfill. Natural compaction will be the loose placing of material (usually pushed or bladed) into the trench. The trench shall then be rolled with the placement equipment with native material mounded over the surface of the trench. Subsequent to final acceptance of

the work and as required by the Plans and Specifications, the trench shall be filled and maintained as necessary.

G. Compaction Requirements. All embankments and backfill placed by mechanical or water densified means shall be compacted to a minimum of 90% of standard proctor density. Compaction within street right-of-way shall be a minimum of 95% of standard proctor density. The Contractor shall notify the Engineer prior to the density test, such that the Engineer may witness the test.

H. Field Testing. Leakage tests may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) shall not exceed 200 gallons per inch of pipe diameter per mile per day for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet.

Deflection tests shall be performed on all flexible pipe. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of 5 percent. The deflection test shall be made with a rigid ball or mandrel. It shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without the use of mechanical pulling devices.

Lamping shall be performed by the Contractor in the presence of the Inspector. The Contractor shall provide a mechanical method of exchanging the air within the sewer line and use explosion proof devices as required by applicable OSHA regulations. If, in the opinion of the Engineer, any deviation in grade or alignment is excessive, then the Contractor shall correct the pipe alignment at his expense. In general, a full 3/4 of the barrel of the pipe shall be visible from manhole to manhole or appurtenance.

All of the before mentioned testing shall be conducted by the Contractor, all cost shall be included in the price bid for other items of work. The Contractor shall inform the Engineer, in writing, 24 hours in advance of any testing.

I. Borings. The boring shall proceed from a pit provided for the boring equipment and workmen. The location of the pit shall meet the approval of the Engineer. The holes are to be bored mechanically. The boring shall be done using a pilot hole. By this method an approximate 2 inch pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored. Excavated material will be placed near the top of the working pit and disposed of as required. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Jetting will not be permitted.

615.04 METHOD OF MEASUREMENT. Pipe conduit will be measured by the linear foot along the centerline of the conduit actually laid. Conduit with sloped or skewed ends will be measured along the invert. That length of line within manholes and special structures will not be measured for payment. No additional payment shall be made for vertical pipe or fittings required for drop manhole connections.

Earth backfill, sheeting, shoring and bedding material will not be measured for unless otherwise provided. Concrete cradles, rock foundations or cradle, and other material required to properly construct the trench bottom, will not be a separate pay item unless otherwise provided.

Bedding material will not be measured for payment unless otherwise indicated by the Plans and Specifications.

Trench excavation will be measured by the linear foot for the depth of excavation specified.

615.05 BASIS OF PAYMENT. Accepted quantities of pipe conduit of the types and sizes specified, measured as provided above, will be paid for at the contract unit price for:

(A)	Ductile or Steel Pipe	Lin. Ft.
(B)	Vitrified Clay Pipe	Lin. Ft.
(C)	Polyvinyl Chloride (PVC) Pipe	Lin. Ft.
(F)	Trench Excavation *	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified, including all in-line wye and riser pipe to complete a service connection.

* Payment will be made for the depth of excavation specified on the plans with a pay item included for each range of trench depth.

616.00 WATER PIPE AND FITTINGS

616.01 DESCRIPTION. This work shall consist of the construction of waterlines and service lines of the type shown on the Plans in accordance with these and other applicable Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.

616.02 MATERIALS.

A. Pipe. Pipe shall be of the kind specified on the Plans and shall be identified with appropriate AASHTO, ASTM, ANSI or AWWA specifications numbers.

In no case shall pipe or fittings with a pressure rating of less than 200 pounds per square inch be used. Whenever plastic pipe is used, it shall bear the seal of the National Sanitation Foundation (NSF), have a Standard Dimension Ratio (SDR) not exceeding 14 and shall have an outside diameter (OD) equal to the OD of the equivalent size ductile iron pipe.

Ductile Iron Water Pipe. Ductile iron pipe shall conform to and be tested in accordance with the American Standard for Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids, AWWA Designation C151, ANSI A21.50.

The minimum thickness class of cast or ductile iron pipe shall be Class 50 unless otherwise specified.

The interior surfaces of ductile iron pipe and fittings shall be provided with cement lining conforming to ANSI/AWWA C104/A21.4.

B. Joints. Cast iron pipe and fittings shall be jointed with any of the end types as specified below, unless a particular end type is specified. Flange ends shall be used only where specifically noted on the drawings, except that the valve connection end of all tapping sleeves shall be flanged.

Mechanical and push-on joints shall conform to and be tested in accordance with the American Standard for Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings, AWWA C 111, ANSI A21.11 and shall be made for use in fresh water with Styrene Butadiene Rubber (SBR).

Flange joints shall conform to the American Standard for Cast Iron Pipe Flanges and Flanged Fittings, ANSI A21.15, AWWA C115, Class 125. Flange gaskets shall be red rubber ring type 1/8" thick conforming to ASTM D1330.

C. Fittings. Standard water service line connections shall conform to and be tested in accordance with ASTM B62, ASTM B88 and AWWA C800. Corporations and curb ball valves shall be full port and all brass and shall be manufactured by Mueller, Ford, Jones or an approved equal. Meter setters

shall be 7 inch with 1 inch CTS pack joint as manufactured by Ford, Mueller or an approved equal.

Water line fittings shall be SSB-Ductile Iron, Mechanical Joint, Class 350. 3" through 16" Mechanical Joint Ductile Iron Fittings shall be produced in strict accordance with all applicable terms and provisions of ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/A21.11. 18" through 24" diameters shall be manufacturer's standards with wall thickness equivalent to Class 56 ductile iron pipe. The working pressure rating shall be 350 PSI. Cement lining meets ANSI/AWWA C104/A21.4-85.

D. Valves.

1. *Gate Valves.* Gate valves shall conform to and be tested in accordance with the AWWA Standard for Gate Valves for Ordinary Water Works Service, AWWA C 509. Valves shall have resilient seat, non-rising stem, vertical mounting, "O" ring stem seal with stem extension and guides, counterclockwise opening, and ends to fit the pipe or fittings to which attached (mechanical or flanged). A valve position indicator on 12" valves or larger shall be supplied.

   Gate valves shall be Darling, M & H, Mueller or approved equal.

2. *Ball Valves.* Ball valves shall be designated for 150 pounds per square inch working pressure; flanged end; O ring rotor bearing seals; constructed of high-tensile strength cast iron; equipped with totally enclosed manual operators, with open-closed indicator and hand wheel with standard size square wrench nut for one-man operation at 150 pounds per square inch unbalance across the valve. Valves shall be tested by, and shall withstand without leak, a hydrostatic pressure of: (1) 250 pounds per square inch on the valve body with the rotor in the open position; and (2) 150 pounds per square inch on each side of the valve with the opposite side open to atmosphere. Four copies of the test results and manufacturer’s drawings shall be submitted for approval prior to delivery of the valve. They shall be Mueller, Ford or approved equal.

3. *Air Relief Valves.* Air relief valves shall be heavy-duty combination air release and vacuum type for 300 pounds per square inch water working pressure, tested to 300 pounds per square inch, 2 inch in size. Body, cover and baffle shall be cast iron. All internal parts to be either highest quality stainless steel or bronze, and the inside of valve coated with rust inhibitor. They shall be Apco No. 145C, Darling, Rensselaer or approved equal.

4. *Check Valves.* Check valves shall be horizontally mounted, single disc, swing type with a full diameter passage providing minimum pressure loss. Valves shall be of the non-slamming type designed for the future

installation of outside lever and weight. Disc faces and seat rings shall be bronze. Ends shall fit the pipe or fitting to which attached (push-on, mechanical, bell-and-spigot, or flanged).

They shall be Darling, M & H, Mueller or approved equal.

5. *Butterfly Valves.* Valves shall be designed, manufactured, and tested in accordance with AWWA C504, latest revision. Valves shall be rated and tested for absolute zero leakage shut-off.

Valve body shall be ductile iron per ASTM A536 Grade 65-45-12. Valve body to include a stainless steel seat ring that is mechanically retained without use of clamping devices, adjusting segments, or other hardware being in the waterway.

Valve disc shall be solid type ductile iron without any external vanes, ribs, etc., to obstruct flow. Resilient seat shall be located on edge of disc, offset from the shaft, and seal against mating stainless steel body seat with 360° uninterrupted contact. Valves shall be American Darling, Mueller or approved equal.

E. ***Valve Boxes.*** Unless otherwise specified on the Plans, valve boxes shall be of the screw type adjustable valve box, complete with dome lid or traffic ready model (where necessary).

F. ***Fire Hydrants.*** Fire hydrants shall conform to and be tested in accordance with the AWWA Standard for Fire Hydrants for Ordinary Water Works Service, AWWA C 502. All hydrants shall have: breakable connection features and a breakable coupling on the stem immediately above the bury line which have a lower breaking point than the rest of the unit; 5-1/4 inch compression main valve; full 6" barrel; 4.5 feet bury length; two 2.5 inch hose nozzles with National Standard threads; one 4-1/2 inch pumper nozzle; “O” ring seal; drain valve, left (counterclockwise) opening; two coats silver finish paint above ground line; and National Standard pentagon operating nut.

Fire hydrant extensions shall be of the proper design to accommodate the make of fire hydrant installed.

Fire hydrants shall be Darling, Mueller Improved, M & H or approved equal.

G. ***Lining.*** When specified, cast iron pipe and fittings shall be lined in accordance with the American Standard for Cement Mortar Lining for Cast Iron Pipe and Fittings for water, AWWA C 104.

H. Certification. Tests will not ordinarily be made by the laboratory on the above materials, but the materials furnished shall be recognized standard products and the manufacturer of such products shall furnish the Engineer a Certification.

I. Copper Water Service Pipe and Fittings.

1. *Material Covered.* This item covers copper water service pipe and fittings.

2. *Copper Service Pipe.* Copper service pipe shall be a seamless copper tubing cold drawn to size. It shall be Type K soft annealed and shall meet the requirements of ASTM B 88 and AASHTO M 258.

   Sampling and testing shall be done as provided in ASTM B 88, with the exception that making the chemical analysis shall be optional with the Engineer.

3. *Fittings.* All fittings including corporation stops and curb stops shall be of cast brass or bronze and shall be finished in a thoroughly workmanlike manner. They shall be sound, clean, free from blow holes, porous places, cracks, or any other defects affecting their strength or appearance, which would indicate inferior quality of metal. All moving parts shall be accurately fitted up so as to work smoothly and freely without binding. They shall be of standard type commonly used and shall be the product of a recognized manufacturer of such fittings. Each casting shall bear the name or trademark of the manufacturer, permanently cast in metal.

   Fittings shall withstand an hydrostatic pressure test of 200 pounds per square inch without leaking or showing any indications of metal fracture.

J. Polyethylene (PE) Plastic Tubing, Water Service Pipe and Fittings.

1. *Material Covered.* This item covers polyethylene (PE) water service pipe and fittings.

2. *Polyethylene Plastic Tubing.* Polyethylene (PE) plastic tubing shall be 1" CTS (copper tubing size) rated at 200 psi and shall meet all the requirements of PE 3408 SDR-9.0, wall thickness and tolerances shall have the National Sanitation Foundation stamp indicating its use for the transport of potable water NSF-PW, the PE plastic extrusion compound shall meet the requirements of grade A 23. Sampling and testing shall be done as provided in ASTM - D 2737.

3. *Fittings.* All fittings including corporation stops and curb stops shall meet the requirements of copper water service pipe and fittings Section 616.02 I.

616.04 CONSTRUCTION METHODS.

A. General. In general, the depth of trench shall be such that it will provide a covering of at least 4 feet below the surface of the natural ground or established sub-grade.

During construction adequate provisions for drainage of the trench shall be made by the Contractor. Pipe laying operations should be suspended during rains or whenever the trench cannot be kept dewatered. A watertight plug shall be placed in the open end of the main when construction is stopped at the end of each day's work or for any other cause.

The Contractor shall locate or have located before excavation of the water line trench is begun all intersecting sewer lines, house sewer lines and sewers within 10 feet of the proposed water line location. These locations will be mapped and the Contractor shall take measures to prevent the discharge of waste into the trench. If any sewer is disturbed it must be carefully restored immediately to a tight operating condition at the Contractor's expense.

Horizontal and vertical separation of sanitary sewers and water mains must be maintained. Whenever possible, a water main shall be located at least 10 feet horizontally from any existing or proposed sanitary sewer line. Whenever possible, sewer pipe joints will be located at least 10 feet from any water line. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be constructed equal to water pipe and shall be tested to assure watertightness prior to backfilling.

All bends, tees, crosses, outlet assemblies, valves and plugs shall be blocked with concrete except where the fittings have flanged, welded or harnessed joints. Concrete blocking shall be placed so that joints are accessible for repair.

B. Excavation. Excavation shall be in accordance with Subsection 615.04 B.

C. Bedding. Bedding shall be in accordance with Subsection 615.04 C.

D. Laying Pipe. Laying pipe shall be in accordance with Subsection 615.04 D.

E. Joining Pipe Conduit. Joints shall be made in accordance with the Manufacturer's recommendations and requirements of the AWWA. Prior to making pipe joints all surfaces of the portion of the pipe to be jointed shall be cleaned and dried. Trenches shall be kept water free during jointing and for a sufficient period thereafter to allow the joint to become fully set and completely resistant to water penetration. There shall be no realignment of the pipe after the joint is completed unless the pipe is removed and a completely new joint constructed.

F. Connecting to Existing Lines. Where shown on the Plans or required by the Engineer, connections shall be made to existing lines. The Contractor shall furnish the materials required and make the connection. No additional compensation will be allowed for this, but the cost of same shall be included in the price bid for other items on the work.

G. Removal of Existing Lines. When necessary to remove existing line or lines to provide for new installation, no additional compensation will be paid for removal, but the cost of same shall be included in the price bid for the new line.

H. Setting Valves. Valves shall be located where shown on the Plans or as directed by the Engineer. They shall be set with the valve stem up unless otherwise specified, and the joints shall be as specified for other joints in the pipeline. Care should be taken to see that all parts are in first class working condition and that the valve is entirely free from foreign material before placing.

I. Setting Fire Hydrants. Fire hydrants shall be located where shown on the Plans or designated by the Engineer. The hydrant shall be harnessed, all thread from tee to valve with 3/4" cadmium coated all thread to prevent the hydrant and valves from blowing off the line. Each hydrant shall be placed on a slab of stone or concrete not less than 4 inches thick and 16 inches square. Around the drain of the hydrant shall be placed not less than 7 cubic feet of broken stone, gravel so the hydrant will properly drain. Backfill around the hydrant shall be firmly tamped to the surface of the ground and to a distance of 5 feet in front of the hydrant. Before placing any hydrant, care shall be used to see that all foreign matter is removed from within the body or barrel. The hydrant valve opened and closed to see that all parts are in a first class working condition. Hydrant leads shall be ductile iron pipe.

J. Dead Ends. Dead ends shall be closed with the required cap, valves or plug and blowoff. Caps, valves and plugs shall meet the same requirements as other cast iron fittings.

K. Backfilling. Backfilling shall be in accordance with Subsection 615.04 F.

L. Field Testing. The installed pipe shall be pressure tested and leakage tested in accordance with AWWA Standard C 600. Working pressure of the pipe should not exceed 2/3 of the rated pressure of the pipe. Leakage should not exceed 10 gallons per inch per mile of pipe per 24 hours at 150 pounds per square inch testing pressure.

All new, cleaned or repaired water mains shall be disinfected. Water with 100 parts per million of chlorine shall be allowed to stand 24 hours and develop a residual of at least 10 parts per million of chlorine. The spent solution shall be drained in an acceptable manner and replaced with potable water prior

to use of the line. Safe bacteriological samples shall be obtained on two consecutive days before that portion of the line may be used.

All of the before mentioned testing shall be included in the price bid for other items of work. The Contractor shall inform the Engineer in writing 24 hours in advance of any testing.

M. Inspection. All negotiations, decisions, instructions, interpretations of applicable Specifications and other matters influencing the work shall be directed to the Engineer.

N. Borings. The boring shall proceed from a pit provided for the boring equipment and workmen. The location of the pit shall meet the approval of the Engineer. The holes are to be bored mechanically. The boring shall be done using a pilot hole. By this method an approximate 2 inch pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored. Excavated material will be placed near the top of the working pit and disposed of as required. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Jetting will not be permitted.

616.05 METHOD OF MEASUREMENT.

A. Water Pipe. Water pipe will be measured for payment by the linear foot, including such fittings as crosses, tees, sleeves, outlet assemblies, plugs and other specified fittings, complete in place and accepted. Each separate size of pipe shall constitute a separate item for payment. In measuring water pipe for payment it will be measured along the center line of the completed line and no deductions will be made for the space occupied by fittings, valves, etc.

B. Water Service Pipe. Water service pipe and fittings will be measured by the each, including corporation stops, meter setters and other specific fittings for a complete in place service.

C. Valves. Valves will be measured for payment by each valve installed. Valves of different sizes shall constitute separate pay items. The price bid for these items shall include all the costs of work required to install them such as tapping, tapping sleeves, valve boxes, meter boxes, etc.

D. Fire Hydrants. Fire hydrants will be measured for payment by each such fire hydrant set, complete in place and approved including placing drainage stone, blocking, fire hydrant extensions (if required), all threading, paint, and etc.

Excavations, bedding material, blocking, testing and fittings will not be measured for payment as a separate item, but the cost of same will be

included in the contract unit price for water pipe. Corporation stop includes tapping, double banded service clamp for 1-1/2" or larger, and coupling for a complete installation.

Meter installation includes meter can as approved by Water Department, meter yoke with ground key angle stop, and fittings for a complete installation.

616.06 BASIS OF PAYMENT. Accepted quantities of water pipe and appurtenances of the types and sizes specified and supple mental drawings, measured as provided above, will be paid for as the contract unit price for:

(A)	Ductile Iron Pipe (Lined)	Lin. Ft.
	Polyvinyl Chloride (PVC) Pipe	Lin. Ft.
(B)	Water Service Pipe and Fittings	Ea.
(C)	Valves	Ea.
(D)	Fire Hydrants	Ea.
(E)	Corporation Stop Installation	Ea.
(F)	Meter Installation	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Service lines 1-1/2" and larger shall be installed with a full port, teflon coated ball valve in lieu of the normal meter yoke.

619.00 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

619.01 DESCRIPTION. This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, bridges, culverts, fences, structures, old pavements, abandoned pipe lines and any other obstructions which are designated or permitted to remain except for the obstructions to be removed and disposed of under other items in the Contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes and pits.

This work, when specified, shall also consist of removing designated traffic signal and highway lighting items such as: pole assemblies, luminaries, pull boxes, power supplies, signal heads, controllers and other related electrical equipment and delivering them to a location specified on the Plans and in a manner approved by the Engineer. This work shall also consist of removing abandoned items and restoring the site to match the surrounding conditions.

When the proposal does not include pay items for removal of structures and obstructions as set out in this Section such work shall be performed under Section 202 - Excavation and Embankment.

619.04 CONSTRUCTION METHODS.

A. General. The Contractor shall raze, remove and dispose of all buildings and foundations, structures, fences and other obstructions , any portions of which are on the right-of-way, except utilities and those for which other provisions have been made for removal. When one part of or portion of a system or configuration is removed the removal of that one part or portion shall be performed in such a manner that the remaining parts or portions shall continue to operate or function as previously intended. All designated salvable material shall be removed without unnecessary damage in sections or pieces which may be readily transported and shall be stored by the Contractor at specified places. Unusable perishable material shall be destroyed. Nonperishable material may be disposed of outside the limits of view from the project with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners are to be furnished to the Engineer. Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and if within the prism of construction shall be compacted in accordance with Subsection 202.04 C. and D. Floors of basements shall be broken in a manner acceptable to Engineer to provide adequate drainage from the basement.

When the work includes or involves traffic signals or highway lighting, the Contractor shall carefully disconnect the item to be removed from the existing footing, conduit and wiring system and carefully remove the item or assembly so that it may be stored for future use or reset. The Contractor shall be responsible for damage to the removed item as a result of his negligence and shall repair or replace the damaged item to the satisfaction of the Engineer.

B. Removal of Bridges, Culverts and other Existing Structures. Bridges and culverts in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Removal of existing structures when shown on the Plans shall be in accordance with Subsection 104.06.

1. When structures are to remain the property of the City, the method of dismantling of steel superstructure and wood bridges shall insure the material against unnecessary damage. Steel members shall be dismantled at the original field splices and shall be supported on falsework during the operation of dismantling or shall be dismantled in a manner and method approved by the Bridge Engineer. Any steel damaged shall be replaced or satisfactorily repaired by the Contractor without compensation. Before dismantling, steel members shall be match marked by painting and by using steel stencils in a manner approved by the Bridge Engineer for re-erection purposes.

Piers, abutments and piling shall be cut off at the ground line or in case of channel change at the elevation of the channel excavation shown on the Plans.

Salvaged lumber, structural steel, etc., shall be stacked on the right-of-way outside of the ditch line in a neat and workmanlike manner.

Old concrete and other similar materials shall be broken up and placed in the fill as specified for placing solid rock in fills or otherwise disposed of as directed by the Engineer.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down one foot below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. In no case shall material be left in the channel.

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

2. When structures or material in structures are to become the property of the Contractor, he shall remove and dispose of the material in accordance with Subsection 104.08. Piers, abutments, piling and substructures shall be removed as specified in 1. above.

C. Removal of Culvert and Sewer Pipe. Unless otherwise provided all salvable culvert and sewer pipe shall be carefully removed and every precaution taken to avoid breaking and damaging the pipe. Pipes to be re-laid shall be removed and stored when necessary so that there will be no loss or damage before relaying. The Contractor will be required to replace sections lost from storage or damaged by negligence or by use of improper methods.

D. Removal of Pavement, Sidewalks, Curbs, Etc. All concrete pavement, base course, sidewalks, curbs, gutters, etc., designated for removal shall be broken into pieces weighing not more than 150 pounds and stockpiled at designated locations for use by the City or in a manner approved by the Engineer.

There will be no separate payment for excavating for removal of structures and obstructions or for backfilling and compacting the remaining cavity.

When the removal of asphalt concrete or portland cement concrete pavement is specified the joint shall be sawed in a manner approved by the Engineer. Sawing shall be reasonably true to line and the depth of sawing shall be such that when removing the material undue underbreakage or shattering of the adjacent area will not occur.

E. Structures Abandoned. Existing structures which are to be abandoned shall be broken off or removed to a depth of not less than 6 inches below the foundation grade of new structure.

Sewer lines, water lines, etc., to be abandoned shall be tightly plugged at each end with concrete in a manner approved by the Engineer.

Manholes and similar structures to be abandoned shall be removed to the depth specified, filled with suitable material and compacted in accordance with Subsection 202.04. If the structure abandoned and so backfilled is to be under paving or another structure, the backfill material shall be tamped in uniform layers not exceeding 6 inches in depth and compacted as specified in Subsection 202.04.

If the structure is not under paving or other structures, settlements may be obtained by thoroughly flushing with water during backfill operations.

F. Disposable Materials. Any abandoned concrete footing, concrete apron, conduit and other miscellaneous material shall become the property of the Contractor and shall be removed and disposed of in a manner approved by the Engineer. Materials such as drop inlet grates and frames, manhole covers and frames, concrete or clay pipe, water pipe, goosenecks, valves, stops, valve boxes or any material of value shall remain the property of the City, unless the Plans or Special Provisions provide otherwise for their disposal.

619.05 METHOD OF MEASUREMENT. When the Contract stipulates that payment will be made for removal of obstruction on a lump sum basis, the pay item, removal of obstructions, will include all structures and obstructions encountered within the right-of-way in accordance with the provisions of this Section. Where the proposal stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the Contract

When such work is not separately classified for payment on the Plans or in the Proposal, it will be considered as incidental work and will not be paid for directly, but the cost will be included in the contract unit price for other items of work.

The length of pipe removed when stipulated as a pay item will be measured in linear feet computed by multiplying the number of commercial lengths removed by the nominal laying length or by measuring in place prior to removal if practicable.

When sawing of pavement is shown on the Plans as a pay item, it will be measured by the linear foot or lump sum.

619.06 BASIS OF PAYMENT. The accepted quantities of items, measured as provided above, will be paid at the contract unit price bid for:

(A)	Removal of Structures and Obstructions	Lump Sum
(B)	Removal of (Specific Item)	Ea., Lin. Ft., Sq. Yd., Cu. Yd., Lump Sum
(C)	Sawing Pavement	Lin. Ft., Lump Sum
(D)	Removal of Existing Bridge Structure	Lump Sum

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified. The price shall also include salvage of materials removed, their custody, preservation, storage and disposal as provided herein. There will be no separate payment for the excavation, removal, disposal, backfilling and compacting of the cavity created by the removal of these items.

622.00 PIPE RAILING AND MISCELLANEOUS PIPE WORK

622.01 DESCRIPTION. This work shall consist of furnishing and erection of pipe railing with pipe posts, pipe railing with concrete posts, or miscellaneous work in accordance with these Specifications and in reasonably close conformity with the design, lines, grades and dimensions shown on the Plans or established by the Engineer.

622.02 MATERIALS. Materials shall meet the requirements of Subsection 732.04.

When standard black steel pipe is used, it shall be painted with 2 coats of aluminum paint (finish field coat) in accordance with Subsection 730.04 B. 3.

Concrete posts, when specified, shall be in accordance with Section 505. Reinforcement shall be in accordance with Subsection 723.01 or 723.02.

622.04 CONSTRUCTION METHODS.

A. Pipe Railing. All work shall be performed complete in every detail in accordance with the very best practice for the various items involved.

The rail pipe shall be joined to the post with fittings as shown on the Plans. Splices in pipe by couplings between connections will not be permitted, approved methods of welding will be permitted.

Each railing post shall be secured in position by means of such fittings as specified on the Plans.

B. Miscellaneous Pipe. Pipe used in miscellaneous work such as conduits or drains through concrete curb, sidewalks, or retaining walls shall be set as shown on the Plans or as directed by the Engineer. When pipe is embedded in concrete, care shall be taken to work the concrete in well around the pipe.

622.05 METHOD OF MEASUREMENT.

A. Pipe Railing. Pipe railing will be measured by the linear foot of pipe railing complete in place, measured center to center of the end posts. Posts of steel or concrete will not be measured for payment.

B. Miscellaneous Pipe Work. When classified for payment miscellaneous pipe work will be paid for by the linear foot of pipe. When this class of work is not specifically classified on the Plans or in the Proposal for payment, it will be considered as incidental work and will not be paid for as a separate item but the cost of same will be included in other contract prices.

622.06 BASIS OF PAYMENT. Accepted quantities of pipe railing and

miscellaneous pipe work, measured as provided above, will be paid for at the contract unit price for:

(A)	Pipe Railing	Lin. Ft.
(B)	Miscellaneous Pipe Work	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

623.00 GUARD RAIL AND GUIDE POSTS

623.01 DESCRIPTION. This work shall consist of the construction of guard rail and guide posts in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.

623.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Guard Rail Posts	732.01
Guide Posts (Wood)	732.02
Spacer Blocks	732.01
Zinc Rich Paint	730.06
Beam Guard Rail Elements	732.01
Fittings (Steel) Hardware	732.01
Wire Cable and Fittings	732.05
Reflective Sheeting	733.05
Nonshrink Grout	733.07
Portland Cement Concrete, Class A	701.
Reinforcing Steel	723.

Epoxy resin adhesive (epoxy pourable grout) shall meet the requirements of AASHTO M-235, Type III and be pourable in consistency.

623.04 CONSTRUCTION METHODS.

A. Setting Posts for Guard Rail, Guide Posts or Barrier Posts.

Posts for guard rail shall be set in accordance with the Plans. When posts are set in the ground, the posts shall be set in holes dug in thoroughly compacted soil and the bottom of the holes shall be thoroughly rammed so that the post will have a stable foundation. The posts shall be spaced as shown on the Plans, set plumb and with the front faces in a straight line, or if on a curve, at a uniform distance from the edge of the pavement. The top of the post shall be set to the elevation shown on the Plans or as approved by the Engineer. After the posts are placed, the holes shall be backfilled with approved material, thoroughly rammed in layers not to exceed 6 inches in depth and in such manner as not to shift the posts from the correct alignment. Posts for guard rail may be machine driven in lieu of drilling holes and backfilling as specified above.

All other requirements shall be as shown on the current guard rail standard drawings.

B. Rail Elements. Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be

drawn tight. Bolts shall be of sufficient length to extend beyond the nuts.

Where painting of railing components is specified, any damage to the shop coat of paint shall be corrected by an application of an approved rust-inhibitive primer prior to other painting. Any surfaces inaccessible to painting after erection shall be field painted before erection. The railing components shall be given the specified number of coats of paint uniformly applied by thorough brushing or by approved pressure spray as specified.

Galvanized surfaces which have been abraded so that the base metal is exposed, threaded portions of all fittings and fasteners and cut ends of bolts shall be protected with 2 coats of an approved zinc rich paint.

Where double-faced guard rail is specified, it shall be installed in accordance with the Plans.

C. Placing Metal Plate Rails and Fittings. Where metal plate rails are specified or used, they shall be fastened to the posts in the manner shown on the Plans. The plate shall be at the elevation shown on the Plans. All laps in the rail shall conform to the direction of traffic on the roadway.

When the type of metal plate guard rail to be used is not specifically set out on the Plans, no more than one type will be permitted on any one Project.

D. Placing Reflective Sheeting on Guide Posts. After the posts are set, posts shall be provided with reflective sheeting, when specified, fixed to the post with four 8d box nails as shown on the Plans.

E. Guard Rail Anchor Units. Guard rail anchor units shall be constructed as shown on the Plans.

When rock harder than medium sandstone (outcropping on surface, massive boulders and ledge rock under overburden) is encountered during construction of the concrete anchor, the following steps should be followed.

For surface outcropping, drill four properly spaced and patterned 2 inch diameter holes to receive the full depth anchor bolts as shown on the Plans. Half fill the rock holes with pourable epoxy grout, insert the bolts and stabilize them to their final position, then fill the remainder of the hole. Air bubbles and voids shall be expelled from the holes to guarantee full bearing of the bolts.

For rock with a soil overburden up to 18 inches deep the following steps shall be followed. Drill the four properly spaced holes to receive the anchor bolts. Drill four additional 2-1/2 inch diameter holes spaced at 90° and 12 inches from center of concrete anchor. Half fill the outer holes with pourable epoxy grout, insert and stabilize plumb, one number 9 reinforcing steel bar per hole, cut to the proper length. Then fill the remaining hole and expel any bubbles.

Length should enable insertion of full 12 inches into the rock and clear the top of the concrete anchor by 2 inches. Tie the 6x6-W1 .5xW1. 5 wire mesh to the bars after grout is dry. Pourable epoxy grout shall be spread on the mating surface between the rock and concrete for positive bond. Construct the upper portion with the same details as shown on the Plans.

For encountered rock at depths greater than 18 inches omit the holes for the four anchor bolts and construct the anchor as covered in the previous paragraph.

623.05 METHOD OF MEASUREMENT. Beam guard rail installations will be measured by the linear foot between end sections.

Guard rail anchor units and beam guard rail-transition sections will be measured separately as units shown on the standard drawings.

Fittings will not be measured separately but included as incidental to the type specified.

Guide posts will be measured by the number of posts, including reflective sheeting.

623.06 BASIS OF PAYMENT. The accepted quantities of the various items, measured as provided above, will be paid for at the contract unit price for:

(A)	Beam Guardrail	Lin. Ft.
(B)	Beam Guardrail-Transition Section	Ea.
(C)	Guardrail Anchor Unit	Ea.
(D)	Guide Posts	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

624.00 FENCES

624.01 DESCRIPTION. This work shall consist of the construction of fence and gates in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.

The style, type and/or class of fence will be as shown on the Plans. The styles are designated as follows:

(A) Fence, Style WWF (Woven Wire Fence)
(B) Fence, Style SWF (Strand Wire Fence)
(C) Fence, Style CLF (Chain Link Fence
(D) Fence, Style GDF (Glare Deflector Fence)

Fence gates shall be of the style, type and/or class, and size as shown on the Plans, and shall be installed at locations shown on the Plans or as directed by the Engineer. They shall be installed in accordance with the Plans.

624.02 MATERIALS. Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Fence, Style WWF	732.06
Fence, Style SWF	732.06
Fence, Style CLF	732.07
Fence, Style GDF	732.08
Zinc Rich Paint	730.06
Portland Cement Concrete, Class A	701

When not specified on the Plans or in the Proposal, the kind of post, hardware and fittings meeting the requirements of Section 732 shall be optional with the Contractor, but the kind selected shall be used throughout any one project unless otherwise approved in writing by the Engineer.

624.04 CONSTRUCTION METHODS.

A. General. The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to the required grade and alignment. Existing fencing on permanent right-of-way when the work order is issued will become the responsibility of the Contractor. At locations where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made. Cross fencing connections shall include an end post approximately perpendicular to the right-of-way fence, or at an angle dictated by the route of the cross fence.

When the Plans require that posts, braces or anchors be embedded in concrete, the Contractor shall install temporary guys, or braces as may be required to hold the posts in proper position until such time as the concrete

has set sufficiently to hold posts. Unless otherwise permitted, materials shall not be installed on posts or strain placed on guys and bracing set in concrete until 5 days after the placing of the concrete.

Line posts may be driven instead of set in concrete footings or tamped in earth holes at the option of the Contractor, and with the approval of the Engineer. For the driving option, wooden line posts shall be sharpened by the supplier prior to preservative treatment, and the top shall be protected. Splitting or damage to the post top as a result of the driving operation will be cause for rejection. Field sharpening or taper dressing will not be allowed. Metal posts shall also have a fitted impact head to minimize deformation or damage to the galvanized or painted finish.

Deformed and/or damaged tops of metal posts shall be cleaned and painted with a zinc-rich paint after driving.

Severely deformed or poorly painted tops will be cause for rejection.

Adequate plumb and offset (alignment) control shall be exercised to assure a smooth profile and alignment. In shallow depressions the use of extra length posts and barbed wire fans shall be utilized to maintain a smooth top of fence profile. Strengthened fence construction and the use of movable water gates may be necessary in installations over deep ravines. Under no circumstances shall swales or ravines subject to periodic water flow be filled to facilitate fence construction. Adequate provision for drainage must be maintained.

For installations in earth and soft rock (softer than medium sandstone) the following criteria shall be adhered to: Driven posts shall reach the minimum embedment as shown on the Plans unless refusal of the post is reached. Refusal is defined as one inch or less entry per minute of driving with a 60 pound hammer utilizing mechanical or pneumatic means, delivering a minimum of 60 blows per minute. If refusal is encountered at 24 inches or deeper, the post may remain and be top cut for profile control. If refusal is encountered at less than 24 inches depth, the post shall be pulled and a concrete footing of the dimensions as shown on the Plans for earth installations shall be installed.

For installations in medium to hard rock (medium sandstone or harder) when encountered at the surface, the following criteria shall be adhered to: a hole of the diameter and depth for footings in rock, as shown on the Plans for the type of post being used shall be drilled. The post shall then be inserted, plumbed, and braced, and the hole filled with lean grout.

The procedure for installations when medium to hard rock is encountered under a layer of earth is as follows. At any depth less than the minimum driven embedment (as shown on the Plans) at which rock is encountered, the earth shall be augured and treated like a regular concrete embedded earth

footing. A hole of the diameter for footings in rock (as shown on the Plans for the type of post being used) shall be drilled to a depth which will yield the total minimum earth embedment, or the minimum rock embedment, whichever occurs first. The rock hole shall then be half filled with an approved type of lean grout, (thin hydraulic cement), the post inserted, plumbed braced, and the remainder of the rock hole filled with lean grout. Concrete for earth footing may be immediately placed above the grouted hole.

The intent is for all driven posts to be firmly in the earth a minimum of 24 inches where driving has been refused, or the minimum earth embedment as shown on the Plans, unless rock is encountered. The minimum rock embedment shall be required unless the total minimum earth embedment is reached prior to the rock embedment being reached. When these conditions have been fully satisfied, the post may be top cut for profile control.

The tops of all posts shall be set approximately to the required grade and alignment. Cutting of the tops of the posts will be allowed only with the approval of the Engineer or under the conditions specified herein or on the Plans.

Tops of wood posts shall be liberally painted with a preservative solution after cutting. Cut areas (no flame cuts allowed) on metal posts shall be cleaned and painted with a single coat of zinc-rich paint. Wire or fencing of the size and type required shall be firmly attached to the posts and braces in the manner indicated.

All wire shall be stretched taut and be installed to the required elevations.

At each location where an electric transmission, distribution or secondary line crosses any of the types of fences covered by the Specifications, grounding of the fencing shall be accomplished in accordance with the following: a galvanized or copper coated steel ground rod 8 feet long having a minimum diameter of 1/2 inch shall be installed directly below the point of crossing. The rod shall be driven vertically until the top is six inches below the ground surface. A No. 6 solid copper conductor or equivalent shall be used to connect each fence element to the grounding rod. The connections shall be either brazed or fastened with approved non-corrosive clamps.

When a powerline runs parallel or nearly parallel to and above the fence, the fence shall be grounded at each end and gate post and at intervals not to exceed 1,500 feet.

The Contractor shall provide the abutting property owners with the equivalent property protection given by the existing fences. The Contractor shall be responsible for the maintenance of all fences and gates that he constructs during his construction operations.

B. **Fence-Style WWF (Woven Wire Fence).** This item shall consist of woven wire fabric with smooth, barbless, or barbed wire strands on a steel and/or wood post system.

1. *Alignment.* The Plan sheets show the general alignment, angles, corners and attachment types at culverts. In general, fence shall be constructed on the permanent right-of-way line and wire usually will be attached to the private property side of the fence posts. On curves, wire fabric shall be placed on that side of the post which will maintain the wire in a taut condition. The area where the right-of-way fence is to be constructed shall be cleared of obstructions and the ground leveled of minor irregularities so the fence can be free of an excessive number of anchor posts and fans.

2. *Setting Posts.* Line posts shall be of the size indicated on the Plans and shall be set on the permanent right-of-way line, or to a line shown on the Plans or approved by the Engineer, and in a reasonably true line on the property owner's side to which wire generally is to be attached. They shall be embedded in the ground to the depth shown on the Plans and shall be well tamped and firmly set. Spacing between line posts shall not exceed dimensions shown on the Plans. Additional posts shall be set at each abrupt change in grade, alignment, or at locations approved by the Engineer.

   Extra length posts (fan posts) shall be required at small depressions where it is not practicable for the fence to follow closely to the contour of the ground. At such small ground depressions the Contractor shall close the space below the bottom of the fence fabric with wire, stretched taut between posts, either on horizontal lines or fanned at 6 inch maximum spacing, as shown on the Plans or as approved by the Engineer. The wires shall be stretched taut and securely fastened to the posts to prevent vertical movement of the wires.

   Concrete for encasing posts as indicated on the Plans may be poured without forming if the excavation is of sufficient stability to receive the concrete without caving or sliding in. If specified by the Engineer, footings shall be formed.

3. *Placing Fencing.* Barbed wire, barbless wire, or smooth wire shall be fastened to all fan, end, corner, gate and/or stretcher posts, and to all line posts by substantial and approved means. Fastening shall be done by the use of tools designed for the purpose in accordance with the manufacturer's recommendations. The tension for stretching shall be applied by mechanical fence stretchers or with single-wire stretchers designed for the purpose. All strands shall be stretched taut to a tensile force of approximately 300 pounds as shown on the Plans or as recommended by the manufacturer.

Splicing of strand wire, and wire fabric shall be made by a mechanical device of an approved type, or a wire splice may be made in the following manner: The ends of wires shall be carried 2 inches past the splicing tools and wrapped around both wires backward from the tool for at least five turns. An approved single strand of smooth steel wire or barbless wire may be substituted to the top strand of barbed wire, or for all the barbed wire with the approval of the Engineer, and the concurrence of the Contractor.

Woven wire fabric shall be stretched uniformly tight by means of an approved mechanical tensioning device and in conformity to the location on the posts designated on the Plans. Parallel stays shall be straight, and uniformly spaced as shown on the Plans. Each woven fabric wire and strand wire shall be stapled to wood posts or fastened with approved fittings to steel posts. Woven wire shall be cut or spliced at stretcher or wood posts as required to prevent buckling or undue stretching.

Attachment assemblies shall be built according to the Plans. When it is necessary to make attachments to culvert or bridge endwalls after the culvert is constructed, the hole shall be drilled with a drill of the same size as the expansion device and the holes shall be neat, without chipping or breaking the concrete.

C. Fence-Style SWF (Strand Wire Fence). This item shall consist of smooth, barbless, or barbed wire strands on a steel and/or wood post system constructed in the same manner as fence-style WWF, except the fencing fabric shall consist of strands of an approved smooth wire, barbless wire, or barbed wire. Fence-style SWF shall have the number of strands of wire as shown on the Plans or as approved by the Engineer. The fence shall be set on the permanent right-of-way line.

D. Fence-Style CLF (Chain Link Fence). This item shall consist of chain link type fabric fencing on galvanized steel or aluminum alloy post system, with or without barbed wire, smooth tension wire, or climb barrier systems.

1. *Alignment.* The provisions of Subsection 624.04 A. General and 624.04 B. 1. Fence-style WWF shall govern.

2. *Setting Posts and Placing Fencing.* See Subsection 624.04 A. General for alternate driving criteria for line posts. Post holes shall be dug to the minimum size and spacing as shown on the Plans. Posts shall be set plumb, centered in the hole and to the lines shown on the Plans. Posts shall be placed in the concrete before initial set, thoroughly puddled and supported plumb until concrete has set. Wire shall not be stretched until concrete in post holes is at least five days old. Wire shall be stretched slightly above the tension recommended by the manufacturer for the season of the year in which construction takes place and allowed to slack

away slightly when pullers are released. Pullers shall attach to the wire full width and ties made in at least seven places on each post before releasing. If desired, pulls may be made from two ways and jointed by inserting one picket. All post braces shall be set before placing any wire. Tension and barb wire shall be placed after proper size of fabric is placed. Wire shall be placed on the outside of the posts, with respect to the road, except on curves where wire shall be placed on the outside of the post with respect to the center of the curve.

3. *Concrete Wall for Fence.* Across ravines where it would not be practical to set posts and follow the ground line with the fence, posts shall be set in a concrete wall as shown on the Plans and at locations directed by the Engineer. When a wall is constructed across any dry wash or periodically wet ravine, adequate provision for drainage must be made. A partial wall on each bank with a water gate or fan in the center, or culverts through any solid wall will satisfy the drainage requirements.

3.1 *Concrete.* All concrete shall be Class A and meet the requirements of Section 701.

3.2 *Reinforcing Steel.* Reinforcing steel shall meet the requirements of Section 511.

624.05 METHODS OF MEASUREMENT. Fence will be measured by the linear foot. Measurement will be along the ground line of the fence from outside to outside of end posts for each continuous run of fence. Connections to cross fences will not be measured separately, but costs shall be included in price bid for fence.

Gates will be measured as complete units of the size, type, and class specified. Concrete wall for fence, when specified, will be measured in accordance with the dimensions shown on the Plans and will be paid for under Section 509, Class A Concrete or Class A Concrete for Small Structures and Section 511, Reinforcing Steel.

624.06 BASIS OF PAYMENT. The accepted quantities of fence, measured as provided above, will be paid for at the contract unit price per linear foot of fence and per each for gates of the types and sizes for:

(A)	Fence-style WWF	Lin. Ft.
(B)	Gate-style WWF	Ea.
(C)	Fence-style SWF	Lin. Ft.
(D)	Fence-style CLF	Lin. Ft.
(E)	Gate-style CLF	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

625.00 REMOVAL AND STORAGE OR RECONSTRUCTION OF FENCING, GUARD RAIL AND GUIDE POSTS

625.01 DESCRIPTION. This work shall consist of the removal and storage or reconstruction of fencing, guard rail and guide posts in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.

625.02 MATERIALS. When reconstruction is called for, materials salvaged from the existing installation may be used if in good condition. All other material shall be replaced with approved materials. Paint shall meet the requirements of Subsection 730.04 D. Unless otherwise specified, the paint for refurbishing shall be aluminum. Zinc rich paint shall meet the requirements of Subsection 730.06.

625.03 CONSTRUCTION METHODS.

A. Removal and Storage. The removed material, unless otherwise provided, shall be stored at a designated location, as may be directed by the Engineer. Care shall be taken in removal of material to prevent damage to posts, cable, fence, plates, or fittings. Cable or fence shall be coiled and tied tightly before storing. Fittings shall be tied together in bundles or boxed. Such items as metal plates and posts shall be neatly stacked on blocks to prevent contact with the ground.

B. Reconstruction.

1. *Guard Rail or Fence.* When reconstruction of guard rail or fence is provided in the Contract, the guard rail or fence in place shall be removed and stored as required above until such time as it is to be reset. All construction of guard rail or fence shall be done in the same manner as provided for new work. The Contractor will be required to replace at his own expense any material damaged or lost. All fresh or new cut holes, etc. will be coated with zinc rich paint. After erection of metal plate rail, all abrasions of the existing paint shall be thoroughly cleaned and given one coat of aluminum paint. After this paint coat is thoroughly dry, the plate rail and all fittings shall be given one coat of aluminum paint as required for new metal plate guard rail. Setting of guard rail furnished by the State, when such work manner as provided for new work.

2. *Guide Post.* Reconstructing guide posts shall consist of removing, storing and resetting guide posts. All reconstruction on of guide posts or setting guide posts shall be done in the manner as provided for new work. The Contractor will be required to replace at his own expense any guide posts damaged during removal or storage or any posts that may be lost.

625.04 METHOD OF MEASUREMENT. Guard rail or fence removed and stored and not to be replaced will be measured by the length in linear feet from center of

end posts as measured before removal.

Guard rail or fence removed and stored to be reset will be measured by the length in linear feet from center to center of end posts as measured after reconstruction and approval.

Guide posts removed and stored, and not to be replaced, will be measured by the number of such guide posts actually removed and stored as directed.

Guide posts removed and stored to be reset will be measured by the number of such posts removed and reset as measured after reconstruction and approved.

625.06 BASIS OF PAYMENT. Accepted quantities of the various items, measured as provided above, will be paid for at the contract unit price for:

(A)	Remove and Store Fence	Lin. Ft.
(B)	Remove and Reconstruct Fence	Lin. Ft.
(C)	Remove and Store Guard Rail	Lin. Ft.
(D)	Remove and Reconstruct Guard Rail	Lin. Ft.
(E)	Remove and Store Guide Posts	Ea.
(F)	Remove and Reconstruct Guide Posts	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

642.00 CONTRACTOR CONSTRUCTION STAKING

642.01 DESCRIPTION. When specified in the Contract this work shall consist of the Contractor furnishing, placing and maintaining construction layout stakes necessary for the proper prosecution and inspection of the work under the contract in accordance with these Specifications.

642.02 CONSTRUCTION METHODS. The City will locate and reference the center line of construction and will establish bench marks.

The Contractor shall exercise care in the preservation of stakes and bench marks and shall have them reset at his expense when any are damaged, lost, displaced or removed. The Contractor shall use competent personnel and suitable equipment for the layout work required.

The Contractor shall provide field forces and shall set all additional stakes needed, such as offset stakes, reference point stakes, slope stakes, pavement and curb line and grade stakes, stakes for bridges, sewers, roadway drainage, pipe underdrains, paved gutter, fence, culverts or other structures, and any other horizontal or vertical controls necessary to secure a correct layout of the work. The Contractor shall also do all layout work and shall set stakes necessary for carrying out utility changes when such utility changes are required during the course of the Contract. Stakes for line and grade shall be adequate to maintain the specified tolerances for the operation being performed. The station number and the distance from the center line of construction shall be marked on all grade stakes.

The Contractor shall furnish the original of his survey records to the Engineer for computation of quantities and for the permanent file. These records shall be furnished as they are completed during the progress of the work. These records shall be in permanently bound field books and/or level books and formatted in a manner commonly accepted by the surveying profession. The Engineer may at any time check the correctness of the Contractors staking work by using spot check method. When significant errors occur, the Contractor shall resurvey to the satisfaction of the Engineer. The Contractor shall furnish, at his expense, platforms and equipment necessary for proper and safe access for checking his staking. Any inspection or checking of the Contractor's layout by the Engineer and the acceptance of all or any part of it shall not relieve the Contractor of his responsibility to secure the proper dimensions, grades, and elevation of the several parts of the work.

642.03 METHOD OF MEASUREMENT. Measurement for contractor construction staking will be made on a lump sum basis.

642.04 BASIS OF PAYMENT. Contractor construction staking, measured as provided above, will be paid for at the contract price for:

Staking	Lump Sum

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

Payment for this item of work shall be on the following schedule:

25 percent on first estimate
25 percent when 10 percent of the contract work is completed
25 percent when 50 percent of the contract work is completed
20 percent when 75 percent of the contract work is completed
5 percent when all field books and records have been furnished to the Engineer.

700.00 MATERIALS

701.00 PORTLAND CEMENT CONCRETE. This Specification covers all materials, classification, mix designs, proportioning and testing of portland cement concrete. All concrete except that used for pre-stressed concrete members shall be air entrained unless otherwise shown on the Plans.

The equipment and tools necessary for the mixing of concrete shall meet the requirements of Subsection 414.03.

701.01 MIX DESIGN AND PROPORTIONING. The materials used shall comply with the requirements of all Subsections of this Specification.

A. **Classes of Concrete.** The classes of concrete are shown in the following table:

CLASSES OF CONCRETE					
Class of Concrete	**Cement lbs. per Cu. Yd. a/**	**Air Content Percent**	**Maximum Water-Cement Ratio b/ lb. per lb.**	**Slump, Inches c/**	**Minimum Compressive Strength-28 day psi**
AA	**658**	**4-6**	**.49**	**1-3**	**3500**
A	**564**	**4-6**	**.53**	**1-3**	**3000**
B	**470**	**4-6**	**.58**	**2-4**	**2500**
C	**395**	**4-6**	**.62**	**2-4**	**2400**
P6	**611 to 752**		**.42**	**1-3**	**6000**
P5	**611 to 705**		**.44**	**1-4**	**5000**

a/ Fly ash meeting the requirements of Section 702 may be substituted for approximately 15 percent cement in the ratio of 1.35 pounds of fly ash for each 1.0 pounds of cement. This substitution will not be allowed for high early strength concrete or when Type IP cement is used.

b/ The water-cement ratio will be calculated by the following equation:

W/C (Lbs of Water) / (Lbs. of Cement + Lbs. of Fly Ash)

The water actually used is determined by the water measured into the batch plus the free water on wet aggregate minus the water absorbed by dry aggregate and shall not exceed the limit specified.

c/ The slump shall be as shown or as approved by the Engineer, and the consistency required shall be that which will provide satisfactory workability for the type work being done. Slump tests will be made during the progress of the work as a measure of uniformity of the consistency of the concrete.

When the class of concrete is not expressly indicated on the Plans, the following requirements shall govern:

Class AA – Slabs and girders without wearing surface, concrete piles, handrails and all bridge floors.

Class A – Slabs and girders with wearing surface, pavements, piers, abutments, retaining walls, culverts and all reinforced concrete not requiring Class AA concrete.

Class C – Concrete may be used for soil erosion control structures.

When high early strength concrete is used or specified, it shall meet all other requirements for that class of concrete except that Type III or Type III (AE) cement shall be used. When requested by the Contractor and approved by the Engineer, 25 percent additional Type I cement can be used in lieu of Type III or Type III (AE) cement to achieve high early strength concrete.

B. **Proportioning.** The mix design shall be based on absolute volume for the class of concrete specified and the consistency suitable for satisfactory placement of the concrete. The Contractor shall submit a mix design for the Engineer's acceptance which shall include all ingredients to be used in the mix. This mix design shall include supporting compressive strength data. The Engineer may require trial batches and require adjustments in the mix as necessary to attain workability and the specified air content when applicable. Adjustments to the mix will be made by the Contractor in a manner to maintain the specified cement factor based on absolute volume. During the progress of the work, no change shall be made in the batch proportions of the ingredients without the approval of the Engineer.

In the event a satisfactory mix with the required workability cannot be produced without exceeding the maximum water specified, the cement content shall be increased so that the maximum water cement ratio will not be exceeded. The Contractor shall not receive additional compensation for the extra cement which may be necessary by reason of such adjustment.

The cement used shall be within 2 percent of the specified amount of cement per cubic yard of concrete. During the progress of the work the Engineer may require the Contractor to verify the yield and require adjustments in the batch proportions as may be necessary to secure the specified cement content within the allowable limits. Any verifications required shall be done at the Contractor's expense.

The batch proportions accepted by the Engineer apply only for materials from the same source and having the same characteristics as the materials used in the mix design. Materials from any other source shall be used only with the approval of the Engineer.

Should a change in sources of materials be made, a new mix design shall be established by the Contractor before the new material is used. When unsatisfactory results or other conditions make it necessary, the Contractor shall establish a new mix design to get the desired results.

In proportioning the material for batches the least amount of sand and mixing water which will insure concrete of the required workability for the placing conditions involved should be used. Any change in weight of fine aggregate or mixing water made for the purpose of adjusting workability shall be compensated for by proportionate changes in the other mix components in order to maintain the total mix weight and water-cement ratio.

C. Adjustments Due to Temperature. An approved water-reducing, set-retarding chemical admixture shall be added to Class AA concrete when the prevailing ambient temperature is 75° F or above unless otherwise shown on the Plans. The admixture may be used for other types of structural concrete or at lower temperatures if requested by the Contractor and approved by the Engineer.

It is the intent of this Specification that when the admixture is used, it shall be used for a full section, panel or pour.

The admixture shall be used according to the manufacturer's recommendations to reduce the water content and extend the setting time for the specified job conditions.

The Engineer may require trial batches to adjust the amounts of air-entraining agent and amounts of mixing water to produce a concrete of satisfactory consistency and air content.

D. Tests. Slump will be determined using AASHTO T 119, and air content using AASHTO T 121, AASHTO T 152 or AASHTO T 196 as appropriate. Test specimens will be made and cured in accordance with AASHTO T 23 except that after the initial curing, specimens for acceptance testing will be cured in a medium maintained at 40° F to 85° F until they are tested.

Acceptance of test specimens will be tested in accordance with AASHTO T 22 for cylinders.

Unless otherwise provided, the minimum modulus of rupture when test beams are permitted as a criteria for removal of forms, placing a structure in service, etc., shall be 550 pounds per square inch when tested with the third-point method (AASHTO T 97) or 650 pounds per square inch when tested with the midpoint method (AASHTO T 177) or the minimum compressive strength of cylinders shall be 3000 pounds per square inch.

701.02 PORTLAND CEMENT. Portland cement shall conform to the requirements of AASHTO M 85 or AASHTO M 240.

Type I, Type IA and Type IP shall be used in concrete for general concrete construction. When white portland cement is required, it shall meet the requirements of Type I.

Type II and Type IIA shall be used in concrete exposed to moderate sulphate action or moderate heat of hydration, when specified on the Plans or in the Proposal.

Type III and Type IIIA shall be used when high early strength concrete is required.

Unless otherwise approved by the Engineer, the product of only one mill of any one brand and type of portland cement shall be used on the project, except for reduction of any excessive air entrainment where air entraining cement is used.

The contractor shall provide suitable means of storing and protecting the cement against dampness. Cement which for any reason has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

All methods of sampling and testing shall be in accordance with the requirements of AASHTO M 85 or AASHTO M 240.

701.03 ADMIXTURES (OTHER THAN FLY ASH). Admixtures shall not be used without written permission from the Engineer, except as otherwise provided in these Specifications.

Admixtures shall not be used to replace cement.

Admixtures containing chlorides as C1- in excess of ten thousand ppm shall not be used in pre-stressed or reinforced concrete.

Admixtures shall be measured accurately into each batch by methods approved by the Engineer.

Admixtures shall be dispensed in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to pre-measured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. The dosage shall not vary more than 5 percent from the dosage established by the Engineer for the mix requirements. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement of the admixture dosage.

Admixtures shall be stored in a manner to prevent freezing and shall be agitated to prevent separation or sedimentation of solids. Air agitation shall not be used.
If more than one liquid admixture is used, said admixtures shall be compatible and each shall be dispensed by separate equipment, unless otherwise permitted in writing by the Engineer. Any type of admixture shall be uniform in properties

throughout its use in the work. Should it be found that the admixture as furnished is not uniform in properties, it shall be discontinued.

Only those admixtures shall be used which have been approved by the Engineer. Admixtures may be accepted if the manufacturer presents a Type A certification defined in Subsection 106.12 that the admixture meets all the requirements of AASHTO M 154 or AASHTO M 194 as appropriate.

The Contractor shall furnish the Engineer a Type C certification from the manufacturer with each lot or shipment to the effect that the admixture supplied for use in the work is identical in all essential respects, including concentration, to the admixture tested and approved under these Specifications.

A. Air Entraining Admixtures. Air entraining admixtures shall conform to AASHTO M 154.

An exception to the above requirement may be granted in the case of admixtures manufactured by neutralizing vinsol resin with caustic soda provided the manufacturer furnishes certification that the product is neutralized vinsol resin and contains no other additive.

B. Chemical Admixtures. Chemical admixtures shall conform to AASHTO M 194 for the particular type specified.

If a high range water reducer is to be used, the mix shall meet the requirements of Subsection 701.01 prior to the addition of the admixture.

After addition of the admixture, the mix shall have a slump of 8 inches or less.

Trial batches shall be required when a high range water reducer is used.

701.04 WATER. All water used in mixing or curing portland cement concrete or cement treated base shall be clean and practically free from oil, salt, acid, alkali, organic matter or other substances injurious to the finished product.

Water from City water supply may be accepted without being tested.

Water from doubtful sources shall not be used until tested and approved. When required by the Engineer, the quality of the mixing water shall be determined in accordance with AASHTO T 26.

When tests are made comparing the water with water of known satisfactory quality, any indication of unsoundness, marked change in time of set, or reduction in mortar strength shall be sufficient cause for rejection of the water under test.

701.05 FINE AGGREGATE.

A. Materials Covered. These Specifications cover the quality and size of fine aggregates for portland cement concrete.

Mortar sand shall meet the requirements of AASHTO M 45.

B. General Requirements. Fine aggregate shall consist of natural sand, or subject to approval, combinations of manufactured sand and natural sand, having hard, strong, durable particles and shall conform to these Specifications.

Fine aggregate from different sources of supply shall not be mixed or stored in the same stockpile nor used alternately in the same class of construction or mix, without permission from the Engineer, or as provided herein for manufactured sand.

Fine aggregate shall be stockpiled in accordance with Subsection 106.07.

When manufactured sand is approved for use in combination with natural sand, at least 50 percent of the total fine aggregate by weight shall be natural sand. The two materials shall be stored and batched separately. Each of the materials shall conform to the requirements of these Specifications, except that the mortar strength test shall be made on the blend of materials proposed for use.

C. Deleterious Substances. The amount of deleterious substances shall not exceed the following limits:

ITEM	MAXIMUM PERMISSIBLE LIMITS MASS PERCENT
Clay lumps and friable particles	3.0
Coal and Lignite	0.5

D. Soundness. When the fine aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted loss shall not exceed 10 mass percent.

E. Organic Impurities. All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the calorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified below. Should the aggregate show a darker color than that of samples originally approved for the work, its use shall be withheld until tests satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.
A fine aggregate failing in the test may be used provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with Section 10 of AASHTO T 71 is not less than 95 percent.

F. Gradation. Fine aggregate shall be well-graded from coarse to fine and when tested by means of laboratory sieves shall conform to the following requirements.

SIEVE	MASS PERCENT PASSING
3/8 inch	100
No. 4	95-100
No. 16	45-85
No. 50	5-30
No. 100	0-10
No. 200	0-3

The gradation requirements given above represent the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus (Note) determination shall be made upon representative samples, from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample may be rejected.

Note: The fineness modulus of an aggregate is determined by adding the percentages by weight retained on the following sieves having square openings, and dividing by 100: 3 in., 1 ½ in., ¾ in., 3/8 in., no. 4, no. 8, no. 16, no. 30, no. 50 and no. 100.

G. Methods of Sampling and Testing. Sampling and Testing of fine aggregate shall be in accordance with the following methods of the American Association of State Highway and Transportation Officials:

Sampling	T 2
Friable particles	T 112
Coal and lignite	T 113
Amount of passing a No. 200 sieve	T 11
Organic impurities	T 21
Mortar-making properties	T 71
Sieve analysis	T 27
Soundness (sodium sulfate or magnesium sulfate)	T 104

701.06 COARSE AGGREGATE.

A. Materials Covered. These Specifications cover the quality and size of coarse aggregate for use in portland cement concrete.

B. General Requirements. Coarse aggregate shall be stockpiled in accordance with Subsection 106.07.

Coarse aggregate shall be a gravel or crushed stone which shall conform to the requirements of AASHTO M 80, Class A, except as modified by these Specifications. Coarse aggregate shall produce Class A concrete with a durability factor of 50 or more. The durability factor will be determined after 350 cycles of alternate freezing and thawing in accordance with AASHTO T 161, Procedure A. The Los Angeles Abrasion percent wear shall be limited to a maximum of 40 percent after 500 revolutions, when tested in accordance with AASHTO T 96.

Coarse aggregate shall consist of clean, tough, durable particles, practically free from clay, shale, coatings of any character, disintegrated or soft pieces, conglomerates, mud balls, sticks, salt, alkali, or vegetable matter.

Crushed stone or crushed gravel from different sources may be combined in the mix when batched separately in recommended proportions upon written permission of the Engineer.

At least 70 percent of all aggregate retained on the no. 4 sieve in the combined mix shall be crushed stone or mechanically crushed gravel having two or more fractured faces and shall contain not more than 15 percent of flat and elongated pieces. (A flat and elongated piece is one in which the length is greater than five times the average thickness.)

C. Gradation. The coarse aggregate shall be well-graded within the limits of the following table:

PERCENTAGE BY WEIGHT PASSING LABORATORY SIEVES HAVING SQUARE OPENINGS IN INCHES					
SIEVE SIZE	**NO. 3 (2" TO 1")**	**NO. 357 (2" TO #4)**	**NO. 57 (1" TO #4)**	**NO. 67 (_" TO #4)**	**NO. 7 (_" TO #4)**
2"	100	100			
2"	90-100	95-100			
1"	35-70	100			
1"	0-15	35-70	95-100	100	
¾"			90-100	100	
½"	0-5	10-30	25-60	90-100	
3/8"			20-55	40-70	
No. 4		0-5	0-10	0-10	0-15
No. 8			0-5	0-5	0-5
No. 200	0-1.5	0-1.5	0-1.5	0-1.5	0-1.5

1. Coarse aggregate for Class A and Class AA concrete shall be furnished in the No. 57 size only, except that coarse aggregate for pavements and base courses may be furnished, in the No. 3 and No. 57 sizes, combined. When two separate sizes are used, the batch requirement of each size shall be between 35 and 65 percent of the total quantity of coarse aggregate required for each batch.

2. Coarse aggregate for massive Class A concrete shall be furnished in the No. 357 size. Coarse aggregate for Class C concrete may be either No. 57 or No. 357.

3. Coarse aggregate for thin section concrete shall be furnished in the No. 7 size.

4. Coarse aggregate for Class P5 or P6 concrete shall be furnished in the No. 67 size.

701.07 CURING AGENTS. Concrete curing agents shall consist of burlap, earth, waterproof paper, white or red-pigmented membrane curing compound, polyethylene film, linseed oil emulsion or water for ponding. The curing agents shall be reasonably free from ingredients which may damage or be detrimental to the surface of the concrete.

A. Burlap. Burlap cloth shall conform to AASHTO M 182, Class 3 or better.

Burlap shall be new burlap or burlap which has been used for no purpose other than the curing of concrete. New burlap, not previously used for curing concrete, shall be reasonably free from starch, filler, or other substances

added during the process of manufacturing, or shall be washed by repeated rinsing in clear water until reasonably free from such substances. Worn burlap or burlap with holes will not be permitted. Burlap shall be at least 2 feet longer than the width of the pavement slab.

B. Earth. Earth used in curing concrete pavement shall be reasonably free of roots, sticks, stones, or other ingredients which may be detrimental to the surface of the concrete, and shall be of such nature as to retain moisture.

C. Water for Ponding and Material for Dikes. Water for ponding shall be reasonably free from salt, acid, alkali, oil or any substance that would injure or discolor the surface. Water suitable for use in mixing portland cement concrete will be satisfactory to use for ponding. Material for dikes shall be loam, sand, clay or any combination of the above, free from rocks, sticks or any objects that would prevent formation of a watertight dike.

D. Liquid Membrane Forming Compounds. Liquid membrane forming compounds shall conform to AASHTO M 148 with these exceptions:

The Type 2, white pigmented compound hiding power shall have an apparent daylight reflectance of not less than 65 percent compared to magnesium oxide as determined by ASTM E 97.

The Type 1-D compound shall be colored by a red fugitive dye so that inspection may indicate complete coverage. The color must be maintained at least 4 hours after which it should gradually disappear.

When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent.

E. Sheet Materials. Sheet Materials shall conform to AASHTO M 171. Sheet Material not specifically defined in AASHTO M 171 may be approved providing all other requirements of AASHTO M 171 are met.

The sheeting material shall be fabricated into sheets of such width as to provide a complete cover for the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint.

Sections of membrane which have lost their moisture retaining qualities shall not be used.

F. Linseed Oil Emulsion. Linseed oil emulsion shall comply with the following table of composition:

COMPOSITION	WEIGHT PERCENT
Oil Phase (50% min. by volume)	
Boiled linseed oil	97.0 + 0.1
Saturated Tallow Alcohols	3.0 + 0.1
	100.0
Water Phase (50% Max. by volume)	
Water	99.60 + 0.01
Sodium hydroxide	0.37 + 0.01
Dipicolinic acid	0.03 + 0.001
	100.00

The emulsion shall be stable at the time of application.

Moisture Retention. When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent when applied at the rate of 175 square feet per gallon.
Containers. All linseed oil emulsion furnished under this Specification shall be in plastic containers. Each container shall be marked or labeled with the manufacturer's name, contents Linseed Oil Emulsion, lot number and date of manufacture.

701.08 JOINT FILLERS AND SEALERS. This Subsection establishes the requirements for joint fillers and sealers for portland cement concrete.

A. Preformed Expansion Joint Filler (Bituminous Type). This joint filler shall conform to the requirements of AASHTO M 33. This type filler should not be used in joints for which the Plan detail requires a sealer.

B. Pre-formed Expansion Joint Fillers. (Non-extruding and Resilient Types).

1. *Non-Bituminous Joint Filler.* The non-bituminous joint filler shall conform to the requirements of AASHTO M 153.

2. *Bituminous Joint Filler.* The bituminous joint filler shall conform to the requirements of AASHTO M 213, except that the maximum permissible load to compress the test specimen to 50 percent of its thickness before testing shall be 1500 pounds per square inch. Compliance with the asphalt content requirement is waived providing the material meets all other physical requirements as specified.

C. Pre-formed Elastomeric Compression Joint Sealer.

1. *Description.* These Specifications cover pre-formed elastomeric compression joint sealers for use in portland cement concrete pavements and concrete bridge floors.

2. *Materials.*

   2.1 *Pre-formed Joint Seals.* The joint seals shall be manufactured from an elastomeric material that is resistant to heat, oil, jet fuel and ozone. The material shall be compatible with concrete and shall conform to the physical requirements of AASHTO M 220. All tests will be made on samples taken from the pre-formed joint sealer.

   2.2 *Shape and Dimensions.* The molded joint seals shall be of cross-sectional dimensions, lengths and tolerances shown on the Plans. The sealer shall be one piece for the full length of the transverse joint and in the practical lengths for longitudinal joints.

   Elongation of the joint material of more than 2 percent during placement will require the pre-formed elastomeric compression joint sealer to be removed and replaced.

   2.3 *Inspection.* Representative sections of each lot shall be subject to surface and dimensional inspection by the Engineer to determine visual compliance with applicable requirements of this Specification which do not require physical tests.

   2.4 *Lubrication Adhesive.* Any lubricant adhesive used shall be compatible with the sealer and the concrete and relatively unaffected by the normal moisture in the concrete. The lubricant adhesive shall be a compound consisting of the same base polymer as the sealer, blended with a suitable volatile solvent. It shall maintain a suitable consistency at the temperature at which the seal is installed.

   2.5 *Certification.* A Type A certification will be required for each lot or shipment of materials.

   Any cracking visible after recovery testing is basis for rejection.

D. Polymer Type, Two Component Cold Applied Machine Extruded and Pourable Joint Sealer.

1. *Description.* These Specifications cover two component, polymer type, rubberlike, cold applied joint sealing compounds for use in portland cement concrete pavements and bridge floors.

A primer, when recommended by the manufacturer, shall be used in accordance with the manufacturer's recommendation.

The shape of the joint and joint sealer shall be as shown on the Plans.

2. *Materials.* Materials meeting Federal Specifications SS-S-200 may be used. The bond breaker recommended by the materials manufacturer shall be used as shown on the standard drawings.

   2.1 *Acceptance.* A Type A certification shall be furnished with each shipment or lot.

   2.2 *Packaging.* The joint sealer shall be packaged in sealed containers identified by the name of the manufacturer, the manufacturer's lot number, the date of manufacture and shall be bear instructions for mixing and application. Containers including the curing agent shall be marked "A", and the container including the polymer shall be marked "B".

   If a primer is required by the manufacturer, it must be so stated on Containers "A" and "B". Proper instructions for use of the primer shall be given on its container.

   2.3 *Tests.* Tests shall be made in accordance with OHD L-21.

3. *Machine Extruded Joint Sealer.*

   3.1 *General.* The joint sealer shall be a modified poly sulfide or poly urethane polymer consisting of 2 components to be machine mixed and machine extruded directly into the joints.

   The poly sulfide components shall be mixed at a 1:1 ratio by volume and the poly urethane components shall be mixed in accordance with the manufacturer's recommendations.

   Upon opening, component B shall not exhibit more than a slight degree of skinning.

3.2 Properties of Laboratory Mixed Materials.

Penetration at 77° F **Penetration at 158° F**	**50 to 120** **1.5 Penetration at 77° F**
Cold Flow 3 minutes 40 minutes	 inch maximum inch maximum
Resilience at 77° F	70% minimum **60% minimum
Resilience of oven-aged sample at 7 days	70% minimum **60% minimum
Resilience at 158° F	60% minimum **50% minimum
Bond to concrete, 100% extension, dry, at -20° F, a/	No failure
Bond to concrete, 100% extension, dry, at -20° F, a/	No failure
Nonvolatile content	88% minimum

** This requirement applies if penetration at 77° F is 90 to 120.
a/ Cure Sample for 24 hours at 77° F, then oven age for 7 days at 158° F + 2° F.

4. Pourable Joint Sealer.

4.1 General. The joint sealer shall be a polymeric material consisting of two components to be uniformly mixed and poured directly into the joints. The weight of Component A in the mixture shall be not less than 10 percent of the weight used of Component B.

Upon opening, neither component shall exhibit more than a slight degree of skinning.

4.2 Properties of Laboratory Mixed Material.

DETERMINATION	REQUIREMENTS
Viscosity, 5 minutes after mixing	200 to 350 poises
Application time (Pot life or time to reach 2000 poises) at 77° F	1 hour minimum
Penetration at 77° F after 24 hours aging	150 maximum
*Penetration at 77° F	50 to 120
*Penetration at 158° F	1.5 x Pen @ 77° F
*Resilience at 77° F	70% minimum **60% minimum
*Resilience at 158° F	60% minimum **50% minimum
*Resilience of oven-aged sample at 7 days	70% minimum **60% minimum
Bond to concrete, 100% extension, dry, at -20° F a/ 100% extension, wet, at -20° F a/	 No failure No failure
Nonvolatile content	88% minimum

* After 96 hours aging at 77° F.

** This requirement applies if penetration at 77° F after 96 hours at 77° F is 90 to 120.

a/ Cure sample for 24 hours at 77° F, then oven age at 158° F + 2° F for 7 days before testing.

E. Low Modulus Joint Sealant.

1. *Description.* These Specifications cover low modulus silicone joint sealant and expanded polyethylene bond breaker rod for use in sealing portland cement concrete pavement joints. The silicone sealant shall be furnished in a one-part silicone formulation. Acetic acid cure sealants are not acceptable.

2. *Materials.*

   2.1 Silicone Sealant. The silicone sealant shall meet the current Federal Specification TT-S-001543 for Class A sealants except as modified by the following test requirements:

TEST	LIMIT	TEST METHOD
Flow	0.3 in. maximum	MIL S 8802
Extrusion Rate	75-250 gms/min.	MIL S 8802
Tack Free Time at 77° F and 45-55% R.H.	20-75 minutes	MIL S 8802
Specific Gravity	1.01 – 1.515	ASTM D 792 Method A*
Durometer, Shore A	10-27 max. @ 0° F	ASTM D 2240*
Tensile Stress at 100% Elong	75 psi maximum	ASTM D 412 Die C*
Elongation, %	500 minimum	ASTM D 412 Die C*

Concrete primer may be used if specified by the sealant manufacturer.
Note: *Cured 7 days at 77 + 4° F and 50 + 5 percent R. H.

2.1.1. Acceptance. The sealant shall be accepted on the basis of manufacturer's certification and approval by the Engineer in accordance with Subsection 106.12.

A Type A certification shall be furnished for the above listed test requirements.

A Type D certification shall be required for compliance with current Federal Specification TT-S-001543 in accordance with Subsection 2.1 of these Specifications.

2.1.2. Storage and Shelf Life. Storage and use of the joint sealant shall be in accordance with the manufacturer's recommended practices.

2.2. Bond Breaker Rod. The bond breaker rod shall be of the size and dimensions shown on the Plans. The bond breaker rod shall be compatible with the joint sealant and no bond or reaction shall occur between the rod and sealant.

F. Hot Poured Joint Sealer.

1. Description. Joint sealers furnished shall be of the hot poured type which readily bond to concrete surfaces.

2. Materials.

2.1 Sealer. Joint sealers used under these Specifications shall meet the requirements of Federal Specification SS-S-1401. The sealant material shall be heated for application to the temperature within

the range recommended by the manufacturer unless otherwise established by the Engineer.

2.1.1. Safe Heating Temperature. The safe heating temperature shall be set forth by the manufacturer and furnished with samples for approval. The safe heating temperature shall also be shown on all containers and packages in each shipment received at the job site.

2.1.2. Acceptance. Hot poured joint sealer furnished under these Specifications will be accepted for use upon receipt of a Type C certification in accordance with Subsection 106.12.

Sealer materials damaged by excessive or prolonged heating will be rejected.

2.2 Bond Breaker Rod. When shown on the Plans, the use of a bond breaker rod of the size and dimensions shown shall be required. The bond breaker rod shall be compatible with the joint sealant.

701.09 METAL PARTING STRIPS. These Specifications cover metal parting strips for use in forming longitudinal joints in concrete pavement or concrete base course.

Metal parting strips shall be shaped from metal of the sheet thickness shown on the Plans and shall be free from bends and kinks. It shall conform to the dimensions and be punched for pins and tie bars as shown on the Plans. Punching for pins may not be farther apart than 3 feet center to center. Sections of metal parting strips shall be not less than 10 feet in length and so designed that adjoining sections may be securely fastened together by lapping and pinning, by means of a slip joint, or other approved method.

701.12 PENETRATING WATER REPELLENT FOR TREATMENT OF CONCRETE SURFACES. *Description.* This Subsection covers the material requirements for penetrating water repellents for use on concrete surfaces.

A. General. The penetrating water repellent treatment solution shall consist of an organo silicon compound dissolved in a suitable solvent carrier that, when applied, will produce a hydrophobic surface covalently bonded to the concrete.

The organo silicon compound shall be one of the following:

Alkyl-Alkoxysilane
Oligomerous Alkyl-Alkoxysiloxane

The solvent shall leave less than one percent residue by weight upon evaporation.

The material shall have met the following performance criteria based on a single application of the solution in accordance with the manufacturer's recommended rate of coverage.

The penetrating water repellent treatment solution shall not stain, discolor or darken the concrete. Application of the solution shall not alter the surface texture or form a coating on concrete surfaces and shall be compatible with the use of special surface finish texture coatings specified in Subsection 509.04 O. Treated concrete shall be surface dry within 30 minutes after application.

B. Test of Treated Concrete Specimens.

1. Absorption:

TEST	DURATION	MAX. ABSORPTION	METHOD
Water	48 hours	1% by weight	ASTM C 642
Immersion	50 days	2% by weight	ASTM C 642

2. Chloride Ion Penetration:

TEST	DURATION	MAX. ABSORBED CL-	METHOD
Salt Water	90 days	0.75 lb. per cu. yd.	AASHTO T 259
Ponding*		Depth: ½ inch to 1 inch	AASHTO T 260

*****Based on non-abraded specimens.

3. Treatment:

TEST	MINIMUM DEPTH	METHOD
Penetration	0.15 inch	OHD L 34

4. Vapor Permeability. Treated concrete shall retain its moisture vapor permeability as determined by Oklahoma Department of Transportation Laboratory test procedure OHD L-35.

C. Certification. A Type A certification shall be submitted for approval.

A Type C Certification shall be submitted for each lot or shipment of material prior to use.

The manufacturer's recommended rate of coverage for the treatment solution as approved for use under these Specifications shall be included with the Type A and Type C certifications.

701.13 EPOXY RESIN ADHESIVES FOR GENERAL USE WITH CONCRETE. Description. This Subsection covers two component, epoxy-resin bonding systems for application to portland cement concrete.

A. General. Epoxy-resin adhesives for general use with concrete shall comply with AASHTO M 235.

If the type, grade and class of epoxy-resin are not specified on the Plans or in the Proposal, the Contractor shall furnish an epoxy-resin system that is appropriate for its intended use in accordance with AASHTO M 235.

Epoxy-resin adhesives for bonding pavement markers to pavement surfaces shall meet the requirements of Subsection 736.04 of these Specifications.

B. ***Acceptance.*** The Contractor shall furnish a Type A certification for each batch or lot of each component.

702.00 FLY ASH

702.01 DESCRIPTION. This Section covers fly ash to be used as an admixture for concrete and to modify or stabilize soils. Fly ash shall meet the requirements of ASTM C 618, Class C or Class F.

The product of only one plant shall be used on the project, unless otherwise approved by the Engineer. The Contractor shall provide suitable means of storing and protecting the fly ash against contamination and dampness. Fly ash which has become partially set, contains lumps of caked fly ash or has been contaminated will be rejected.

All methods of sampling and testing shall be in accordance with the requirements of ASTM C 311.

703.00 MINERAL AGGREGATE, MISCELLANEOUS USES

Description. This Specification covers the requirements of mineral aggregate intended for various uses not specifically covered in other sections of these Specifications.

703.01 AGGREGATE FOR AGGREGATE BASE.

A. Materials Covered. These Specifications cover the aggregate for use in the construction of aggregate base courses Section 303.

B. General Requirements. The aggregate base course material shall consist of an intimate mixture of graded aggregate, coarse and fine, and shall be practically free from vegetable or other deleterious substances. Coarse aggregate (material retained on a No. 10 sieve) shall consist of sound, tough, durable particles or fragments of gravel, stone, mine chats, disintegrated granite, crushed concrete, or other inert finely divided mineral matter.

At least 40 percent of that portion of the completed mixture retained on the No. 4 sieve shall be composed of uniformly graded crushed particles (pieces of aggregate with one of more fractured faces resulting from the artificial crushing).

C. Physical Properties. The coarse aggregate retained on the 3/8 inch sieve of the finished mixture shall have a percent of wear, Los Angeles Abrasion Test, of not more than 50. No source of material used in the blend shall have a percent of wear of more than 50.

D. Gradation. The graded aggregate when uniformly blended and sampled from trucks or windrows shall conform to the following requirements depending on the type being used. Materials for base courses which contain oversize particles of rock, gravel, lumps of clay or conglomerated material shall not be loaded into vehicles for delivery to the road. Such oversize particles of aggregate must be screened, crushed or otherwise processed to meet the Specifications before delivery to the road. The samples taken from trucks or windrows after the graded aggregate has been uniformly blended, shall conform to the gradation limits for the type being constructed, as follows:

SIEVE SIZE	PERCENT PASSING	
SQUARE	TYPE A	TYPE B
3 in.		100
1½ in.	100	40-100
¾ in.	40-100	30-75
3/8 in.	30-75	25-60
No. 4	25-60	20-50
No. 10	20-43	15-35
No. 40	8-26	7-22
No. 200 a/	4-12	3-10

a/ Note: The material passing the No. 200 sieve shall not be greater than 2/3 of the amount of material passing the No. 40 sieve.

E. Characteristics of material passing the No. 40 sieve.

For all types, the material passing the No. 40 sieve shall conform to the following:

The plasticity index shall not exceed 6

The liquid limit shall not exceed 25

The blending of separate aggregates will be permitted to produce an aggregate mixture meeting the above requirements providing no individual aggregate has a plasticity index in excess of 8.

F. Sampling and Testing. Tests shall be conducted in accordance with the latest revision of the following AASHTO Methods except as noted:

Los Angeles Abrasion	T 96
Sieve Analysis	T 27
Sampling	T 2
Determining Plastic Limit & Plasticity Index	T 90
Fractured Faces	OHD L-18
Method of Preparation of Samples	T 87
Determining Liquid Limit	T 89
Standard Density	Method D

703.02 COVER AGGREGATES FOR BITUMINOUS SURFACE TREATMENTS.

A. Material Covered. This section establishes the requirements for aggregate to be used in construction of various items throughout these specifications.

B. General Requirements. The aggregate shall consist of clean, sound and durable particles of mine chats, crushed gravel, or crushed stone. The

material shall be of uniform quality throughout with not more than 5 percent of slate, shale or soft stone particles and shall be substantially free from organic matter, clay, loam, or objectionable coating. A minimum of 75 percent of the aggregate retained on the No. 4 sieve shall have 2 or more mechanically fractured faces.

The aggregate shall be reasonably dry when placed.

After the work starts, the same kind of material shall be used throughout the project unless otherwise permitted in writing by the Engineer.

C. Physical Properties. The aggregate shall conform to the following requirements:

Los Angeles Abrasion, % wear	40 max.
Durability, Dc Factor	40 min.
Flat or elongated pieces, % (length is greater Than 5 times the average thickness)	15 max.

D. Gradation. The gradation requirements for aggregates shall be as follows:

PERCENT PASSING			
Sieve Size	**No. 1 Aggregates**	**No. 2 Aggregates**	**No. 3 Aggregates**
¾ in.	100		
5/8 in.			100
½ in.	25-60	100	90-100
3/8 in.	0-15	90-100	40-75
No. 4	0-5	0-25	0-15
No. 8		0-5	0-5
No. 200	0-2	0-2	0-2
*Dust Coating	0-1	0-1	0-1

*Dust Coating on aggregates retained on No. 8 sieve shall be determined by wash loss (AASHTO T 11) after dry sieving.

The specific gradation of gradations shall be used throughout the project unless otherwise permitted in writing by the Engineer.

E. Pre-coated Cover Aggregates. When pre-coated material is specified, cover aggregate meeting the above Specification requirements shall be treated with bituminous material meeting the requirements of Subsection 708.03. The application of bituminous material is to be within the range of 0.30 to 1.75 percent by weight of the untreated aggregate, depending on the type and grade of bituminous material applied. The quantity applied shall be sufficient to satisfy the particular needs of surface absorption, dust dissipation and film coating of the aggregate to be treated. The coating shall be durable and free

of scales and blisters. When applied to the road, it shall be free of excess binder or moisture which might hinder the handling, spreading or rolling operations. The producer shall obtain the approval of the Materials Engineer pertaining to the type, grade, and amount of asphalt treatment prior to starting production.

The producer shall consistently ascertain that the aggregate is free of surface or absorbed moisture which will interfere with binder absorption and adhesion, or cause blisters or subsequent scaling of the treatment. However, when it is advisable or necessary to facilitate uniform coating of the aggregate with the bituminous material, water may be added at the pugmill in an amount not to exceed 2 percent by weight of the aggregate. When heating is required, or elected by producer, he shall maintain the bituminous materials at temperatures below the flash points or damaging temperatures. The temperatures of asphalt materials shall be within the mixing range for the particular type and grade as shown in Subsection 708.03 C. during application of the asphalt material to the aggregate.

Flow quantities of the treated aggregate shall be such that it may be satisfactorily spread by approved mechanical spreading devices.

The required percent of asphalt for pre-coating the aggregate shall be determined by inspection of the type and grade of bituminous material and aggregate used.

F. Sampling and Testing. Sampling and testing shall be conducted in accordance with the following AASHTO methods except as noted:

Sampling	T 2
Sieve Analysis	T 27
Los Angeles Abrasion	T 96
Dust Coating	
(Plus No. 8 material after dry sieving)	T 11
Durability, Dc Factor	T 210
Soft Particles	OHD L-38
Fractured Faces	OHD L-18

703.03 AGGREGATES FOR TRAFFIC BOUND SURFACE COURSE.

A. Materials Covered. This Subsection covers the requirements and test methods for aggregates to be used in the construction of traffic bound surface course in Section 403.

B. General Requirements. Traffic bound surface course material shall consist of an intimate mixture of graded aggregate, coarse and fine, and shall be practically free from vegetation or other deleterious substances. Coarse aggregate, material retained on a No. 10 sieve, shall consist of sound, tough, durable particles or fragments of gravel, stone, mine chats, disintegrated

granite, or combination thereof, crushed to size if necessary. Fine aggregate shall consist of sand, stone dust, or other inert finely divided mineral matter.

C. Physical Properties. The coarse aggregate retained on the 3/8 inch sieve of the finished mixture shall not have a percent wear of more than 40 when tested in accordance with the Los Angeles Abrasion Test.

D. Gradation. This Specification permits the selection and use of one of 5 gradations or types of surface course. The type required on the project may be specified in the bid item of the Proposal. When the type is not so specified, the Contractor may select the gradation or type in advance of construction. The material produced or processed shall conform in gradation for the type specified or selected. After work starts the same type of material as specified or selected shall be used throughout the project unless otherwise permitted in writing by the Engineer.

If the Contractor elects to deliver oversized particles of rock, gravel, lumps of clay or conglomerate materials to the road, all oversize material shall be crushed to meet the Specification sizes and shall then be incorporated in the surfacing material.

PERCENT PASSING					
SIEVE SIZE	**TYPE A a/**	**TYPE B b/**	**TYPE C c/**	**TYPE D d/**	**TYPE E e/**
1 ½ in.				100	
1 in.	100	100	100	90-100	
¾ in.	95-100	95-100			
½ in.				25-60	
No. 4	5-75	0-85	40-75	0-5	
No. 20	0-30				
No. 40			20-40		
No. 200	0-10	0-20	8-25		
Plasticity Index			8-18		
Liquid Limit			Not more than 35		

a/ Type A material shall consist of hard durable particles of sand, gravel, mine chats, crushed rock or a combination of these materials.

b/ Type B material shall consist of hard, durable particles of disintegrated granite with natural binder.

c/ Type C material shall produce a bonded traffic bound surface course and shall consist of an intimate mixture of graded aggregate, coarse and fine. Coarse aggregate (material retained on a No. 10) sieve shall consist of sound, tough, durable particles or fragments of gravel, stone, disintegrated granite or combination thereof, crushed to size if necessary.

Fine aggregate shall consist of sand, stone dust, or other inert finely divided mineral matter.

d/ Type D material shall consist of hard durable particles of gravel or crushed stone.

e/ Type E material shall meet the requirements for Aggregate Base, Type A in Subsection 703.01.

E. Sampling and Testing. Applicable methods of Subsection 703.01 F. shall apply.

703.04 COVER MATERIAL FOR PIPE UNDERDRAINS.

A. Coarse Cover Aggregate. Coarse cover material shall be gravel or crushed stone with a minimum durability, Dc factor, of 40, a maximum abrasion loss of 50 and shall conform to the following gradation requirements:

Passing ½ inch sieve	100%
Passing 3/8 inch sieve	90-100%
Passing No. 4 sieve	20-55%
Passing No. 16 sieve	5-30%
Passing No. 50 sieve	0-10%
Passing No. 100 sieve	0-5%

B. Filter Sand. Filter sand shall be well-graded sand and conforming to the following requirements:

Passing 3/8 inch sieve	100%
Passing No. 4 sieve	95-100%
Passing No. 8 sieve	45-85%
Passing No. 16 sieve	5-30%
Passing No. 50 sieve	0-10%

C. Sampling and Testing. Sampling and testing shall be in accordance with the following AASHTO methods:

Sampling	T 2
Sieve Analysis	T 27
Durability, Dc Factor	T 210
Los Angeles Abrasion, % loss	T 96

704.00 SOIL AGGREGATES

704.01 SOIL AGGREGATES FOR SUB-BASES. *Description.* These Specifications cover the material for use in the construction of a sub-base foundation course in Section 306.

A. Materials. Sub-base material shall conform to the requirements listed herein for the type material designated on the Plans or in the Proposal. Unless otherwise shown on the Plans, the Contractor shall furnish soil aggregate for sub-bases. The Contractor shall make such preliminary investigations as may be necessary to locate the proposed source of acceptable material. Information obtained by the Department in its preliminary investigations will be available to prospective bidders at the Materials Laboratory. Sub-base materials shall meet the specified requirements before incorporation in the work. No material shall be delivered to the roadbed when the plasticity index exceeds the specified requirements by more than 2 points.

Type I. Sub-base material to be used in this work shall pass a 2 inch sieve. Any material hauled on the project which does not reduce to 2 inches or less shall be removed from the right-of-way limits.

The material passing the 2 inch sieve and retained on the No. 10 sieve shall be composed of sound and durable particles. Lumps or clods will be broken down for testing.

The fraction passing the No. 10 sieve shall conform to the following gradation:

Passing the No. 200 sieve, 5 percent – 45 percent

The soil constants determined for the fraction passing the No. 40 sieve shall be as follows:

Liquid Limit not more than	30
Plasticity Index not more than	10

Type II. Sub-base material to be used in this work shall be produced from approved sandstone deposits including pack sand and non-solidified sand in the same deposit. Unsuitable overburden shall be stripped as directed by the Engineer and production shall exclude clay pockets and deleterious shale beds.

The sandstone material shall have a Jar Slake test value of 4, 5, or 6.

The sandstone material shall be crushed sufficiently to produce 100 percent passing the 3-inch sieve and to secure the specified density and finish requirements. If the Contractor so elects, the material may be crushed on the roadbed.

Samples shall be prepared for test by crushing or pulverizing in the laboratory. The fraction passing the No. 10 sieve shall conform to the following gradation:

Passing the No. 200 sieve, 5 percent to 45 percent

The soil constants, determined for the fraction passing the No. 40 sieve shall be as follows:

Liquid Limit no more than	30
Plasticity Index not more than	10

Type III. Sub-base material to be used in this work shall be a soil aggregate obtained from an approved source. Material retained on the No. 10 sieve shall be composed of sound and durable particles or fragments of sand, gravel, crushed stone, crushed concrete, mine chat, disintegrated granite, stone screening or a blend of these materials. The gradation and soil constants shall conform to the requirements of the table for grading A, B, and C. The grading for Type III Sub-base shall be as specified on the Plans or in the Proposal.

Processing, including blending may be necessary to comply with the grading or soil constants requirements for the grading specified.

TABLE REQUIREMENTS FOR GRADING AND SOIL CONSTANTS			
	PERCENTAGE BY WEIGHT PASSING		
SIEVE SIZE SQUARE	GRADING A	GRADING B	GRADING C
2 ½ in.	100		
2 in.	90-100	100	100
1 ½ in.	60-100	95-100	95-100
3/8 in.	30-75		
No. 4		45-100	
No. 10	15-50	25-100	55-100
No. 40	8-35	10-50	30-70
No. 200	3-20	3-20	8-25
Liquid Limit	-35	-35	-30
Plasticity Index	-15	-12	-10

The fraction passing the No. 200 sieve shall not be greater than 2/3 of the fraction passing the No. 40 sieve.

Type IV. Sub-base material to be used in this work shall meet the requirements for Type III, Grading B, with the additional requirements that the soil constants as determined for the fraction passing the No. 40 sieve shall be:

Liquid Limit not more than	25
Plasticity Index not more than	6

B. Sampling and Testing. Sampling and testing shall be done in accordance with the following AASHTO methods:

Sampling	T 2
Sieve Analysis	T 88
	(omitting Hydrometer Test)
Preparing Samples	T 87
Liquid Limit	T 89
Plastic Limit and Plasticity Index	T 90
Jar Slake Test	OHD L-37
Standard Density	T 99

704.02 SOIL AGGREGATE FOR SAND CUSHION. *Description.* These Specifications cover the material for use as sand cushion for concrete in Section 308.

A. Materials. Sand cushion shall all pass a one-inch sieve and shall contain 5 to 35 percent of material passing the No. 200 sieve. The final material shall have a liquid limit not exceeding 35 and a plasticity index not to exceed 8.

The material shall consist of natural sand, or subject to approval, combinations of manufactured and natural sand, having hard, strong, durable particles and shall conform to these Specifications.

When manufactured sand is approved for use in combination with natural sand, at least 50 percent of the total material shall be natural sand.

B. Sampling and Testing. Sampling and testing shall be in accordance with AASHTO methods except where otherwise specified.

Sampling	T 2
Sieve Analysis	T 27
Liquid Limit	T 89
Plastic Limit & Plasticity Index	T 90
Standard Density	T 99

704.04 SOIL AGGREGATE FOR CEMENT TREATED BASE. *Description.* This Subsection covers the requirements and test methods for soil aggregate for cement treated base in Section 312.

A. Source of Materials. Suitable soils meeting these requirements shall be obtained from sources furnished by the Contractor and approved by the Engineer. The Contractor will be responsible for testing both the suitability and adequacy of the source proposed for use.

The Contractor shall make such preliminary investigations as may be necessary to locate the proposed source of suitable material.

The Contractor shall open the proposed source of suitable soil for the Engineer to inspect. Such explorations as are necessary shall be made by the Contractor to obtain sufficient samples to be fully representative of the deposit. Each sample shall be representative of the full depth proposed for use. Tests of these samples will be made to determine if the material is suitable, the extent of the suitable material, and the proportioning of portland cement required. Sampling and testing of the proposed source in advance of construction operations is required.

Tests to determine the cement requirements will be made only from samples obtained.

Excavation and production of the suitable material shall be done in a manner to deliver to the mixer a homogenous mixture represented by the samples which were used to determine the cement requirement.

B. ***Soil.*** The soil aggregate to be used in the soil-cement base shall be sand, sand-gravel, silty sand, sand-clay, silt clay soil, limestone screenings, sandstone, or jig sand obtained from approved sources and shall be free of roots, sticks and sod tufts and reasonably free of deleterious concentrations of other organic matters, acids and minerals. It shall meet the following requirements prior to addition of cement:

Passing the 2 inch sieve	100%
Passing the 1 inch sieve	95-100%
Passing the No. 4 sieve	Not less than 55%
The silt and clay fraction (smaller than 0.05 mm)	Not more than 50%
The clay and colloid fraction (smaller than 0.005 mm)	Not more than 20%
The liquid limit	Not more than 35
The plasticity index	Not more than 9

C. ***Mixtures.*** The proportions of soil-cement and water for each soil shall be determined by laboratory tests.

D. Sampling and Testing. Sampling and testing shall be done in accordance with the following AASHTO methods:

Sampling	T 2
Water	T 26
Preparation of Samples	T 87
Mechanical Analysis	T 88
Liquid Limit	T 89
Plastic Limit and Plasticity Index	T 90
Target Density	T 134

The target density shall be determined in the field by moisture density tests on representative samples of cement treated mixture obtained from the roadway. The test method for the target density is AASHTO T 134 modified to provide one compacted specimen of the soil-cement mixture as obtained from the roadway, and separate portions of the sample used for additional specimens with the moisture reduced or increased. The soil-cement mixture shall be mixed and compacted within + 2 percentage points of optimum moisture content specified by the Engineer before there is any appreciable moisture loss.

705.00 SELECT BORROW

Description. This Subsection covers the requirements and test methods for select borrow in Subsection 202.02 F.

705.01 MATERIALS.

A. General Requirements. Select borrow for use under these Specifications shall be a material meeting the following group classifications and group index values as defined in AASHTO M-145.

GROUP CLASSIFICATION	GROUP INDEX (MAXIMUM VALUE)
A-1	(0)
A-2-4	(0)
A-3	(0)

This soil group shall be limited to a maximum of 40 percent passing the No. 200 sieve.

When a lens, layer or stratum of material is found in a borrow pit or roadway cut and is intended for use by the Contractor which does not comply with the specified requirements, it may be included in the mixture if a uniform blend of acceptable material will result from the blending and mixing accomplished in the production, loading, handling and placement operations, in the normal course of construction. Any additional testing shall be done by the Contractor at his expense if unsuitable material is used.

The material shall be uniform in gradation and plastic properties throughout the entire plan depth.

Unless otherwise provided, the Contractor shall furnish all materials for select borrow. The Contractor shall make such preliminary investigations as may be necessary to locate and verify the proposed source of acceptable material.

B. Sandstone. If select borrow is specified to be from a sandstone or sand rock formation, the material shall be produced from approved sandstone deposits including pack sand and non-solidified sand in the same deposit. Unsuitable overburden shall be stripped as directed by the Engineer and production shall exclude clay pockets and deleterious shale beds.

The sandstone material shall have a Jar Slake test value of 4, 5 or 6.

The sandstone material shall be crushed sufficiently to produce 100 percent passing the 3-inch sieve and to secure the specified density and finish requirements. If the Contractor so elects, the material may be crushed on the roadbed.

Samples shall be prepared for test by crushing or pulverizing in the laboratory. The fraction passing the No. 10 sieve shall conform to the following gradation:

Passing the No. 200 sieve	5-45%

The soil constants, determined for the fraction passing the No. 40 sieve shall be as follows:

Liquid Limit not more than	30
Plasticity Index not more than	10

C. Testing. Testing shall be in accordance with the following AASHTO Methods except as noted:

Sieve Analysis	T 88 (Omitting Hydrometer Test)
Preparing Samples	T 87
Liquid Limit	T 89
Plastic Limit & Plasticity Index	T 90
Jar Slake Test	

706.00 LIME

Description. These Specifications cover lime requirements for lime treatment of soils in Section 307.

706.01 HYDRATED LIME.

A. Definition. Hydrated lime for stabilization shall consist essentially of a calcium hydroxide with a lesser amount of calcium oxide, magnesium oxide and magnesium hydroxide made from a dry powder obtained by treating quick-lime with enough water to satisfy its chemical affinity for water under the conditions of its hydration.

B. Chemical Composition. When tested under the appropriate sections of ASTM C 25, the lime shall conform to the following requirements:

Available calcium hydroxide.
Available lime index (as is basis) expressed as Ca(OH) 2 – Not less than 90 percent.

C. Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

Percent passing No. 20 sieve	99 or more
Percent passing the No. 200 sieve	80 or more

706.02 QUICK LIME.

A. Definition. Quick lime for stabilization purposes shall consist of a calcined material, the major part of which is calcium oxide or calcium oxide in natural association with a lesser amount of magnesium oxide capable of slaking with water.

B. Chemical Composition. When tested under the appropriate sections of ASTM C 25, the lime shall conform to the following requirements:

Available calcium hydroxide expressed as calcium oxide.
Available lime index (as is basis) expressed as CaO – not less than 90 percent.

C. Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

Percent passing the no. 200 sieve	90 or more
Slaking Temperature Rise	40° C or more
Total active Slaking Time	20 minutes or less

When tested in accordance with method OHD L-28 the lime shall conform to the following requirements:

Percent passing 5/8 in. sieve	95 or more
Percent passing the no. 200 sieve	15 or less

706.03 BY-PRODUCT LIME. By-product lime will be tested under the appropriate sections of ASTM C 25 to determine the available lime index (by rapid sugar method) expressed as available calcium hydroxide Ca(OH).

Calculations will be based on the dry weight of the material. Sufficient tonnage of the by-product lime shall be required to provide an equivalent amount of available lime based on 90 percent availability per ton (dry weight) of hydrated lime.

706.04 AGRICULTURAL LIMESTONE. Agricultural limestone shall be a high calcic or dolomitic limestone having a neutralization value of at least 80 percent of calcium carbonate. It shall be of such fineness that 100 percent passes the No. 4 sieve, at least 90 percent passes the No. 8 sieve, and at least 30 percent passes the No. 60 sieve. The neutralization value and sieve analysis shall be in accordance with ASTM C 602. The material shall be free from harmful quantities of toxic salts and other objectionable matter.

708.00 PLANT MIX BITUMINOUS BASES AND SURFACES

Description. This Section covers the materials requirements, mix designs, proportioning, mix tolerances, and sampling and testing methods for plant mixed bituminous bases and surfaces.

708.01 APPROVAL OF MATERIALS. Prior to use, aggregate sources and percentage of blends must be approved by the Engineer.

The aggregate shall be stockpiled in accordance with Subsection 106.07 and may be accepted in stockpile at the plant site. The plant mixed materials may be accepted after blending and mixing at the plant. Asphalt must be obtained from an approved source and may be conditionally accepted in accordance with Subsection 708.06 B.

708.02 MINERAL AGGREGATE. The mineral aggregate shall be composed of coarse aggregate, fine aggregate and mineral filler as required to meet these Specifications. If natural gravel is to be crushed for use in any of the mixes, a washing operation may be required to provide complete separation of all fines which may be stuck to the gravel. In no case will the blending of different material in the same storage or feeder be permitted.

The aggregates shall meet the requirements set forth in Table 1.

The use of a crusher run or similarly graded aggregate shall not be the sole source of crushed coarse aggregate in asphalt concrete, Types A, B and C.

A. Coarse Aggregate. The coarse aggregate shall be that part of the aggregate retained on the No. 10 sieve and shall consist of clean, tough, durable particles. It shall be practically free from soft and disintegrated pieces, shale, clay, organic or other injurious matter occurring either free or as a coating on the aggregate.

Natural gravel shall not be used a source of insoluble material unless it has been crushed so that at least 75 percent of the material retained on the No. 4 sieve has two or more mechanically fractured faces. The natural gravel used as a source of insoluble materials shall have not more than 30 percent passing the No. 4 sieve after crushing except when used in asphalt concrete, Type D.

B. Fine Aggregate. Fine aggregate shall be that part of the aggregate passing the No. 10 sieve and shall consist of hard, durable grains of natural sand, crushed stone, stone dust, crushed gravel, mine chat or jig-sand or any combination of these materials. Crushed materials shall be produced from material conforming to the requirements of coarse aggregate.

When used in the wearing course, the material in the natural sand passing the no. 200 sieve shall be less than 50 percent of that contained in the combined aggregate including mineral filler.

C. Mineral Filler. Mineral filler, when required in addition to that naturally contained in the aggregate, shall conform to AASHTO M 17.

TABLE 1 PHYSICAL PROPERTIES OF AGGREGATES		
Aggregates to be used in:		
TEST	**ASPHALT CONCRETE**	**HOT MIX COLD**
L. A. Abrasion (max. % wear) a/	40	40
Sand Equivalent (min.) b/ Wearing Course Base or Binder	 45 40	 45 40
Mechanically fractured Faces (min. %) b/ c/	75 w/2	75 w/2
Durability Dc factor (min.) a/	40	40
Insoluble residue (min. %) d/ e/	30	NA
Flat or elongated pieces (max. %) b/ c/ f/	15	15
Clay balls and Friable Particles (max. %) g/	1.0	1.0
Soft particles (max. %) a/	5	5
Sticks or roots (max. %) a/	0.5	0.5

a/ Applies to each source except as noted.
b/ Applies to the combined aggregate except as noted.
c/ Applies to the aggregate retained on the No. 4 sieve.
d/ Applies to the combined coarse aggregate.
e/ The coarse aggregate used in the asphalt concrete surface course, shoulders and detours excepted, shall contain not less than 30 percent insoluble residues.
f/ A flat or elongated piece is one in which the length is greater than five times the average thickness.
g/ Applies to the combined aggregate. Provided the maximum for the combined aggregate is not exceeded, a maximum 1.5 percent will be allowed for any one source.

708.03 ASPHALT MATERIALS.

A. General. Bituminous materials shall meet the requirements shown in Tables 2A through 2E for the type and grade of asphalt material specified.

B. Handling. The handling, loading, hauling, transfer pumping or similar operations connected with the movement of bituminous materials shall be in compliance with the requirements of the manufacturer, and/or the Engineer. If at any time materials furnished for use under these Specifications fail to produce satisfactory results, further shipments will be rejected. The material will not be accepted for further work until the producer satisfies the Engineer that the material has been so corrected as to produce satisfactory results.

C. ***Application Temperature.*** The temperature to which asphalt materials shall be heated at the time of use shall be as shown in Table 2E, unless otherwise specified.

TABLE 2A

REQUIREMENTS FOR ASPHALT CEMENT GRADED BY VISCOSITY AT 140° F
(Grading based on original asphalt)
Asphalt cement shall be prepared from crude petroleum by suitable methods, shall be homogeneous, free from water, and shall not be heated to 347° F.

	VISCOSITY GRADE			
TEST	**AC-3.5**	**AC-7.5**	**AC-10**	**AC-20**
Viscosity, 140° F, poises	350 + 70	750 + 150	1000 + 200	2000 + 400
Viscosity, 275° F, Cs-minimum	145	215	250	300
Penetration, 77° F, 100 g. 5 sec.	220-300	110-160	80-125	60-100
Flash Point, COC, ° F minimum	350	400	425	450
Solubility in trichloroethylene, percent minimum	99.0	99.0	99.0	99.0
Test on residue from Rolling Thin-Film Oven Test:				
Loss on heating, percent-maximum		1.0	1.0	1.0
Viscosity, 140° F, poises-maximum	1500	3000	4000	8000
Ductility 77° F, 5 cm per minute, cm-minimum	100 a/	100	75	5
Spot test with Standard Naptha Solvent	Negative for all grades			

a/ If ductility is less than 100, the material will be accepted if its ductility at 60° F is 100 minimum.

TABLE 2B
REQUIREMENTS FOR CUT-BACK ASPHALT (MEDIUM CURING TYPE)
Cut-back asphalt shall be produced by fluxing an asphalt base with suitable petroleum distillates, shall show no separation or curdling prior to use, and shall not foam when heated to application temperature.

	MC-30		MC-70		MC-250		MC-800		MC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140° F Centistokes	30	60	70	140	250	500	800	1600	3000	6000
Flash Point (Tag, open-cup), degrees F	100		100		150		150		150	
Water percent Distillation test:		0.2		0.2		0.2		0.2		0.2
Distillate percentage by volume of Total distillate to 680° F										
to 437° F		25	0	20	0	10				
to 500° F	40	70	20	60	15	55	0	35	0	15
to 600° F	75	93	65	90	60	87	45	80	15	75
Residue from distillation to 360° C 680° F Volume percentage of sample by difference	50		55		67		75		80	
Tests on residue from distillation:										
Absolute viscosity at 140° F, Poises	400	1200	400	1200	400	1200	400	1200	400	1200
Ductility, 5 cm/min., cm. a/	100		100		100		100		100	
Solubility in Trichlorethylene, percent	99.0		99.0		99.0		99.0		99.0	
Standard Naptha	Negative for all grades									

a/ If the ductility at 77° F is less than 100, the material will be acceptable if its ductility at 60° F is more than 100.

TABLE 2C
REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

Type	Rapid-Setting				Medium-Setting					
Grade	RS-1		RS-2		MS-1		MS-2		MS-2h	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Tests on emulsion:										
Viscosity, Saybolt Furol at 77° F, s	20	100			20	100	100		100	
Viscosity, Saybolt Furol at 122° F, s			150	400 c/						
Storage stability test, 24-h, %		1		1		1		1		1
Demulsibility, a/ 35 ml., 0.02 N CaC1^Q, %	60		60							
Coating ability and water resistance										
Coating					Good		Good		Good	
Coating Retention					Fair		Fair		Fair	
Sieve Test, %		0.10		0.10		0.10		0.10		0.10
Residue by distillation, %	55		63		55		65		65	
Tests on residue from distillation test:										
Viscosity, 140° F, poises d/	400	1200	400	1200	400	1200	400	1200	1600	4800 d/
Penetration, 77° F, 100 g, 5a	100	200	100	200	100	200	100	200	40	90
Ductility, 77° F, 5 cm/min, cm	40		40		40		40		40	
Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5	

Typical applications b/:

For RS-1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.
For RS-2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).
For MS-1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat.

For MS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.

For MS-2h: Cold plant mix, hot mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat.

TABLE 2C (CONTINUED)												
TYPE	**HIGH FLOAT**								**SLOW SETTING**			
GRADE	**HFMS-1**		**HFMS-2**		**HFMS-2H**		**HFMS-2s**		**SS-1**		**SS-1h**	
	Min.	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Tests on emulsions:												
Viscosity, Saybolt Furol at 77° F, s	20	100	100		100		50		20	100	20	100
Viscosity, Saybolt Furol at 122° F, s												
Storage stability test, 24-h, %		1		1		1		1		1		1
Coating ability and water resistance:												
Coating Coating Retention	Good Fair		Good Fair		Good Fair		Good Fair		Good Fair		Good Fair	
Cement mixing test, % Sieve test, % Residue by distillation, %	0.10 55		0.10 65		0.10 65		0.10 65		2.0 0.10 57		2.0 0.10 57	
Tests on residue from distillation test:												
Viscosity, 140° F, poises Penetration, 77° F 100 g, 5 s Ductility, 77° f, 5 cm/min., cm Solubility in trichloroethylene, % Float test, 140° F, s	400 100 40 97.5 1200	1200 200	400 100 40 97.5 1200	1200 200	1600 40 40 97.5 1200	4800 d/ 90	200 200 40 97.5 1200	600	400 100 40 97.5	1200 200	1600 40 40 97.5	4800 d/ 90
Typical application b/: HFMS-1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat. HFMS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, and seal. HFMS-2h: Cold plant mix, hot plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat. HFMS-2s: Dense-graded cold plant mix and road mix, stockpile mix, crack treatment, patching mix. SS-1 & SS-1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.												

a/ The demulsibility test shall be made within 30 days from date of shipment.

b/ These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.
c/ Maximum viscosity at the point of manufacture shall be 500 seconds. The viscosity at the job site shall be from 100 to 400 seconds.
d/ Variability will be limited to + 600 poises from the target value established by the manufacturer.

TABLE 2D
REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogenous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE	Rapid-Setting				Medium-Setting				Slow-Setting			
GRADE	CRS-1		CRS-2		CMS-1		CMS-2		CSS-1		CSS-1h	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Tests on emulsions:												
Viscosity, Saybolt Furol at 77° F, s									20	100	20	100
Viscosity, Saybolt Furol at 122° F, s	20	100	150	400 d/	50	500	50	450				
Storage stability test, 24-h, % a/	1		1		1		1		1		1	
Demulsibility, a/ 35 ml 0.8% Sodium diocytl Sulfosucinate %	40		40									
Classification test	Passes		Passes									
Coating ability and water resistance:												
Coating					Good		Good		Good		Good	
Coating Retention					Fair		Fair		Fair		Fair	
Particle charge test	Positive		Positive		Positive		Positive		Positive b/		Positive b/	
Sieve test, %		0.10		0.10		0.10		0.10		0.10		0.10
Cement mixing text, %										2.0		2.0
Distillation:												
Oil distillate, by volume of emulsion, %		0.1		0.1		8		12				
Residue, %	60		65		65		65		57		57	
Test on residue from distillation test:												
Viscosity 140° F, poises	400	1200	400	1200	f/		400	1200	400	1200	1600	4800 a/
Penetration, 77° F, 100 g., 5 s 100	250	100	250	300		100	250	100	250	40	90	
Ductility, 77° F, 5 cm/min., cm	40		40		40		40		40		40	

Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5		97.5	
Typical applications c/: CRS-1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch. CRS-2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple). CMS-1: Cold plant mix, road mix, hot mix-cold lay. CMS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat. CSS-1 & Css-1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.												

a/ The 24 hour storage stability test results do not necessarily predict satisfactory 5-day settlement test results.
b/ If the particle charge test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.
c/ These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.
d/ Maximum viscosity at the point of manufacture shall be 500 seconds. The viscosity at the job site shall be from 150 to 400 seconds.
e/ Variability will be limited to + 600 poises from the target value established by the manufacturer.
f/ The Saybolt Furol viscosity of the residue shall be 200-600 seconds when tested at 180° F (82° C).

TABLE 2E SUGGESTED TEMPERATURES FOR USE OF ASPHALT MATERIALS			
		ASPHALT TEMPERATURE	
TYPE OR GRADE OF ASPHALT	MIXTURE AT AT DISCHARGE MAX. °f	FOR MIXING °F	FOR SPRAYING °F
AC-20	350	275-350	285-350
AC-10	325	275-325	285-350
AC-7.5	325	275-325	285-350
AC-3.5	325	240-290	260-325
MC-30		50-120	50-120
MC-70		80-150	80-150
MC-250	200	100-200	100-200
MC-800	210	160-210	185-260
MC-3000	250	200-250	225-275
ALL EMULSIONS		50-160	50-160

708.04 COMPOSITION °F MIXTURES.

A. Asphalt Mix Design and Initial Job-Mix Formula. The asphalt mix design and initial job-mix formula are the responsibility of the Contractor and shall be submitted to the Engineer for approval.

The mix design shall be prepared in a laboratory of the Contractor's choice.

The initial job-mix formula shall meet the requirements of Table 3A or 3B and Table 4 for the type mix specified on the Plans or in the Proposal.

The Engineer may require the Contractor to prepare a trial mixture to confirm the initial job-mix formula.

If the trial mixture, prepared at the initial job-mix formula proportions, fails to meet the requirements of Table 4, the Contractor may propose changes to the job-mix formula. If these changes do not result in a mixture meeting the requirements of Table 3A or 3B and Table 4, the Engineer will require a new mix design.

If the changes do result in a mixture meeting these Specifications, the job-mix formula will be adjusted accordingly.

The job-mix formula shall establish a single percentage of aggregate passing each required sieve, a single percentage of asphalt to be contained in the mixture, and a single temperature of the mixture at point of discharge from the plant.

For all mixtures the job-mix formula with allowable tolerances shown in Table 5 shall establish the specification limits for that mixture. These limits may be outside the broad range given in Table 3A or 3B except for the absolute maximum size sieve. (For example, the absolute maximum size sieve for asphalt concrete, Type C is the ½ inch sieve.)

B. ***Plant Produced Mixtures.*** The plant produced mixture shall be a uniform mixture of the combined aggregate and asphalt and shall conform to the requirements of Table 4 and the specification limits established by the job-mix formula with allowable tolerances.

After the plant is in operation, the Contractor may propose adjustments to the job-mix formula within the limits shown in Table 3A or 3B. If test results indicate these adjustments will result in a mixture meeting the requirements of Table 4, the job-mix formula will be adjusted accordingly.

Should a change in sources of materials be made, a new job-mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer will require a new job-mix formula.

The job-mix formula for asphalt is the target value. Every effort shall be made by the Contractor to incorporate that amount of asphalt into the mixture irregardless of the allowable tolerances.

For temporary construction, such as crossovers and detours, the requirements given in Table 3A for minimum percent asphalt and Table 4 for retained strength and V.M.A. will be waived.

C. ***Recycled Bituminous Pavements.*** Bituminous mixtures containing up to 40 percent reclaimed asphalt concrete pavement (RACP) will be accepted, except in the wearing course, providing all the requirements of these Specifications are met.

The following table shall be used in selecting the viscosity grade asphalt cement to be used in recycling the RACP:

	ALLOWABLE PERCENTAGES OF RACP	
PENETRATION OF RECOVERED ASPHALT CEMENT	**FOR AC-20**	**FOR AC-10**
0-22	0-20	21-40
23-27	0-25	26-40
28-32	0-30	31-40
33-37	0-35	36-40
38 and up	0-40	(Not Permitted)

TABLE 3A - TABLE OF MIXTURES (Hot Mix – Hot Lay)				
Mixture:	**Asphalt Concrete**			
Open Graded Type:	**A i/**	**B i/**	**C i/**	**D a/**
Sieve Size	**Percent Passing**			
1-1/2″	100			
1″	90-100			
¾″		100		
½″	70-90	90-100	100	
3/8″		70-90	90-100	
No. 4	40-65	45-70	60-80	80-100
No. 10	25-45	25-50	35-60	50-90
No. 40	10-26	12-30	15-35	20-50
No. 80	6-18	7-20	8-22	10-30
No. 200	See j/	See j/	See j/	5-15
% AC Soluble in Solvent c/	3.8-6.5	4.7-7.5	5.1-7.5	5.5-7.5
Viscosity Grade Asphalt Cement	AC-20	AC-20	AC-20	AC-20

TABLE 3B - TABLE OF MIXTURES (Hot Mix – Cold Lay)				
Gradation Size:	HC1	HC2	HC3	HC4 a/
Sieve Size:	Percent Passing d/ e/ f/ g/			
1-1/2″	100			
1″	90-100			
¾″		100		
½″	70-90	90-100	100	
3/8″		70-90	90-100	100
No. 4	40-65	45-70	60-80	80-100
No. 10	25-45	25-50	35-60	50-90
No. 40	10-26	12-30	15-35	20-50
No. 80	6-18	7-20	8-22	10-30
No. 200	3-6	4-7	4-8	5-15
Asphalt Type c/	MC-800	MC-800	AC 3.5 or MC-800	MC-800 or CMS-1 Emulsion

Footnotes for Tables 3A & 3B

a/ Shall be a blend of at least 75 percent crushed stone with a maximum of 25 percent sand.

c/ Expressed as a percent of total mix weight. Lower limit may be adjusted if the effective specific gravity of the combined aggregates is greater than 2.65. This adjustment will only be allowed if the lab molded specimens meet the VMA requirement at 4 percent air voids.

Footnotes for Tables 3A & 3B, Continued:

d/ If emulsion or MC grade asphalt is used, the aggregate shall be surface dry and heated to a temperature above 160° F.

e/ AC Type Mixtures. The aggregate shall be thoroughly dried and delivered to the mixer at a temperature above 200° F and not higher than the temperature of the asphalt binder. Water, not exceeding 3 percent and primer not exceeding 1.2 percent of the aggregate by weight, shall be added as necessary to assure the required workability of the mixture. The quantity of water and primer added to the aggregate shall be accurately controlled by a meter or other suitable measuring device. Except as otherwise requested by the Engineer, the workability of the mixture shall be suitable for stockpiling and use at ambient temperatures.

f/ The temperature of the aggregate shall not be heated in excess of the temperature of the liquid asphalt at time of mixing.

g/ MC-3000 may be substituted for MC-800 when specified or approved by the Engineer.

h/ The job-mix formula for percent AC in the open-graded friction course is calculated by the following equation:

% AC (16.5) / (Effective Specific Gravity 0.165)

i/ If the ADT is 2,500 or more, the total amount of natural sand and gravel shall not exceed 15 percent of the combined aggregate. For ADT less than 2,500, the natural sand and gravel shall not exceed 25 percent of the combined aggregate.

j/ For Types A, B, and C asphalt concrete, the ratio of the percent passing the No. 200 sieve to the percent asphalt cement shall be a minimum of 0.6 to a maximum of 1.2. This ratio will establish the master range for the job-mix formula on the No. 200 sieve. The job-mix formula, with allowable tolerances, will establish a specification range which may be outside the master range.

TABLE 4 – PROPERTIES OF LABORATORY MOLDED SPECIMENS		
Mixture Property	**Asphalt Concrete**	**Hot Mix Cold Lay**
Density, % of max. theo. sp. gr.		
5000 ADT or More	94-96	93-97
1000 to 5000 ADT	95-97	93-97
1000 ADT or less	96-98	93-97
Hveem Stability, min, 2500 ADT ore more a/	40	35
Less than 2500 ADT	35	35
% Retained Strength min. for 2500 ADT or more	75	NA

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	ASPHALT CONCRETE			
	Type A	**Type B**	**Type C**	**Type D**
V.M.A. min. % b	13	15	16	17

a/ Includes all City streets.
b/ V.M.A. (Voids in the Mineral Aggregate) is based on the effective specific gravity of the aggregates.

708.05 TOLERANCES. The tolerances shown in Table 5 shall be applied to the job-mix formula (JMF) as described in Subsection 708.04.

The job average for gradation shall meet the state tolerances. An individual sample will be allowed 1-1/2 times the tolerance shown for gradation, providing adjustments are made and the subsequent sample is within the stated tolerance.

TABLE 5 – RANGE OF TOLERANCES (PERCENT)		
Passing Sieve Size	**Asphalt Concrete**	**Asphalt Surf. Course (HM-CL)**
No. 4 & larger	+7	+7
No. 10	+4	+5
No. 40	+4	+4
No. 80	+4	+4
No. 200	+2	+2
Asph. Soluble in solvent	+0.4c/	+0.5c/
Temp. of mix as discharged from mixer °F	+20	+20

c/ The tolerances shown for asphalt content are for individual samples. The average asphalt content, by extraction, shall be within +0.2 percent of the job-mix formula.

708.06 SAMPLING AND TESTING.

A. Methods. Sampling and testing shall be done in accordance with AASHTO Methods, except as noted blow:

1. Sampling and Testing Aggregates:

Sampling	T 2
Sieve Analysis	T 27
Material Passing No. 200 Sieve	T 11
Wear (Los Angeles Abrasion)	T 96
Mud, Clay Balls, Sand Clusters, Sticks and Roots, Retained No. 4 Sieve	OHD L-9
Fractured Faces	OHD L-18
Sand Equivalent	T 176
Durability Factor (Plastic Fines in Aggregates)	T 210
Insoluble Residue	OHD L-25
Soft Particles	OHD L-38

2. Sampling and Testing Bituminous Mixtures:

Mechanical Analysis of Extracted Aggregate	T 30
Sampling a/	T 168
Bitumen Content	OHD L-26
Recovery of Asphalt from Solution by Abson Method	T 170
Maximum Specific Gravity of Bituminous Paving Mixtures	T 209
Bulk Impregnated Specific Gravity of Aggregates b/	OHD L-7
Compacting Materials for Stabilimeter Value (Texas Gyratory)	OHD L-8
Specific Gravity and Wg. Per C.F. of Compressed Bituminous Mixture	OHD L-14
Test for Stabilimeter Value (Hveem)	OHD L-16
Retained Strength	OHD L-36

a/ The sample size of compacted bituminous pavement shall be in accordance with T 166.

b/ OHD L-7 shall only be used when the results obtained from AASHTO T 209 are suspect.

3. Testing Asphalt Materials:

Absolute Viscosity	T 202
Kinematic Viscosity	T 201
Saybolt Furol Viscosity	T 72
Penetration	T 49
Flash Point	T 48
Solubility in Trichloroethylene	T 44
Thin Film Oven Test	T 179
Ductility	T 51
Spot Test	T 102
Water	T 55
Rolling Thin Film Oven Test	T 240
Distillation	T 78
Flash Point	T 79
Testing Emulsified Asphalt	T 59
pH of Aqueous Solutions with the Glass Electrode	T 200
Coating & Retention Testing for Mixing Grade Emulsions	T 59 Modified
Specific Gravity by Pycnometer	T 228
Specific Gravity by Hydrometer	ASTM D3142

B. Method and Procedure for Sampling Bituminous Materials. Sampling of bituminous materials shall be in accordance with AASHTO T 40, except that the method at the project site or mixing plant shall be in accordance with OHD L-5.

The producers of the bituminous materials shall be furnished with the correct project designation and instructed that such designation shall be used in connection with all materials shipped on the project. Sampling will be done at the point of manufacture whenever the quantity shipped will warrant such procedure and samples may also be taken at the point of destination. Bituminous materials shall not be used until approved by the Engineer.

709.00 ELECTRICAL CONDUIT

Description. This Section covers the requirement of materials for electrical conduit of the size, type and at the locations shown on the Plans or established by the Engineer in Section 802.

709.01 METALLIC CONDUITS.

A. Rigid Steel. Rigid galvanized steel conduit, intermediate metallic tubing, electrical metallic tubing and rigid aluminum conduit shall comply with AASHTO M 272.

B. PagFlexible Steel. Liquid-tight flexible steel conduit and fittings shall comply with the requirements of UL-360.

709.02 NON-METALLIC CONDUITS.

A. Rigid Plastic. Rigid plastic conduit shall comply with the requirements of AASHTO M 272.

B. Flexible Plastic. Flexible plastic conduit shall comply with the requirements of NEMA TC7 and shall be smooth wall coilable duct of high density polyethylene (HDPE) meeting the requirements of ASTM D 1248, Type III Class C, Grade P33, Category 5, Schedule 40, unless otherwise specified in the Plans.

C. Cable-in-Duct. Cable-in-duct conduit shall be factory assembled. The duct shall be HDPE and comply with paragraph B. above and be the size shown on the Plans. The conductors shall be of the type, size and number shown on the Plans. Identification of the conductor shall be accomplished by color coding the insulation by means of a continuous longitudinal colored stripe or various solid colors of continuous longitudinal colored stripe or various solid colors of insulation, in addition to the standard conductor markings.

709.03 OUTLET BOXES, FITTING AND ENTRANCE CAPS.

A. General. Outlet boxes, fitting and entrance caps shall comply with current industry standards, and be compatible with the conduit material used.

B. Fittings. Fittings and cement used with plastic conduit shall be compatible with the conduit material.

709.04 TESTING. Conduit may be accepted on the project without testing provided it is visually inspected and all pieces are clearly labeled with the UL label or a Type D certification is furnished by the manufacturer.

710.00 DELINEATORS

Description. This Section establishes the requirements for materials and tests for delineators in Section 853.

710.01 REFLECTORS.

A. General. Reflectors that are mounted on a post to form a delineator unit shall be circular and provided with a single mounting hole through the center. The mounting hole shall have an inside diameter of 0.188 inch to 0.203 inch. The reflector shall have the capacity of accommodating a 3/16 inch nominal diameter blind rivet expanded to 0.196 inch without fracturing. The center mount reflectors may or may not be fabricated with an aluminum housing.

B. Delineators. Delineators shall consist of reflectors as specified herein, mounted on galvanized steel posts when installed on roadway shoulders, galvanized steel posts installed on guard rail posts or galvanized steel posts and brackets installed on bridges.

C. Acrylic Plastic Reflector. The reflector shall be acrylic plastic methyl methacrylate, meeting requirements of Federal specifications L-M-5002, Type 1, Class 3.

Reflectors shall consist of a crystal (colorless), amber or red transparent face with a minimum dimension of 3 inches and not less than 7 square inches of reflective area, herein referred to as the lens, with a heat sealable acrylic plastic or heat sealable metal foil back fused to the lens under heat and pressure around the entire perimeter of the lens and the central mounting hole to form a unit permanently sealed against water and water vapor. The embossed aluminum housing shall have a thickness of 0.02 + 0.002 inches. The center mount reflectors without aluminum housing shall be backed by a vapor-tight, hermetically sealed plastic backing to prevent vapor and dust from reaching the reflex surface.

The lens shall consist of a smooth front surface free from projection or indentation other than a central mounting hole and identification with a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's name or trademark shall be molded legibly into the face of the lens.

D. Definitions.

1. Incidence angle shall mean the angle at reflector between direction of light incident on it and direction of reflector's axis.

2. Divergence angle shall mean the angle at reflector between observer's line of sight and direction of light incident on the reflector.

3. Specific intensity shall mean candlepower returned at the chosen divergence angle by a reflector for each foot-candle of illumination at the reflector.

E. ***Specific Intensity.*** The specific intensity of each reflex reflector intended for use as delineators or markers shall be equal to or exceed the following minimum values regardless of reflector orientation.

Divergence Angle Degrees	Incidence Angle Degree	Specific Intensity Candlepower Per Foot-candle		
		Crystal	Amber	Red
1/10	0	119	71	29
1/10	20	47	28	11
1/3	0	20	12	5
1/3	20	8	5	2

F. ***Specific Intensity Test.*** Specific intensity will be determined in accordance with Federal Test Method Standard 370.

Failure to meet the specific intensity minimum shall constitute failure of the reflector being tested. Failure of more than 4 percent of the reflectors subjected to test shall constitute failure of the lot or shipment except that when 25 or less samples are submitted, failure of more than one reflector subjected to test shall constitute failure of the lot or shipment.

G. ***Seal Test.*** The following test shall be used to determine whether a reflector is completely sealed against dust and water: Submerge the samples in a water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches of mercury for 5 minutes. Restore atmospheric pressure and leave sample submerged for 5 minutes, then examine the samples for water intake. Failure of more than 4 percent of the number tested shall be cause for rejection.

H. ***Sampling.*** The sample reflectors required for optical and seal tests will be selected at random. The number of reflectors required for a sample are as indicated in the schedule below:

Quantity in Shipment or Lot	No. of Reflectors required for Sample
100 or less	3
100 to 800	3 percent
800 to 5000	25 to 50
5000 and over	1 percent

710.02 POSTS.

A. Galvanized Steel Delineator Posts. This item shall consist of furnishing, cutting, drilling, punching, fabricating, and galvanizing a finished channel-type or hat-type delineator post, according to these requirements and the Plans.

The galvanized channel-type post shall be fabricated from 1-1/2 x ½ x 1/8 inches steel bar channel, cut to the specified length, and drilled, or punched, as required, suitable for mounting the approved type delineator and installed on guard rail posts when so intended. The basic steel channel employed in the fabrication shall meet dimensional tolerances for the specified size above according to Table 28 of ASTM A 6 for bar size shapes less than 3 inches.

An alternate galvanized steel hat section type post may be used. It shall be rolled from sheet steel to the dimensions and shape shown on current Department standard drawings. The alternate post shall weigh 1.12 pounds + 3.5 percent per linear foot before galvanizing.

It shall be the Contractor's responsibility to furnish the correct size fasteners required for the type post used, unless otherwise shown on the Plans.

All cutting and hole drilling or punching shall be accomplished prior to galvanizing.

The posts shall receive a 2 ounce zinc coating according to ASTM A 123.

B. ***Testing.*** One or more samples will be required for determination of zinc coating, according to ASTM A 123, and compliance with dimensional requirements required by ASTM A 6 and these Specifications.

711.00 TRAFFIC STRIPE

Description. This Section establishes the requirements for materials and tests for thermoplastic compounds, preformed plastic tapes, traffic stripe paint and glass beads.

711.01 THERMOPLASTIC COMPOUNDS.

A. ***Hot Applied Thermoplastic Compound Materials.*** The hot applied thermoplastic compound shall meet the requirements of AASHTO M 249. The binder component shown in Section 4.2, Table 1 Composition, shall be made of hydrocarbon material unless otherwise specified on the Plans. Each shipment of the product shall be accompanied by a Type A Certification as specified in Subsection 106.12.

711.02 PERMANENT PAVEMENT MARKING TAPE.

A. General. The plastic striping tape as supplied shall be of good appearance, free from cracks, and edges shall be true, straight and unbroken. The material shall be available in rolls and there shall be no more than 3 splices per 50 yards of length.

Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the current Manual on Uniform Traffic Control Devices for Streets and Highways.

The plastic striping tape shall be packaged in standard commercial containers so constructed as to insure acceptance by the carrier and prevent damage during shipment and storage.

The plastic striping tape as supplied shall be capable of retaining required properties when stored at temperatures up to 100° F for periods up to one year.

A Type A Certification shall be furnished in accordance with Subsection 106.12.

The plastic striping tape shall conform to the following requirements:

1. Composition. The retroreflective, preformed pavement marking film shall consist of high quality plastic materials, pigments and glass beads uniformly distributed throughout its cross-sectional area and with a retroreflective layer of glass beads firmly bonded on the top surface. The preformed plastic film shall be pre-coated with a pressure-sensitive adhesive that is compatible with bituminous concrete and portland cement concrete road surfaces.

2. *Skid Resistance.* The surface of the retroreflective preformed film shall provide a minimum skid resistance value of 35 BPN when tested in accordance with ASTM E 303.

3. *Thickness.* The thickness of the preformed plastic film without adhesive for lane and edge lines shall be not less than 0.060 inch and not more than 0.090 inch.

4. *Tensile Strength and Elongation.* The film shall have a minimum tensile strength of 40 pounds per square inch of cross-section when tested according to ASTM D 638, except that a sample 6 inch x 1 inch shall be tested at a temperature between 70° F and 80° F using a jaw speed of 10 to 12 inches per minute. The sample shall have a minimum elongation of 75 percent at break when tested by this method.

5. *Conformability.* The preformed film shall be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The preformed plastic film shall have characteristics such that it is capable of fusing with itself and previously applied marking film of the same composition under normal conditions of use.

6. *Removability.* The plastic striping tape shall be designed as not to be easily removed after application.

7. *Adhesive.* The plastic striping tape for longitudinal and transverse markings shall have pressure-sensitive backing without liner. Word and symbol tape shall have pressure-sensitive backing with protective liner.

8. *Application Properties.* The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperature of 65° F and rising. If the markings must be applied when the surface temperature is below 65° F, but not below 50° F, the markings are to be applied in strict accordance with the manufacturer's recommended procedures and/or other special instructions.

9. *Glass Beads.* Glass beads shall be incorporated by the manufacturer to provide immediate and continuing retro reflection. 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 with a thumbnail.

10. *Pigmentation.* Color pigments shall be thoroughly blended to provide a pavement marking film that maintains uniform color under both daylight and night lighting conditions throughout the expected life of the film.

White pavement marking film shall be similar to Federal Standard Color No. 595-17886. Yellow pavement marking film shall be similar to Federal Standard Color No. 595-13538.

11. *Reflectance.* The white and yellow films shall have the following initial minimum reflectance values of 0.2° and 0.5° observation angles and 86.0° entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot-candle. The test distance shall be 50 feet and the sample size shall be a 2.0 x 2.5 foot rectangle.

    The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample and reference center shall be taken perpendicular to the test sample.

	White		**Yellow**	
Observation Angle	0.2°	0.5°	0.2°	0.5°
SL (mcd ft -2 fc-1	550	380	410	250

12. *Effective Performance Life.* The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The tape must be qualified by a State Highway or Transportation Department. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back or other signs of poor adhesion.

711.03 TEMPORARY PAVEMENT MARKING TAPE.

A. General. The traffic striping material shall consist of a white or yellow weather and traffic resistant reflective film on a conformable backing pre-coated with a pressure-sensitive adhesive. Satisfactory performance test of not less than 12 months conducted by a State Highway or Transportation Department shall qualify the material.

The striping tape shall be white or yellow as specified. The white and yellow striping tape shall be retro reflective, reflecting white or yellow respectively and shall be readily visible when viewed with automobile headlights at night.

The striping tape shall have a pre-coated pressure-sensitive adhesive which shall not require a liner for protection from contamination, pre-adhesion, or blocking within the roll or require activation procedures.

The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperatures down to 35° F and shall require no protective devices such as traffic cones or barricades.

B. Conformability. The striping material shall be thin, flexible, and formable, and following application shall remain conformed to the texture of the pavement surface.

The average thickness of the material, as determined by five micrometer readings, will not be less than 15 mils nor more than 45 mils.

C. Durability and Wear Resistance. The striping material applied in accordance with manufacturer's recommended procedures shall be weather-resistant and show no appreciable facing, lifting or shrinkage during the useful life of the line.

D. Packaging. The striping material shall be packaged in standard commercial containers so constructed as to insure acceptance by the carrier and prevent damage during shipment and storage.

E. Storage. The striping material as supplied shall be capable of being stored at temperatures up to 100° F for periods up to one year without deterioration.

F. Certification. A Type D Certification shall be required for the temporary pavement marking tape in accordance with Subsection 106.12.

711.04 REMOVABLE PAVEMENT MARKING TAPE.

A. General. Removable pavement marking tape shall consist of a white or yellow all-weather traffic resistant film on a reinforced conformable backing, pre-coated with a pressure-sensitive adhesive. Glass beads shall be uniformly distributed throughout the film for retro reflectivity.

B. Adhesive. The removable, pre-formed pavement marking film shall be pre-coated with a pressure-sensitive adhesive capable of being adhered to asphalt concrete and portland cement concrete pavement surfaces without the use of heat, solvents, additional adhesives or activators and shall be immediately ready for traffic after application. The adhesive shall be capable of bonding to pavement surfaces when applied at temperatures of 50° F and above without pickup or distortion by vehicular traffic.

C. Color. The material shall be white or yellow, as specified, conforming to the standard highway color requirements of the Manual on Uniform Traffic Control Devices.

D. Glass Beads. The glass beads shall be colorless and shall have a minimum refraction index of 1.50 when tested using the liquid immersion method. The size and quantity of beads shall be such that retro reflectivity of the pre-formed film is maintained as the film wears through the surface course.

E. Removability. The pre-formed pavement marking film shall be removable from asphalt concrete and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device, at temperatures above 50° F, and without the use of heat, solvents, grinding or sandblasting.

F. Durability. The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature. The tape must be pre-qualified by a satisfactory performance test of at least 6 months conducted by a State Highway or Transportation Department. The removability characteristics must also be demonstrated to meet the requirements of this section through the above-described performance test. The film shall be weather-resistant and through normal traffic wear shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking.

G. Certification. A Type D Certification shall be required for the removable pavement marking tape in accordance with Subsection 106.12.

711.05 TRAFFIC STRIPE PAINT – TYPE I. The white and yellow traffic paint shall be suitable for spray application and use as a reflecting traffic guide on concrete and bituminous highway pavements. It is the intent of these Specifications to provide both general and composition requirements in sufficient detail to assure a quality paint capable of providing satisfactory reflectorized traffic lines.

The paint shall be of a type in which the glass beads are dropped on the pigmented binder during application (hereinafter designated as binder type) so that, upon drying, the paint line is capable of retro direction of the headlight beams from vehicles. The term paint is herein construed as pigmented binder.

A. Materials. Condition and Stability. The paint shall be homogeneous, shall be well-ground to a uniform and smooth consistency, and shall not skin or settle badly, or cake, liver, thicken, curdle, or gel in the container. The paint shall be capable of being broken up and mixed without difficulty by use of a paddle and shall show the desired characteristics at any time within a period of 6 months from date of delivery.

B. ***Drying Time.*** The paint, when applied to either portland cement concrete or bituminous surfacing at a rate of .015 inch thickness (wet film), shall be sufficiently dry within ½ hour after application so that there will be no pickup under traffic and shall be thoroughly dry and free from tackiness within 40 minutes after application when the atmospheric temperature is a minimum of 77° F and the relative humidity if between 25 and 50 percent.

C. ***Viscosity.*** The paint as received shall have a consistency as determined by the Stormer Viscosimeter at 77° F of 68 to 80 Krebs Units. Any paint which changes consistency within 6 months after receipt so that the consistency falls outside the viscosity limits stated above shall be considered to have failed this test.

D. ***Colors.*** The white and yellow colors for traffic making paint shall conform to the standard highway color code requirements of the Manual of Uniform Traffic Control Devices for Streets and Highways.

E. ***Bleeding.*** The paint shall not show bleeding sufficient to impair the color and visibility of the paint when applied to a suitably prepared and cured bituminous surface. The pigmented binder shall be tested in accordance with Federal Specification TT-P-85b and shall have a minimum bleeding ration of 0.95 when tested.

F. ***Foreign Matter.*** The paint shall be free from skins, dirt and other foreign matter, and shall contain not more than one percent water. (Methods 4081, 4091, and 4902.1, Federal Specification TT-P-141a).

G. ***Composition Requirements. Proportioning.*** The various components shall be proportioned by weight as set forth below:

PIGMENTED BINDER	WHITE (percent)	YELLOW (percent)
1. Pigment:	59.0 Min.	55.5 Min.
Titanium Dioxide (ASTM D 476 Type III)	18.0 Min.	3.2 Min.
Medium Chrome Yellow		14.7 Min.
Talc (ASTM D 605)	25.5 max.	42.3 Max.
Mica (Water Ground) ASTM D 607	7.0 Max.	
Calcium Carbonate (Particular size range 0.5-10.0 microns)	49.7 Max.	40.7 Max.
2. Vehicle:	41.0 Max.	44.5 Max.
Medium Oil Alkyd Resin Solids 1/	37.8 Min.	37.9 Min.

VM&P Naptha (IBP 200° F Min.; DP 290° F Max.)	60.0 Max.	59.9 Max.
Driers and Additives	2.8 Max.	3.5 Max.
3. Binder Constants:		
Viscosity @ 77° F	68-80 KU	68-80 KU
Fineness	2.5 Min. N.S.	2.5 Min. N.S.
Dry Time ASTM D 711	No pick-up	No pick-up
(Minutes)	40 Max.	40 Max.
Wgt. Per Gal. @ 77° F	12.25 lb. Min.	11.80 lb. Min.
Skinning in 48 hours; ¾ full tightly capped container	None	None
1/ Alkyd Resin Linseed Oil or Soya Oil		50 Min.
Phthalic Anhydride		33 Min.
Acid No.		10 Max.
Color (G-H)		9 Max.
Resin, Phenolic, Petroleum Resins		Negative
Solvent		VM&P Naptha

H. Containers. The paint shall be furnished in container size as specified in the Contract. Where 55 gallon containers are specified, they shall be new, standard, round, 18-gage drums with either bung type lids or have a removable and re-sealable drum head as specified in the Contract. Containers shall also meet Federal requirements.

All containers shall be labeled with the following information:

1. The City of Edmond
2. Specification Type
3. Purchase Order Number (if applicable)
4. Manufacturer's Name
5. Date of Manufacture
6. Manufacturer's Batch Number

Labels must be sufficiently weather-resistant to withstand outside storage for a minimum of one year.

I. Inspection, Sampling and Testing. All sampling shall be in accordance with Subsection 730.01 B.

J. Sealed Shipments. Shipments shall be sealed in accordance with Subsection 730.01 C.

711.06 TRAFFIC STRIPE PAINT – TYPE III (DROP ON). The white and yellow traffic paints shall conform on a weight basis to the composition of the standard formula as closely as accepted good paint practice will permit. No

variation from the standard formula will be permitted except for replacements or volatiles lost in processing or those approved by the Engineer.

A. Materials.

1. *Substitutions.* The exact brands and types of raw materials are listed for the purpose of facilitating the selection of parallel material equal not only in quality and composition, but also in physical and chemical behavior after aging in the finished product. Since evaluation of questionable materials may require 60 days after receipt of request from a paint manufacturer, the Contractor is reminded that he should schedule material procurement to permit him to meet delivery commitments. The final decision as to quality of materials shall be made by the Engineer. After the Engineer has approved the brand names of raw materials proposed by paint manufacturer, no substitution will be allowed during manufacture without prior approval of the Department of Transportation.

2. *Pigment.*

   a. Pure Titanium Dioxide Rutile, Type II, shall meet ASTM Specification D 476-73.
   b. Lead Free Zinc Oxide: American Process, Acicular, shall meet Federal Specification TT-P-463a, Type I.
   c. Talc, Paint Grade Magnesium Silicate, shall meet Federal Specification MIL-M15173, Type B.
   d. Calcium Carbonate:

$CaCo_3$	Min. 97 percent
H_2O Max.	0.4 percent
Specific Gravity	2.63 – 2.73

   Fineness Requirements 80 percent less than 5u (microns).
   e. Medium Chrome Yellow ASTM D 211, Type III.
   f. Feldspar, water washed alkali aluminum silicate, Lawson-United LU-340.

   Color: Equal to material listed in standard formula. Substitution in a standard formula shall not result in a viscosity greater than 5 KU.

3. *Resins.*

   a. Traffic Paint Alkyd Resin Solution:

      1. General:

Type:	Pure, drying alkyd
Length:	Medium
Type Oil:	Soya, linseed or tall. No mixture of two or more oils will be permitted.
Solvent:	Toluol, ASTM Specification D 362

Compatibility: A solution of one part 75 percent traffic alkyd and five parts toluol shall be clear.

A solution containing the equivalent of 120 grams of 20 cps chlorinated rubber, 130 grams of 75% traffic alkyd, 200 grams of methyl ethyl ketone shall be clear transparent, and show no separation after 24 hours of storage in a ¾ full test tube at 80° + 5° F. This rubber-alkyd solvent solution shall produce a clear film upon drying.

2. Solid Resin Basis:

	Percent
Phthalic Anhydrides	33 to 37
Percent Oil Acids	48 to 55
Acid Number, Max.	8.0
Ash Residue, Max.	0.10%
Unsaponifiable, Max.	2.0%
Iodine Number of Fatty Acids, Min.	115
Refractive Index of Fatty Acids, Min.	1.4660
Percent Rosin based on Fatty Acids (Tall Oil Alkyds), Max.	1.0

3. 45% Solid Basis:

Color:	Gardner 1953 Standard-9 Max.
Drying Time:	A wet film 3 mils thick shall set to touch in not more than 90 minutes.
Dryers:	Based on the resin solids present, add the equivalent of 0.06% Cobalt (metal) and 1.0% Lead (metal).

Toluol shall be used to reduce the resin solution to 45% solids, and shall meet ASTM Specification D 362.

b. *Chlorinated Paraffin:* Shall meet Federal Specification MIL-C-429A, Type I.

c. *Chlorinated Rubber:*

Appearance:	Free flowing white powder
Viscosity (20 percent w/w in Toluene) (ASTM D 115)	0.018 – 0.222 pas @ 25° C
Chlorine, percent by weight (TT-P-115c 4.3.6)	Minimum 64.5
Ash, percent by weight	Maximum 0.20
Solubility	Soluble in aromatic hydro-carbons, eg., toluene, xylene, and alkylated benzenes.

4. *Thinners.*

   a. Methyl Ethyl Ketone — Federal Spec. TT-M-26

5. *Additives.*

   a. Anti-settling Agent — Bentone 34 or Claytone 40
   b. Stabilizer — Thermolite 813.

B. *Composition Requirements.* The various components shall be proportioned by weight as set forth below:

1. *Paint, Traffic:*

	WHITE (pounds)	**YELLOW (pounds)**
Medium Chrome Yellow		85
Titanium Dioxide, Rutile Type II	100	25
Lead Free Zinc Oxide	25	50
Talc	250	100
Feldspar – LU390		125
Calcium Carbonate	275	250
Anti-settling Agent	5	5
Traffic Alkyd 75% solids	130	130
Chlorinated Rubber 20CPS	105	120
Chlorinated Paraffin	85	75
36% Lead Drier	1.5	1.5
12% Cobalt Drier	0.5	0.5
Anti-skinning Agent	2	2
Thermolite 813	0.5	0.5
Methyl Alcohol	5	6
Methyl Ethyl Ketone	207	270
Toluene	53	
Xylene	10	
TOTAL	1254.5	1245.5
TOTAL GALLONS	99.272	98.592
WEIGHT PER GALLON	12.637	12.633

2. *Properties of Finished Paint:*

   a. Weight per gallon + 0.25 lbs. of theoretical gallon weight
   b. Consistency @ 25° C (Krebs-Stormer) — 75-85 KU
   c. Drying Time: ASTM D711 maximum 5 minutes
   d. Bleeding: Fed. Spec TT-P-85d 4.3.11 — 0.95 minimum
   e. Dry Opacity: Fed. Test Std. No. 141a Method 4121 using wet film of approx. 4 mils. — 0.91 minimum

f. Daylight Reflectance: Fed. Test Std. No. 141a Method 6121 — 80% White, 50% Yellow

g. Fineness of grind (Hegman) — 3 minimum

h. Skinning: The paint shall show no skinning after 48 hours in a ¾ filled tightly closed container.

i. Color: Yellow dry film shall be in compliance with Highway Yellow Color Chart U.S. Dept. of Transportation, Federal Highway Administration

3. *Percent Composition Requirements:*

	WHITE	YELLOW
Percent Total Solids	75.0 + 2%	74.5 + 2%
Percent Pigment	52.2 + 2%	51.4 + 2%
Percent Vehicle	47.8 + 2%	48.6 + 2%
Percent Non. Vol. (Veh./Veh.)	45.5% Minimum	4.5% Minimum

Upon chemical analysis of pigments and vehicle solids, the percentages must be within reasonable manufacturing tolerances as determined by the Engineer.

4. *Containers.* Containers shall meet the requirements of Subsection 711.05 H.

711.07 GLASS BEADS FOR TRAFFIC PAINT. Glass beads used for thermoplastic compound and traffic stripe paint shall meet the requirements of AASHTO M 247, Type I with the exception that the average crushing resistance when tested in accordance with OHD L-12 shall be not less than the following:

PASSING SIEVE	RETAINED SIEVE	CRUSHING STRENGTH
No. 20	No. 30	25 lbs.
No. 30	No. 40	15 lbs.

Beads shall be supplied with a moisture-resistant coating.

712.00 CONSTRUCTION FABRICS

Description. This Section covers fabrics to be used for reinforcement of asphalt pavements and filter fabric for various uses.

712.01 FABRIC REINFORCEMENT FOR ASPHALT CONCRETE PAVEMENT.

A. General. The fabric shall be an approved paving-grade, fused on one side, non-woven, needle-punched, material constructed of long chain synthetic polymers composed of at least 85 percent polyesters, polyolefins or polyamides by weight.

B. Test Requirements. The reinforcement fabric shall meet the following test requirements:

TESTS	LIMIT	TEST METHOD
Weight	3-6 oz/sq yd	ASTM D 2646
Tensile Strength (Grab Method)	90 lbs minimum	ASTM D 1682
Elongation at break	55% minimum	ASTM D 1682
Asphalt Retention	0.20 gal/sq yd minimum	ODOT Procedure

C. Packaging and Storing. The fabric shall be supplied by the manufacturer in rolls of standard widths and lengths uniformly wound onto suitable cylinder forms or cores to aid in handling and unrolling by the use of mechanical laydown equipment. Rolls supplied shall provide full coverage of the payment with a minimal number of joint splices.

Rolls of fabric shall be furnished with a suitable type wrapping for protection against sunlight and moisture. When stored outdoors, the rolls shall be elevated and covered with a tarpaulin.

D. Sampling and Testing. The Contractor shall furnish a Type A Materials Certification for the reinforcement fabric in accordance with Subsection 106.12.

712.02 FILTER FABRIC FOR GABIONS.

A. General. Filter fabric shall be a pervious sheet of non-woven fibers. The fabric shall be constructed of long chain synthetic polymers, composed of at least 85 percent polyesters, polyolefins or plyamides by weight. The fabric shall provide an equivalent opening size (EOS) no finer than U.S. Standard sieve No. 100 and no coarser than U.S. Standard Sieve No. 50. The EOS of the filter fabric shall be determined in accordance with the U.S. Army Corps of Engineers method. The fabric shall be fixed so that the fibers will retain their relative position to each other. The fabric shall be free of defects, flaws,

chemical treatments or coats which significantly affect its physical and/or filtering properties.

B. Test Requirements. The filter fabric shall conform to the following physical property requirements:

TEST	REQUIREMENT	METHOD (CURRENT SPECIFICATION)
Thickness (Min.)	15 Mils	ASTM D 1777
Weight (Min.)	3.9 oz./sq. yd.	ASTM D 2646
Tensile Strength (Min.)	100 lbs.	ASTM D 1682 Grab Test Method 1 inch square jaws and a travel rate of 12 inches per minute
Elongation, %	45-150 %	ASTM D 1682 (Same Method as for Tensile Strength)
Puncture Strength	40 lbs.	ASTM D 751 Tension Testing Machine with ring clamp; steel ball replaced with a 5/16 inch diameter solid steel cykubder with a hemispherical tip centered with a ring clamp
Ultraviolet Degradation at 150 hours	70% Retained Strength (Minimum)	ASTM D 4355

C. Acceptance. The Contractor shall furnish a Type D Material Certification for the fabric in accordance with Subsection 106.12.

712.03 GEOTEXTILES FOR SUBSURFACE DRAINAGE PURPOSES.

A. General. This Subsection covers geotextiles to be used in conjunction with pipe underdrain and other drainage systems. The fabric shall meet the requirements of AASHTO M 288.

B. Acceptance. The Contractor shall furnish a Type D Material Certification for the fabric in accordance with Subsection 106.12.

712.04 FILTER FABRIC FOR USE WITH RIPRAP.

A. General. This Subsection describes a pervious fabric to be used under riprap for slope protection. The fabric shall be an approved non-woven, needle-punched material constructed of long chain synthetic polymers composed of at least 85 percent polyester, polyolefins or polyamides.

B. Test Requirements. The fabric shall meet the following test requirements.

TEST	MINIMUM REQUIREMENT	METHOD
Weight	6 oz. sq/yd	ASTM D 2646
Thickness	70 mils	ASTM D 1777
Grab Strength	180 lbs.	ASTM D 1682
Puncture Strength	75 lbs.	ASTM D 751 a/
Burst Strength	290 psi	ASTM D 751 b/
Trapezoidal Tear Strength	50 lbs. c/	ASTM D 1117
Ultraviolet Degradation at 150 hours	70% Retained Strength	ASTM D 4355
E.O.S.	50-100	d/

a/ Tension Testing Machine with ring clamp, steel ball replaced with a 5/16 inch diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.
b/ Diaphragm Test Method.
c/ Either principal direction.
d/ Determined by the U.S. Army Corps of Engineer Method.

C. **Acceptance.** The Contractor shall furnish a Type D Material Certification for the fabric in accordance with Subsection 106.12.

713.00 STONE FOR RIPRAP, FILTER BLANKET AND GABIONS

713.01 MATERIALS COVERED. This Section covers stone for plain riprap, laid up riprap or grouted riprap, stone for special plain riprap and materials for filter blanket and gabions.

713.02 RIPRAP STONE. General. Stone for riprap shall be hard, sound and durable and shall be approved by the Engineer prior to use.

Tests for weight and absorption will be determined in accordance with ASTM C 97. The minimum weight shall be 140 pounds per cubic foot and the maximum absorption shall be 6 percent.

Soundness (freeze and thaw test) loss of the stone after 20 cycles shall not exceed 15 percent when tested in accordance with the Corps of Engineers test method CRD-C 144.

The size of stone for the various kinds of riprap shall be as follows:

A. Stone for Plain Riprap.

RIPRAP THICKNESS (INCHES)	MAXIMUM (POUNDS)	AVERAGE SIZE (POUNDS)	NOT MORE THAN 20% SHALL WEIGH LESS THAN
12	150	30-50	20 lbs.
18	350	70-125	30 lbs.
24	1000	225-400	40 lbs.
30	1000	225-400	40 lbs.

When placed on the embankment the smaller stones shall be well-distributed throughout the mass. Neither the breadth or the thickness of any piece of riprap shall be less than 1/3 of its length.

B. Stone for Laid-up or Grouted Riprap.

RIPRAP THICKNESS (INCHES)	SIZE RANGE (POUNDS)	AT LEAST 60% SHALL WEIGH MORE THAN
12	50-250	100 lbs.
18	50-500	150 lbs.

Slabs of silver will be rejected. Spalls shall be well-graded of a suitable size for the work.

C. Stone for Special Plain Riprap.

40 percent to 60 percent	5 c.f. to 12 c.f. in volume
20 percent to 30 percent	2 c.f. to 5 c.f. in volume
10 percent to 20 percent	0.25 to 2 c.f. in volume
5 percent to 15 percent	may be less than 0.25 c.f. in volume

713.03 FILTER BLANKET MATERIAL. Material for a filter blanket shall consist of sand, gravel, crushed stone, or other approved materials processed, blended, or naturally combined. It shall be reasonably free from lumps or balls of clay, organic matter, objectionable coatings, or other foreign materials, and shall be durable and sound. Blanket material shall not contain flat and/or elongated particles in an amount exceeding 20 percent. A flat or elongated piece is one in which the length is greater than 5 times the average thickness. The backing material in place shall be reasonably well-graded within the following limits:

SINGLE COURSE BACKING (FILTER BLANKET)	
SIEVE DESIGNATION U.S. STANDARD SQUARE MESH	**PERCENT BY WEIGHT PASSING**
4″	100
2″	60-90
1″	40-70
3/8″	15-40
No. 4	0-15

TWO COURSE BACKING (FILTER BLANKET)		
SIEVE DESIGNATION U.S. STANDARD SQUARE MESH	**PERCENT BY WEIGHT PASSING**	
	LOWER COURSE OF TWO LAYERS	**UPPER COURSE OF TWO LAYERS**
6″	---	100
4″	---	90-100
2″	---	65-85
1″	---	40-70
3/8″	100	15-35
No. 4	95-100	0-10
No. 8	80-90	---
No. 16	55-75	---
No. 30	30-60	---
No. 50	12-30	---
No. 100	0-10	---

713.04 GABIONS.

A. Gabion Materials.

1. *Wire Baskets.* Gabion baskets shall meet the requirements of Subsection 732.09.

2. *Rock Fill.* Rock fill for the gabion baskets shall consist of hard, dense, sound, durable, rough fractured stone as nearly cubical as practicable. No rock shall have a minimum dimension less than 4 inches, nor have a maximum dimension greater than 8 inches. Rock shall have a specific gravity of not less than 2.5.

B. Filter Fabric. The filter fabric shall conform to the requirements of Subsection 712.02.

C. Filter Sand. Filter sand shall meet the requirements of Subsection 703.04 B.

714.00 MASONRY BRICK

Description. This Section covers the requirements for masonry brick (manufactured from either concrete or clay or shale). The particular type will be specified on the Plans or in the Proposal, and shall comply with the requirements set out below for each type.

714.01 MASONRY BRICK MADE FROM CLAY OR SHALE.

A. General Construction Brick. Masonry brick of this type shall comply with the requirements of AASHTO M-114 for building brick. Unless otherwise shown on the Plans, grade MW brick shall be used.

B. Sewer and Manhole Brick. Manhole brick shall comply with AASHTO M 91, grade MM for manholes, junction boxes and other appurtenances.

714.02 CONCRETE BUILDING BRICK. Concrete building brick shall conform to the requirements of ASTM C 55. Unless otherwise shown on the Plans, either Type I, Grade S-I or Type II, Grade N-II shall be used.

Concrete brick shall not be used in the construction or reconstruction of sanitary sewer manholes.

716.00 BITUMINOUS DAMP-PROOFING AND WATERPROOFING MATERIALS

Description. This Section covers bituminous primer and mop coats for use, when specified, in damp-proofing and waterproofing below or at ground level, for application to concrete and masonry surfaces.

716.01 ASPHALT PRIMER. Asphalt primer for use with asphalt for waterproofing or damp-proofing shall meet the requirements of AASHTO M 116.

716.02 CREOSOTE PRIMER. Creosote primer for use with tar for waterproofing shall meet the requirements of AASHTO M 121.

716.03 ASPHALT CEMENT. Asphalt cement for waterproofing or damp-proofing shall meet the requirements of AASHTO M 115, Type II.

716.04 COAL-TAR PITCH. Coal-tar pitch for waterproofing shall meet the requirements of AASHTO M 118.

717.00 MISCELLANEOUS WATERPROOFING MATERIALS

717.01 ASPHALT FELT.

A. Description. This Subsection covers rag felt saturated with an asphalt, for use in the membrane system of waterproofing.

B. General Requirements. Rag felt shall be produced by felting vegetable and animal fibers. Saturation shall be accomplished by passing the dry felt in single thickness through the saturant at a temperature and speed that will not injure the felt and then calendaring it between heated cylinders. It shall then be cooled and wound into rolls.

The surface of the felt shall be uniformly smooth, and upon splitting or tearing on the bias, shall appear reasonably free from lumps or under-beaten stock; i.e., stock that has not been beaten or shredded into fiber in a process of manufacture and from particles of foreign substance such as fragments of stone, metal, leather, rubber, straw, wood, etc.

Felt shall be saturated thoroughly and uniformly and shall show no unsaturated spots at any point upon cutting 2 inch strips at random across the entire sheet and splitting them open for their full length.

The finished felt shall be free from visible defects, such as holes, ragged or untrue edges, breaks, rents or cracks, and shall not be coated or covered with talc or other substance that will interfere with adhesion between the felt and the bitumen.

Rolls of felt shall be wrapped securely or tied to prevent unrolling in transit. It shall be of such quality that it may be unrolled easily at atmospheric temperatures above 50° F without injury from sticking.

Felt shall be delivered to the work in the original packages bearing the manufacturer's brand and label. The kind of material and purpose for which it is to be used shall be indicated on the label.

C. ***Detailed Requirements.*** Rag felt shall meet the requirements of ASTM D 226.

717.02 BITUMINOUS TREATED FABRIC.

A. Description. This Subsection covers cotton fabric uniformly and thoroughly saturated with asphalt, for use in the membrane system of waterproofing. The material shall meet the requirements of AASHTO M 117.

717.03 PLASTIC CEMENT.

A. Description. Plastic cement shall be composed of semi-solid asphalt dissolved in a suitable volatile solvent and stiffened with a mineral filler consisting essentially of short, incombustible, mineral fibers.

B. General Requirements. The asphalt forming the base of the plastic cement shall be refined petroleum asphalt with a penetration at 77° F of 30-70. The mixture shall meet the following requirements:

Asphalt, percent by weight	38+
Mineral Filler, percent by weight	25+
Petroleum Solvent, percent by weight	25-

Plastic cement shall be of such consistency that it can be spread readily with a trowel without drawing or pulling, or can be extruded through a suitable nozzle under a minimum pressure of 50 pounds per square inch.

When applied in a layer 1/16 to 1/8 inch thick, plastic cement shall set within 24 hours to a tough plastic coating free from blisters.

After drying for 72 hours, a patch of plastic cement 1/16 to 1/8 inch thick, applied to the material upon which it is to be used, shall not blister or sag more than ¼ inch upon exposure at a temperature of 140° F for 5 hours.

After drying for 72 hours and exposure at a temperature of 140° F for 5 hours, a patch of cement 1/16 to 1/8 inch thick shall be plastic and adhere well to fabric, saturated felt, metal or concrete, upon exposure at a temperature of 32° F for one hour.

After drying for 24 hours and exposure at a temperature of 140° F for 24 hours, and then cooling to a temperature of 70° to 77° F a patch of the cement 1/16 to 1/8 inch thick shall not crack or break from the saturated fabric, saturated felt, or metal, when bent over a mandrel one inch in diameter.

717.04 INSULATING PAPER. Insulating paper shall be a waterproof paper 36 inches wide, weighing not less than 10 pounds per 100 square feet.

719.00 SIGNS.

Description. This Section establishes the requirements for materials for signs in Section 850.

719.01 PANELS.

A. Aluminum.

1. *Sheet Aluminum.* Sheet aluminum signs shall be ASTM B 209 alloy 6061-T6 or 5052-H38 with mill finish. Thickness, dimensions, hole sizes, and hole locations shall be shown on the Plans. All panels shall be flat and straight within commercial tolerances established by the aluminum industry.

   Sheet aluminum signs shall be treated with a chromate type chemical conversion coating in accordance with ASTM B 449, Class II.

2. *Extruded Aluminum.* Extruded aluminum panel signs shall be ASTM B 221 alloy 6063-T6. Thickness, dimensions, hole sizes and hole locations shall be as shown on the Plans. All panels shall be flat and straight within commercial tolerances established by the aluminum industry. The extruded aluminum shall be free of corrosion, white rust and dirt.

   Type A edge strip shall be aluminum ASTM B 221 alloy 6063-T6. Aluminum Type B sheet metal screws with slotted pan heads shall be placed on 24-inch centers maximum to secure the edge strips to the sign panels. On signs with width of 36 inches or less, a minimum of three screws shall be used.

B. Galvanized Steel. Galvanized sheet steel sign material for flat or formed steel panel signs and edge strips shall be galvanized steel sheet, Physical (Structural) Quality ASTM A 446, Grade A, Coating Designation G90. Material used for flat sheet signs shall be stretcher leveled. Thickness, dimensions, hole sizes and hole locations shall be as shown on the Plans. Galvanizing shall not be done until the sign material has been cut to the proper size and shape and all required bolt holes punched. Holes for fastening letters, symbols, borders and edge strip may be drilled after galvanizing. The steel sign material shall be free of ragged or sharp edges and shall be free of corrosion, rust and dirt.

C. Sign Faces. All sign faces are to be made in accordance with the detailed drawings as shown in the latest revision of the Manual on Uniform Traffic Control Devices for Streets and Highways, and/or as shown on the Plans.

D. ***Basis of Acceptance.*** A Type A or B Certification is required for acceptance of sign panels, extrusions and shapes covered in this Section.

719.02 SUPPORT ARMS AND FITTINGS.

A. Materials. Sign supports for sheet signs shall be structural steel conforming to AASHTO M 183 or aluminum alloy conforming to ASTM B 221 alloy 6063-T6. Structural steel signs shall be galvanized in conformance with AASTHO M 111 after being cut to length and after all required holes are punched or drilled. Thickness, dimensions, hole sizes and hole locations shall be as shown on the Plans.

B. Fabrication. Fabrication of all signs, bracket arms and fittings shall be accomplished in a uniform and workmanlike manner. All fabrication, including cuttings, shearing and punching, shall be completed prior to metal degreasing, etching and application of reflective sheeting. All parts shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs, and all defects resulting from fabrication.

C. Basis of Acceptance. A Type A or B Certification is required for acceptance of material in this Section.

Galvanization will be determined by a sample or coupon test specimen galvanized in accordance with AASTHO M 111, Section 8.

719.03 FASTENERS.

A. Aluminum Signs. Sheet and extruded aluminum. Bolts for fastening sheet aluminum signs to sign bracket arms shall be aluminum fasteners and collars of the size shown on the Plans.

Panel bolts, hex nuts, post clip bolts, stop nuts and flat washers shall be aluminum ASTM B 209 alloy 2024-T4. Extruded aluminum signs shall be attached to posts on each side as shown on the Plans with post clip, post clip bolt and nut and flat washer. Flat washers shall be used under each nut to prevent gouging.

B. Galvanized Steel Signs. Sheet and panel steel signs shall be mounted by use of galvanized bolts, nuts and washers of the size and types shown on the Plans.

719.04 REFLECTIVE AND NON-REFLECTIVE SHEETING.

A. Description. Reflective sheeting used in the fabrication of reflectorized sign faces shall be of types as follows:

Type A. Enclosed lens type consisting of spherical lens elements embedded beneath the surface of a smooth transparent, flexible plastic, resulting in a non-exposed lens, optical reflecting system.

Type B. Encapsulated lens type consisting of spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent waterproof plastic having a smooth surface.

All reflective sheeting shall be of the Type A Classification unless otherwise required by Plan details or the Proposal.

Non-reflective sheeting shall consist of a smooth, flat, durable gloss plastic film.

All sheeting shall be weather-resistant and have a pre-coated adhesive backing protected by a removable liner.

B. Requirements.

1. *Photometric.* Type A Material Requirements for Type A Reflective Sheeting shall be in accordance with the provisions of Federal Specification L-S-300 for Type 1, Class 1 or 2 and Reflectivity Level 1 and the requirements further noted in this Specification.

   Type B Material Requirements for Type B Reflective Sheeting shall be in accordance with the provisions of Federal Specification L-S-300 (latest revision) for Type 1, Class 1 or 2, Reflectivity Level 2, and the requirements further noted in this Specification. Material requirements for non-reflective sheeting shall be the same as that prescribed for reflective sheeting except for the reflectivity requirements and the material shall have a gloss reading of 50 to 70 units at an angle of 45° when measured with a photo voltmeter or a meter capable of giving equal results.

2. *Color.* The chromaticity limits of the colors shown in L-S-300 Table 1, shall be modified to conform to the requirements of the Federal Highway Administration color charts for the colors covered by the tolerance charts.

3. *Tests and Samples.* The Contractor shall furnish a certified test report confirming compliance with the requirements noted hereinbefore in this Specification.

   Verification of color by comparison of samples with color tolerance charts published by the FHWA shall be made on all samples. Noticeable variation of color in a production run shall be cause for ordering inspection of all sign faces and the rejection of any sign face outside of the tolerances provided by the color tolerance charts.

   All testing shall be in accordance with Federal Specification L-S-300.

All completed signs shall be inspected on the project by the Engineer. Faulty application, blemishes or other faults that might impair the serviceability of the sign or any noticeable color mismatching when viewed from a distance of 25 feet under both daylight and night time conditions shall be cause for rejection of any sign face.

719.05 SIGN COPY.

A. Screen Copy.

1. *Direct Screening Process.* The direct screening process may be used for applying non-reflectorized copy on reflectorized or non-reflectorized backgrounds. This method is normally applicable to black copy.

2. *Reverse Screening Process.* The reverse screening process shall be used to provide reflectorized messages on colored backgrounds by the use of transparent color stencil paste applied to a sheeting background of silver white color. This method is normally applicable to a requirement for white copy, for example, "STOP" sign.

3. *Material and Application.* Material for application by the silk screen method shall be a top quality exterior baking screen enamel or stencil paste manufactured especially for use on roadway signs and compatible with the type sign background material being used. Application of screened copy and curing thereof shall be in strict compliance with the manufacturer's recommendations of the background material.

   Colors shall be durable and consistent with the requirements of the FHWA Standards Colors Charts for Signs. The color shall be uniform in acceptable hue when viewed in daylight or under normal headlights at night.

4. *Final Finish.* All of the above-mentioned signs shall be treated after completion as prescribed in Subsection 850.04 D.

5. *Tests.* All screening enamel, stencil pastes and process inks when applied in accordance with recommended procedure and exposed to accelerated weathering for 1000 hours in accordance with Federal Test Method 141/6151 shall show no appreciable discoloration, cracking, crazing, blistering or lifting.

719.06 DEMOUNTABLE REFLECTORIZED AND NON-REFLECTORIZED CUTOUT LETTERS, NUMERALS, ARROW, SYMBOLS AND BORDERS.

A. ***General.*** Demounted reflectorized legend, symbols and borders shall consist of acrylic plastic prismatic reflectors supported by embossed aluminum frames. The prismatic reflectors are to be installed in the embossed aluminum frames

so as to be an integral part of the character, or otherwise securely affixed to prevent their displacement in handling or service. Copy in which reflectors are assembled by means of tape are unacceptable. Demountable non-reflectorized legend, symbols, and borders shall consist of embossed aluminum without plastic reflectors.

Letter design shall be in accordance with the 1966 FHWA standard alphabets (as revised) or other approved standards, modified to accommodate the required reflectors. All items shall be fabricated from sheet aluminum having a minimum thickness of 0.040 inch.

Mounting holes shall be provided within the frames to permit the use of an approved fastener. The size and spacing of reflector holes for reflectorized legend and borders shall be such as to afford maximum night legibility and visibility of the finished cutout figure. There shall be no reflector holes for non-reflectorized legend and borders. After metal fabrication has been completed, the finishing process shall be as follows:

B. Reflectorized Legend and Borders. Aluminum frames shall be degreased, etched, neutralized and treated with an amorphous chromate coating in accordance with ASTM D 1730.

After treating, frames shall be finished with a high-quality baking enamel which shall be applied in strict accordance with the recommendations of the manufacturer. The color shall be white or black as specified on the Plans.

C. Non-reflectorized Legend and Borders. Aluminum legend and borders shall be degreased, etched, neutralized and treated with an amorphous chromate coating in accordance with ASTM D 1730. After treating, legend and borders shall be finished with baking enamel, to be applied in strict accordance with the recommendations of the manufacturer. The color of the non-reflectorized legend and borders shall be as shown on the Plans.

D. Prismatic Reflectors.

1. General. The reflector lens shall be Methyl Methacrylate meeting requirements of Federal Specifications L-M-500a, Type I, Class 3.

The reflector shall consist of a clear and transparent plastic face, herein referred to as the lens, and an opaque or translucent back fused to the lens under heat and pressure around the entire perimeter to form a unit permanently sealed against dust, water and water vapor. The reflector shall be basically colorless.

The lens shall consist of a smooth front surface free from projections or indentations other than for identification or orientation of the reflector. The rear surface shall have a prismatic configuration such that it will

affect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

2. *Optical Requirements.*

2.1 *Definitions.* Incidence angle shall mean the angle at reflector between direction of light incident on it and direction of reflector axis.

Divergence angle shall mean the angle at reflector between observer's line of sight and direction of light incident on reflector.

Specific brightness shall mean candlepower returned at the chosen divergence angle by a reflector per square inch of reflecting surface for each foot-candle of illumination at the reflector.

2.2 *Specific Brightness.* The specific brightness of each reflex reflector intended for use in cutout letters, symbols and accessories shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

DIVERGENCE ANGLE DEGREES	INCIDENCE ANGLE DEGREES	SPECIFIC BRIGHTNESS CANDLEPOWER/SQUARE INCH/FOOT-CANDLE
1/10°	0°	14.0
1/10°	20°	5.6

2.3 *Optical Testing.* The specific brightness shall be determined in accordance with Federal Test Method 370.

Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested. Failure of more than 4 percent of the reflectors subjected to test shall constitute failure of the shipment. In samples of less than 25 reflectors, failure of more than one reflector shall constitute failure of the shipment.

3. *Durability.*

3.1 *Seal Test.* The following test will be used to determine whether a reflector is complete sealed against dust and water.

Submerge the samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches of mercury for 5 minutes. Restore atmospheric pressure and leave samples submerged for 5 minutes; then examine the samples for water intake. Failure of more than 4 percent of the reflectors tested shall be cause for rejection of the shipment or lot. In samples of less than

25 reflectors, failure of more than one reflector shall constitute failure of the shipment.

3.2 Three assembled cutout letters, symbols or accessories shall withstand the combined corrosion test set forth in ASTM B 117.

E. Sampling Procedure. Samples of the reflectorized legend, consisting of letters, numerals, border and symbols will be selected at random to obtain equitable representation of the various size groups according to the stock quantities involved.

The sample of reflectorized legend shall provide sufficient reflectors of each size for compliance with the following schedule:

QUANTITY OF EACH SIZE REFLECTOR	NUMBER OF REFLECTORS PROVIDED BY SAMPLE
100 or less	3
100 to 800	3 percent
800 to 5000	25 to 50
5000 and over	100

F. Packaging. Each cutout figure shall be supplied in an individual package with content marked thereon.

721.00 GALVANIZED STEEL SIGN POSTS

Description. This Section establishes the requirements for galvanized steel sign posts in Section 851.

A Type A or Type B Certification will be required. Galvanized specimens shall be submitted for testing in accordance with Section 8, AASHTO M 111.

721.01 PIPE POSTS. Galvanized steel pipe posts shall be made from new galvanized steel pipe of the size shown on the Plans and shall conform to ASTM A 53. When the wall thickness or weight is not designated, standard weight pipe, Schedule 40, shall be used. Galvanizing shall be done after fabrication and punching or drilling of holes that may be permitted on the Plans, except as provided herein. Cap plates shall be structural steel, AASHTO M 183 galvanized in accordance with AASHTO M 111 or other materials when shown on the Plans.

Sign posts used for signs that are minor items or incidental construction, when approved by the Engineer, may be fabricated and holes drilled or punched after galvanizing provided that the exposed metal surfaces shall be re-galvanized, metalized or painted with an approved zinc dust-zinc oxide paint.

721.02 WIDE FLANGE BEAM POSTS. Galvanized steel wide-flanged beams shall be new material of the size shown on the Plans and shall conform to the requirements of AASHTO M 183. Galvanizing shall be in accordance with AASHTO M 111 and shall be done after punching or drilling of any holes or cutting that may be permitted by the Plans or by the Engineer.

723.00 REINFORCING STEEL

723.01 BAR STEEL REINFORCEMENT – (BILLET STEEL). This Specification covers plain and deformed billet steel bars for concrete reinforcement and dowels used in the work. The billet steel bars shall meet the specification requirements of AASHTO M 31, Grade 40 or Grade 60. Reinforcing steel bars of structural Grade 60 shall be furnished when specified and shown on the Plans.

Sampling. A sample shall consist of two bars, not less than 24 inches in length, from each lot of bars in the shipment. The chemical analysis report shall be furnished with each lot. The term lot used in this paragraph means all bars of one size bearing one manufacturer's roll mark.

723.02 AXLE STEEL. This Specification covers deformed and plain axle steel bars for concrete reinforcement and dowels which may be used in lieu of those as specified in Subsection 723.01. Axle steel bars shall meet the Specification requirements of AASHTO M 53, Grade 40 or Grade 60. Reinforcing steel bars for structural Grade 60 shall be furnished when specified and shown on the Plans.

Sampling shall conform to Subsection 723.01 above except that the carbon range for each lot will be required in lieu of a full chemical analysis.

723.03 WELDED STEEL WIRE FABRIC. These Specifications cover cold drawn steel wire to be used as such, or in fabricated form, for the reinforcement of concrete.

The fabric shall comply with the requirements of AASHTO M 55 or AASHTO M 221. The size and spacing of wires in the fabric shall be as shown on the Plans. Welds shall be of sufficient strength that they will not be broken during handling or placing.

Reinforcing fabric shall be furnished in flat sheets or rolls. Any material that may have become bent or distorted must be straightened and otherwise put in proper condition before using. When placed in the work, the fabric shall be free from excessive rust, scale, or coating of any character which will impair its bond with the concrete.

723.04 STEEL WIRE STRAND FOR PRE-STRESSING. Steel for pre-stressing shall conform to the Specifications for Uncoated Seven-Wire Stress-Relieved Strand for Pre-Stressed Concrete, AASHTO M 203 except that Type A Certification shall be furnished for each reel or coil of strand included in the work.

723.05 BARS FOR POST-TENSIONING. Bars shall be high-strength alloy steel bars meeting the requirements of AASHTO M 275. A Type A Certification shall be furnished for each heat of material.

723.06 POST-TENSIONING STEEL WIRE. Steel cable for post-tensioning shall conform to the Specifications for Uncoated Stress-Relieved Wire for Pre-Stressed Concrete, AASTHO M 204, Type BA or WA. A Type A Certification shall be furnished for each coil of wire.

When low-relaxation wire is specified, it shall meet the requirements of the supplement to AASHTO M 204.

723.07 ANCHORAGES FOR POST-TENSIONED TENDONS. All anchorages shall be capable of de-tensioning or re-tensioning pre-stressing steel at any time prior to grouting. The load from the anchoring device shall be distributed to the concrete by means of approved devices.

Anchorages shall develop the specified ultimate strength of the tendons without exceeding anticipated set.

Bending stresses in the plates or assemblies induced by the pull of the pre-stressing steel shall not exceed the yield point of the material. All parts of the anchoring devices will be at least 2 inches inside the final end surfaces of the members. A Type A certification shall be furnished for each heat of anchorage plates.

723.08 COLD DRAWN STEEL WIRE. Cold drawn steel wire for concrete reinforcement for spiral ties and other reinforcing designated on the Plans in W (Wire) sizes shall comply with AASHTO M 32.

723.09 EPOXY-COATED REINFORCING BARS. Description.

These Specifications cover organic protective coatings electrostatically applied to steel bars to be used for concrete reinforcement.

A. Materials. Epoxy-coated reinforcing bars and epoxy coating material shall meet the requirements of AASHTO M 284 Specifications, except as otherwise stipulated under these Specifications.

1. *Reinforcing Steel.* Reinforcing steel bars shall meet the requirements of Subsections 723.01 or 723.02.

2. *Coating Materials.* Coating materials proposed for use shall be approved by the Engineer.

3. *Color.* The finished epoxy coating shall be of a color and tone that will give easily apparent visual indications of holidays, damage or corrosion staining.

B. Certification. A Type D Certification shall be submitted in accordance with Subsection 106.12.

C. Fabricator's Quality Control. Epoxy coating will be accepted only from fabricators who have an approved quality control program. The quality control program and schedule shall be submitted to the Engineer for review and approval prior to any fabrication.

724.00 STRUCTURAL STEEL

Description. This Section covers the requirements for structural steel, bolts, nuts and washers, shear connector studs, and filler material for welds in Section 506.

724.01 STRUCTURAL STEEL.

A. Materials Covered. Steel shall be furnished according to the following Specifications.

B. General Requirements. The general requirements for delivery of rolled steel plates, shapes, sheet piling, and bars for structural steel shall conform to AASHTO M 160.

C. Specific Requirements. Structural steel shall conform to the requirements of the current AASHTO Specification as follows:

Structural Steel (A 36)	M 183
High-Strength Low-Alloy Structural Steel (A 242)	M 161
High-Strength Low-Alloy Columbium-Vanadium Steels (A 572)	M 223
High-Strength Low-Alloy Structural Steel (A 588)	M 222
High-Yield-Strength, Allow Steel Plate (A 514)	M 244

Unless otherwise specified, steel used in structures shall conform to the current specification for structural steel, AASHTO M 183.

Unless otherwise shown on the Plans, structural steels for main load carrying members subject to tensile stresses listed herein shall meet the longitudinal charpy V-notch tests for zone 2 specified in the AASHTO Supplemental Requirements for the structural steel being used. Members such as shoes, diaphragms, stiffeners (including bearing stiffeners), lateral bracing, diagonals, armor joints and finger joints shall not be considered main load carrying members.

Steel for secondary non-stress-carrying members in unpainted structures shall conform to AASHTO M 222 or ASTM A 242 except that ASTM A 242 steel member shall be used only for riveted or bolted construction, unless the weldability of the steel is established in accordance with AWS D1.1. Mill test reports shall be furnished for each heat of material.

724.02 BOLTS, NUTS, WASHERS, AND OTHER FASTENERS.

A. Bolts, Nuts and Washers. Bolts, nuts and circular washers shall conform to the requirements of AASHTO M 164 except as provided in paragraph B of this Subsection.

When specified on the Plans, nuts, bolts and circular washers conforming to the requirements of AASHTO M 253 shall be used. Bolts manufactured to AASHTO M 253 are identified by markings on the top of the head with the symbol "A 490" and the nuts shall be marked on one face with the legend "2H" or "DH".

B. Other Fasteners. Other fasteners which meet the chemical composition requirements of AASHTO M 164 and which meet the mechanical property requirements of the same specification in full-size tests and which have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions may be used. Such alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.

C. Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. Holes may be punched, sub-punched and reamed, or drilled, as required by the applicable code or specification and shall be a nominal diameter not more than 1/16 inch in excess of the nominal bolt diameter.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale, except tight mill scale, and shall also be free of burrs, dirt and other foreign material that would prevent solid seating of the parts.

Contact surface within friction-type joints shall be free of oil and paint, except for inorganic zinc primer and galvanizing.

When shown on the Plans or in the Proposal that the structural steel is to be left bare and unpainted, the chemical composition of bolts, nuts and washers shall be modified to provide atmospheric corrosion resistance similar to the structural steel being used.

724.03 WELDING.

A. General. All shop and field welding shall be arc welding and shall be done in accordance with the current specifications of AWS Structural Welding Code as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, and as follows:

Radiographic and Magnetic Particle Inspection of welds when made will be paid for by the City as a part of the structural steel inspection.

No welding will be allowed when the air temperature is lower than 20° F, when surfaces are wet or exposed to rain, snow, or wind, or when operators are exposed to inclement conditions that will hamper good workmanship.

Any moisture present at the point of welding shall be driven off by heat before welding commences. Wind breaks shall be required for the protection of all welding operations.

The welder shall place his permanent identification mark with a low-stress stencil adjacent to all welds made by him as soon as they are completed.

If a fabricating shop prequalifies its welders, welding operators and tackers in accordance with this Specification and certifies to the Engineer that the welder, welding operator or tacker has been prequalified within 12 months previous to the beginning of work on the subject structure, the Engineer may consider him qualified. The certificate shall state that the welder, welding operator or tacker has been doing satisfactory welding of the required type within the three-month period previous to the subject work. A certification shall be submitted for each welder, welding operator or tacker and for each project, stating the name of the welder, welding operator or tacker, the name and title of the person who conducted the examination, the kind of specimens, the position of welds, the results of the tests and the date of the examination. Such a certification of prequalification may also be accepted as proof that a welder, welding operator and tacker on the field welding is qualified, if the Contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose.

B. Qualification of Welders.

1. *Field Welders.* Field welders shall be qualified in accordance with the current AWS Structural Welding Code as modified by the AASHTO Standard specifications for Welding of Structural Steel Highway Bridges.

   Field welder as used herein refers to a unit consisting of the welder, the welding machine, and a class or group of manual shielded electrodes suitable for welding structural grades of steel.

   The evidence of qualification of each field welder shall be submitted to and accepted by the Engineer before starting any welding operations.

2. *Shop Welders and Welding Operators.* Shop welders and welding operators shall be qualified in accordance with the Section on Qualification of the AWS Structural Welding Code, as modified by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

725.00 MISCELLANEOUS METALS

725.01 DESCRIPTION. This Section covers steel forgings, cold rolled shafting for pins and rollers, steel castings, iron castings (gray and ductile), and bronze castings.

725.02 COLD ROLLED SHAFTING FOR PINS AND ROLLERS. Pins and rollers up to 8 inches in diameter, unless marked as forgings on the Plans, may be furnished from cold finished shafting meeting the requirements of the Standard Specifications for Commercial Cold Finished Carbon Steel Bars and Shafting, AASHTO M 169, Grade 1035 or 1045, providing that tensile tests made on specimens machined from the finished shafting shall develop a minimum tensile strength of 75,000 pounds per square inch.

725.03 STEEL CASTINGS. Steel castings shall conform to the requirements of the Standard Specification for Mild to Medium Strength Carbon Steel Castings for General application, AASHTO M 103. Grade 65-35 shall be furnished unless other specified.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. All covers and gratings, fitting into frames shall fit properly and seat uniformly and solidly.

725.04 IRON CASTINGS.

A. General. Iron Castings shall be true to pattern in form and within industry acceptable dimensional tolerances for the size and/or shape of unit. They shall be filleted at angles and the arises shall be sharp. Exposed surfaces of the castings shall be free from burnt-on sand and shall be reasonably smooth. Runners, risers, fins, and other cast-on pieces shall be removed. Where shown on the Plans, mating surfaces of cast assemblies shall be machined to provide flat, true surfaces, and ensure well-mated, non-rocking and non-rattling components.

All covers or grates fitting into frames shall fit tight and seat uniformly and solidly. They shall not rock nor rattle when installed.

Where weight is specified on the Plans, castings shall conform to such requirements. All castings shall be identified in an area as shown on the Plans or in an area visible when the unit is installed. The lettering shall be recessed 1/16 inch from the surrounding surface. In the case of a surface having a grid pattern, the lettering shall be recessed into a non-gridded area. Lettering content required shall be sufficient for identification. General requirements will be for identifying manufacturer or distributor, heat and/or pour number and date of casting.

B. Gray Iron Castings. Gray iron castings shall meet the requirements of AASHTO M 105 and shall be Class 35 B for manhole covers and inlet grates. All others shall be Class 30 B unless otherwise shown on the Plans or specified herein.

C. Ductile Iron Castings. Ductile iron castings shall meet the requirements of ASTM A 536, Grade 65-45-12.

D. Malleable Iron Castings. Malleable iron castings shall meet the requirements of ASTM A 47.

725.05 ACCESSORIES FOR CASTINGS AND SPECIAL FABRICATED UNITS.

A. General. Bolts required for casting assemblies shall meet the requirements of AASHTO M 164. They shall be machine bolts furnished galvanized (zinc-coated), cadmium plated, or stainless steel.

Support beams required for casting assemblies shall meet the requirements of AASHTO M 183. "T" handles as shown on standard drawings for locking manhole covers shall be furnished. The minimum shall be two handles for up to and including 20 locking manhole covers and one for every 20 thereafter.

B. Special Fabricated Drainage Grates. Welded steel drainage grates shall meet the material requirements of AASHTO M 183 for the load-bearing members. Stiffeners shall be specified by the manufacturer. Welding shall meet all applicable standards as covered in Section 724 and references. Grate units shall be furnished galvanized after fabrication or painted with an inorganic zinc ethyl silicate base primer and vinyl finish coat. Galvanization shall be in accordance with the requirements of AASHTO M 111. Paint shall meet the materials requirements of Subsection 730.04. Cleaning of grate units (for either procedure) and paint application shall be as covered in Subsection 506.04 D. Painting. Only those procedures which apply to grate-sized units shall apply, and shop-applied paint shall be utilized for both coats.

Pipe for use in fabricated grates shall meet the requirements of ASTM A 53 and be furnished in standard weight, unthreaded mill finish unless otherwise stated. Hydrostatic pressure testing shall be waived. After welding, the grate units shall be thoroughly cleaned and pressure vent holes punched or drilled (only for galvanized units). See Plans for location of vent holes. See paragraph above for paint and painting requirements.

Angle iron and strap iron used for end members or spacers shall meet the requirements of AASHTO M 183 mill-finish.

Butt-welded pipe shall be acceptable for use as grate members with the approval of the Engineer.

725.06 BRONZE. Bronze castings shall conform to the requirements of AASHTO M-107 Copper Alloy C91100. Bronze bearings and expansion plates shall conform to the requirements of the Specifications for Rolled Phosphor Bronze Bearings and Expansion Plates for Bridges and Structures, AASHTO M 108 Copper Alloy C51000.

The class of metal shall be shown on the Plans.

726.00 DRAINAGE CONDUITS

726.01 DESCRIPTION. This section covers the materials requirements for surface and subsurface drainage conduits of the kind specified on the Plans and the requirements of Section 613.

726.02 MATERIALS.

A. Ridged Conduits. Materials covered in this Subsection: non-reinforced concrete pipe, drain tile, porous and perforated pipe, reinforced concrete circular, elliptical, and arch pipe; cast (ductile) iron, precast reinforced concrete box sections, manhole sections, inlet boxes, and junction boxes meeting the following requirements.

1. Concrete and Clay Culverts.

1.1 Concrete Sewer, Storm Drain, and Culver Pipe shall conform to AASHTO M 86 or M 86M (Metric).

1.2 Reinforced Concrete Culvert and Storm Drain shall conform to AASHTO M 170 or M 170M (Metric). In addition to the Pipe Classes shown in AASHTO M 170, a special design Class IV/V conforming to AASHTO M 170 may also be used. Design criteria for Class IV/V is a mid-line interpolation between the design criteria shown for Class IV (Table 4) and Class V (Table 5) of AASHTO M 170.

1.3 Reinforced Concrete Arch Culvert and Storm Drain shall conform to AASHTO M 206 or M 206M (Metric).

1.4 Reinforced Concrete Elliptical Culvert and Storm Drain shall conform to AASHTO M 207 or M 207M (Metric).

1.5 Reinforced Concrete D-Load Culvert and Storm Drain shall conform to AASHTO M 242 or M 242M (Metric).

1.6 Concrete Drain Tile shall conform to AASHTO M 178 or M 178M (Metric).

1.7 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated shall conform to AASHTO M 65.

1.8 Clay Drain Tile shall conform to AASHTO M 179.

2. Rigid Metallic Culverts.

2.1 Ductile Iron Culvert Pipe shall conform to AASHTO M 64.

3. *Precast Sewer Appurtenances and Box Sections for Culverts.*

   3.1 Precast Reinforced Concrete Manhole Sections shall conform to AASHTO M 199 or M 199M (Metric).

   3.2 Precast Reinforced Concrete Curb Inlet Boxes shall conform to ODOT Approved Designs.

   3.3 Precast Reinforced Concrete Junction Boxes shall conform to ODOT Approved Designs.

   3.4 Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers shall conform to AASHTO M 259 or M 259M (Metric).

   3.5 Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less than 2 Feet of Cover Subject to Highway Loadings shall conform to AASHTO M 273 or M 273M (Metric).

4. *Concrete and Clay Underdrain.*

   4.1 Concrete Sewer, Storm Drain, Culvert Pipe shall conform to AASHTO M 86 or M 86M (Metric).

   4.2 Concrete Drain tile shall conform to AASHTO M 178 or M 178M (Metric).

   4.3 Perforated Concrete Pipe shall conform to AASHTO M 175 or M 175M (Metric).

   4.4 Porous Concrete Pipe shall conform to AASHTO M 176 or M 176M (Metric).

   4.5 Vitrified Clay Pipe, Extra Strength, Standard and Perforated shall conform to AASHTO M 65.

   4.6 Clay Drain Tile shall conform to AASHTO M 179 or M 179M (Metric).

5. *Pipe Rejection.* Rejection criteria covered herein shall apply to the previously numbered Subsections: 726.02 A. 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 3.1, 3.2, 3.3, 3.4, 3.5, 4.1, 4.3, and 4.4. A lot of pipe represented by test samples may be rejected for failure to meet any of the requirements of the governing Specifications. Any lot of pipe less than 30 days of age, which meets all requirements except the strength tests, may be retested at a later date when so requested by the manufacturer. Individual

sections of pipe may be rejected for failure to meet the Specification requirements of manufacture, and damage acquired in handling, hauling, delivery and installation, with the following exceptions: (1) a single end crack that does not exceed the depth of the joint; (2) damaged ends when chips do not extend more than half of the joint, either from the end of the joint or along the circumference of the pipe, and providing that in the opinion of the Engineer satisfactory permanent patching can be performed during installation.

6. *Joint Filler.* Joint filler for joints in concrete pipe culverts shall meet the requirements of one of the following materials:

6.1 *Cold Applied Mastic Type.* This compound, when applied according to the manufacturer's directions, shall be resilient and adhesive and maintain an effective seal through repeated cycles of expansion and contraction. The material shall comply specifically with the following requirements:

	MINIMUM	**MAXIMUM**
Specific Gravity 25° C/25° C	1.290	1.350
Pounds Per Gallon	10.75	11.25
Percent Soluble in Trichlorethylene	45.0	--
Percent Ash	50.0	55.0
Percent Water by Volume	--	0
Penetration (Standard Cone) 150 gr., 5 sec., 25° C	175	200
Note: This joint filler shall not be used for precast concrete boxes.		

6.2 *Flexible Watertight Gaskets.* The joint materials shall meet the requirements of AASHTO M 198 and provide a proper fit for a satisfactory seal. A Type A Certification stating the material meets AASHTO M 198 shall be submitted.

B. FLEXIBLE CONDUITS. Materials covered in this Subsection: steel conduits, coated and clad steel conduits, structural plates, aluminum conduits, clad aluminum conduits, and non-metallic conduits meeting the following requirements:

1. *Steel Conduits-Culverts.*

1.1 *Metallic (Zinc or Aluminum) Coated, Corrugated Steel Culverts and Underdrains shall conform to AASHTO M 36.*

1.1.1. Sheets for Culverts. Zinc-coated (Galvanized) steel sheets for culverts and underdrains shall conform to AASHTO M 218. Steel sheet, aluminum-coated (Type 2) by the hot-dip process for sewer and drainage pipe shall conform to

AASHTO M 274. Aluminum-zinc alloy coated sheet steel for corrugated steel pipe shall conform to AASHTO M 289.

1.1.2. Types of Culverts. Culverts shall be Type I (Circular) or Type II (Arch) shape unless otherwise specified on the Plans.

1.1.3. Externally Coated or Clad Culverts.

1.1.3.1. Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches shall conform to AASHTO M 190. Type A bituminous coating shall be used unless Type B, Type C, or Type D is specified.

1.1.3.2. Pre-coated Galvanized Steel Culverts and Underdrains shall conform to AASHTO M 245 or M 245M (Metric) or steel sheet, metallic-coated and polymer pre-coated for corrugated steel pipe conforming to AASHTO M 246 or M 246M (Metric).

1.1.3.3. When bituminous coated or mill pre-coated galvanized steel culverts are called for, aluminum coated (Type 2) steel pipe shall be an equal alternate and paid for under Subsection 613.06 F.

2. Aluminum Conduits-Culverts.

2.1 Corrugated Aluminum Alloy Culverts and Underdrains shall conform to AASHTO M 196. If bituminous coating is specified, it shall be by Type A Coating unless Type B or Type C Coating is specified, meeting the requirements of AASHTO M 190.

2.2 Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.

3. Non-metallic Conduits-Culverts.

3.1 Class PS 50 Polyvinyl Chloride (PVC) Pipe shall conform to AASHTO M 278.

3.2 Corrugated Polyethylene Pipe, 12 to 24-inch diameter shall conform to AASHTO M 294.

4. Steel Conduits-Underdrain.

4.1 Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrain shall conform to AASHTO M 36.

4.1.1. Sheets for Underdrain shall conform to AASHTO M 36 (see Subsection B. 1.1.1.)

4.1.2. Types. Underdrain shall be furnished in Type III pipe with Class I perforations unless otherwise specified on the Plans. Minimum thickness shall be 0.052 inch for 6-inch diameter and .064 inch for all other diameters.

4.1.3. Externally Coated or Clad Underdrains. When called for on the Plans, underdrain shall be furnished clad, meeting the requirements of AASHTO M 245 or M 245M (Metric). Thickness of base metal shall be as shown in 4.1.2.

5. Aluminum Conduits-Underdrains.

5.1 Corrugated Aluminum Alloy Culverts and Underdrain shall conform to AASHTO M 196. If bituminous coating is specified, it shall be Type A Coating unless Type B, Type C or Type D is specified, meeting the requirements of AASHTO M 190.

5.2 Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.

5.3 Types. Aluminum underdrains shall be furnished in Type III Pipe with Class I Perforations unless otherwise specified on the Plans. Thickness shall be .060 inch for all sizes.

6. Nonmetallic Conduits-Underdrain.

6.1 Polyvinyl Chloride (PVC) Pipe. Class PS 50 polyvinyl chloride (PVC) pipe shall conform to AASHTO M 278, or highway underdrain conforming to the requirements of ASTM F 758, Standard Specifications for Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport and Similar Drainage with material specification of ASTM D 1784. This underdrain shall be furnished with a minimum pipe stiffness of 46 (Type PS-46).

6.2 Corrugated Polyethylene Drainage Tubing shall conform to AASHTO M 252. An approved, clearly identifiable mark or line shall denote the top of the underdrain pipe (for proper installation).

6.2 Perforations. Perforations in these pipes shall be circular or elongated slots confined to the lower half of the drainage pipe. The pipe shall be furnished round.

7. Structural Pipe for Pipe, Pipe Arches, and Arches.

7.1 Corrugated Galvanized or Coated Steel.

7.1.1. *Description.* This subsection covers galvanized corrugated steel structural plate structures for use as culverts, drainage structures, underpasses and special shapes for field assembly of sizes and dimensions as shown on the Plans.

7.1.2 *Materials.* The materials shall comply with the requirements of AASHTO M 167. The minimum thickness shall be as required to accommodate the design live load on the project.

7.1.3 *Fabrication.* All structural plate structures shall conform to the requirements of applicable sections of AASHTO Standard Specifications for Highway Bridges. Plate sizes and shapes, forming and punching, radius of curvature, gauge, weight, tolerances, corrugation pitch and depth, and workmanship shall be as specified therein. The minimum plate thickness shall be as shown on the Plans.

7.1.4 *Sampling and Testing.* All sheets or plates used in the fabrication of structural plate structures will be sampled and tested as provided in AASHTO M 167.

7.2 Aluminum Alloy.

7.2.1. *Description.* This Subsection covers aluminum alloy structural plate structures for use as culverts, drainage structures, underpasses and special shapes for field assembly of sizes and dimensions as shown on the Plans.

7.2.2. *Materials.* The materials shall comply with the requirements of AASHTO M 219. The minimum plate thickness shall be as required to accommodate the design live load on the project.

7.2.3. *Fabrication.* All structural plate structures shall conform to the requirements of applicable sections of AASHTO Standard Specifications for Highway Bridges. Plate sizes and shapes, forming punching, radius of curvature, gauge, weight, tolerances, corrugation pitch and depth, and workmanship shall be as specified therein. The minimum plate thickness shall be as shown on the Plans.

7.2.4 *Sampling and Testing.* All sheets or plates used in the fabrication of structural plate structures will be sampled and tested as provided in AASHTO M 219.

7.3 Steel End Sections.

7.3.1. Description. This Subsection covers metal culvert end sections for attachment to the inlet and outlet of corrugated galvanized steel pipe and corrugated galvanized steel pipe arch culverts.

7.3.2. Materials. The materials shall comply with the requirements of AASHTO M 36 for base metal, spelter coatings, rivets, riveting and sampling, accepted brands of metal, sheet manufacturer's certified analysis, sheet manufacturer's guarantee and thickness determination and tolerance.

7.3.3. Fabrication.

7.3.3.1. Shape, Dimensions and Weights. The units, to the shape and dimensions and number of pieces as shown in the standard drawing or special details in the Plans for steel culvert end section, shall be manufactured as integral units so they can be readily assembled and erected in place.

7.3.3.2. Bolts. Galvanized bolts may be used for assembly of end sections where more than one piece is used to form the skirt, when sections have not been riveted together.

7.3.3.3. Workmanship. It is the intent of these Specifications that in addition to compliance with the details of construction, the completed unit show carefully finished workmanship in all particulars. This requirement applies not only to the individual unit, but to the shipment as a whole.

The following defects are specified as constituting poor workmanship and the presence of any of them in an individual unit in any shipment, shall constitute sufficient cause for rejection; not meeting specified dimensions, not of the specified shape, uneven laps, ragged sheared edges, loose, unevenly lined or spaced rivets, poorly formed rivet heads, illegible brands, lack of rigidity, or dents or bends in the metal itself.

7.3.4. Sampling and Testing. All steel culvert end sections will be inspected for compliance with the provisions governing fabrication heretofore given. All sheet stock going into such end sections will be sampled and tested as provided in AASHTO M 36 and T 65.

731.00 TIMBER PRESERVATIVES AND TREATMENT

Description. This Section covers the preservative and treatment of timber where preservative treatment is specified.

A. Materials. Timber preservative treatment shall conform to the requirements of AASHTO M 133. Unless otherwise provided, the type of preservative used shall be as follows:

1. *Creosote Oil and Creosote Solutions.* These preservatives shall be used for piling and structural grade timber.

2. *Creosote Oil, Creosote Solutions, Oil-Borne Preservative and Water-Borne Chromated Copper Arsenate.* These preservatives shall be used for guard rail posts, spacer blocks, guide posts, fence posts and post bracing.

B. Preparation of Treatment.

1. *General Requirements.* All lumber, timber, piling and posts shall be of the grade and size specified and shall be inspected for grade and size immediately prior to the treatment.

2. *Inspection.* All materials and processes used in the treatment shall be subject to inspection at the manufacturer's plant, which shall be equipped with all necessary gauges, appliance and facilities to enable the inspector to satisfy himself that the requirements of the Specifications are fulfilled. Inspection for conformity with the specified treatment shall be in accordance with AWPA Standard M2.

C. ***Handling.*** After treatment the lumber of timber shall be handled carefully, properly piled and allowed to dry thoroughly.

732.00 MATERIALS FOR GUARD RAIL, GUIDE POSTS, BRIDGE RAIL, MISCELLANEOUS RAILING AND FENCES

Description. This Section covers the requirements for materials for guard rail, guide posts, bridge rail, miscellaneous railing, fences and gabion wire baskets.

732.01 METAL BEAM RAIL.

A. Beams. Corrugated steel beams shall conform to the requirements of AASHTO M 18 for the gauge specified on the Plans.

B. Guard Rail Posts and Spacer Blocks.

1. Steel Posts. Steel posts and spacer blocks shall be of the length and size shown on the Plans. Hot rolled (forged) steel shapes shall conform to the requirements of AASHTO M 183 and shall be furnished galvanized in accordance with AASTHO M 111. All punching, drilling, cutting, shearing and grinding shall be performed prior to galvanization. Surface defects shall be repaired by grinding, cutting, welding or other industry acceptable method, then coated with two coats of zinc-dust zinc-oxide primer meeting the requirements of Subsection 730.06. Alternate repair techniques shall be those shown in ASTM A 780, Repair of Hot-Dip Galvanized Coatings.

Steel posts and spacer blocks fabricated by the methods and requirements of ASTM A 769 are acceptable alternates. These fabricated posts shall not vary by more than 5 percent from the weight, dimensions and section properties shown for acceptable hot rolled (forged) shapes. Dimensions, weight, and section properties shall conform to the current edition of the American Institute of Steel Construction (AISC) Manual of Steel Construction, or from suppliers' technical publications endorsed by the AISC.

Sharp sheared edges on the fabricated posts and spacer blocks shall be dulled in the upper 18 inches of the post and all edges on the block. Any industry acceptable method to dull these edges may be used, such as grinding, secondary rolling, sand or shot-blasting. This operation and all hole drilling, punching, cutting, shearing, butt welding, etc., shall be fully completed prior to galvanization. Galvanization shall comply with AASHTO M 111and repair techniques as covered above.

Tests on either type of steel post and compatible spacer blocks shall follow test procedures in the appropriate Specifications. Each cut post or spacer block is one unit of a lot which consists of 200 units, or remainder. One failure in any lot shall require testing on two other units. Failure of two of the three selected units from any lot shall be cause for rejection of the entire lot, or portion thereof.

Testing may be done in the field for visual, mechanical or electronic checks to ensure the units adhere to the requirements of AASHTO M 183, ASTM A 769, and/or AASHTO M 111. Suppliers of hot rolled (forged) or fabricated beams shall certify their product complies with all pertinent Sections of the appropriate Specifications for production and galvanization.

Steel base plats and miscellaneous fabricated guard rail hardware shall be of the section and length as shown on the Plans. Connections to posts (cut to proper length) shall be as shown on the Plans. All cutting, welding, and drilling required shall be completed prior to galvanization. Steel plate shall conform to the requirements of AASHTO M 183 and the galvanization shall conform to requirements of AASHTO M 111.

2. *Wood Posts.* Wood posts and spacer blocks shall be of the length and size specified on the Plans. Both type posts (sawed and round) and sawed spacer blocks shall be cut from live trees and shall be close grained. Posts and blocks shall contain only sound wood.

   2.1 *Round Posts.* Both the outer and inner bark shall be completely removed from all round posts by any process which will yield a relatively smooth surface without excessive damage to the grain and/or fiber of the post. All knots shall be trimmed flush with the face. Defects of any kind which give any post or block an unsightly appearance or impair its strength or durability shall be cause for rejection of the individual unit. Surface and strength defects could include distressed outer fiber and/or grain, loose or unsound knots, excessive size or number of shrinkage cracks, and improperly cleaned outer surface for preservative treatment.

   Sound knots will be permitted provided they occur as single distinct knots (not clustered) and the largest dimension of the knot does not exceed 1/3 the diameter (1/9 the circumference) at the point where the knot occurs. Knots are not permitted in the slabbed portion (upper 18 inches of the post). Posts shall not contain short or reverse bends and shall be straight. A line from the butt center to the top center shall not deviate more than 1-1/2 inch from the centerline of the post.

   2.2 *Sawed Posts and Spacer Blocks.* Sawed posts and spacer blocks shall be of the size and length shown on the Plans. They shall meet the requirements of Section 727 for timber and lumber, furnished rough. Minimum stress grade shall be 1200 F unless otherwise shown on the Plans.

2.3 Post Weakening. The leading posts in the approach anchor unit shall be weakened by drilling holes at the ground line as shown on the Plans.

An alternate method of weakening the leading posts in the approach anchor unit will be to make a saw cut (with chainsaw, etc.) ½ inch deep across the eight inch sides of the rectangular posts or ¼ inch deep around the perimeter of round posts. These cuts shall be just above the ground line.

2.4 Preservative Treatment and Inspection. Wood posts and spacer blocks shall be preservative treated in accordance with Section 731.

The size of the post or block shall be determined at the preservative treatment plant immediately prior to treatment. The diameter of round posts shall be determined by a circumference-diameter tape. Minimum diameter at the bottom edge of the slabbed face shall not exceed ¾ inch less than the nominal diameter, and the actual diameter at any point shall not vary from the nominal diameter by more than one inch, over or under.

All sawing, chamfering, boring, slabbing or cutting shall be performed prior to preservation treatment. The only exceptions are the holes shown drilled at the ground line for weakening the leading posts in the approach anchor unit, or holes enlarged or drilled into new wood to facilitate guard rail attachment. These holes shall be thoroughly and uniformly treated by pulling or pushing a preservative solution saturated rag through or into the holes. Multiple passes of the saturated rag may be required to obtain the treatment level required.

C. Guard Rail Hardware. Unless otherwise specified, all fittings, bolts, washers and other accessories shall be galvanized in accordance with the requirements of AASHTO M 111 or M 232, whichever may apply.

732.02 GUIDE POSTS. Guide posts and underdrain marker posts shall be round posts unless otherwise shown on the Plans. They shall be furnished unslabbed and undrilled and meet the requirements of Subsection 732.01 B. 2.

732.03 METAL BRIDGE RAILING.

A. Materials.

1. Structural Steel Shapes for Posts and Rails. Structural steel shapes for posts and rail shall meet the requirements of Section 724.

2. *Metal Beams.* Metal beams shall meet the requirements of Subsection 732.01.

3. *Aluminum Alloy Tubes.* Aluminum alloy tubes for bridge railing shall meet ASTM B 221, alloy 6063 or 6061 T6.

   Welding, when shown on the Plans or permitted, shall be in accordance with Subsection 720.03 A. 1.

   A certificate of analysis executed by the producer shall be furnished to the Department, setting forth the chemical analysis and test results for tubes.

4. *Cast Aluminum Alloy Bridge Railing Posts.* Cast aluminum alloy bridge railing posts shall meet the requirements of AASHTO M 193.

   Welding, when shown on the Plans or permitted, shall be in accordance with Subsection 720.03 A. 1.

   4.1 Anchor Bolts. Anchor bolts and anchoring methods for cast aluminum alloy bridge railing posts shall be as shown on the Plans.

732.04 PIPE RAILING.

A. Galvanized Steel Pipe and Fittings. Galvanized steel pipe and fittings shall meet the requirements of ASTM A 53, standard weight pipe. The requirement for hydrostatic testing shall be waived.

B. Black Steel Pipe and Fittings. Black steel pipe and fittings shall comply with the requirements of ASTM A 53, standard weight pipe. The requirement for hydrostatic testing shall be waived.

732.05 WIRE CABLE AND FITTINGS. Materials shall meet the requirements of AASHTO M 30.

732.06 FENCE, STYLE WWF OR FENCE, STYLE SWF.

A. Description. This item covers the materials requirements for fabric, strand wire and other wire items, framework for fence and gates, and all fastening and bracing hardware necessary for the construction of woven wire or strand wire fence. The height of fence, or number of strands, the height and size of opening for gates, and the shape, size, and length of posts shall be as shown on the Plans or in the Proposal.

B. Materials.

1. *Wire Items.*

1.1 *Woven Wire.* The woven wire shall be design number 832-6-12-1/2 with a Class 1 zinc coating meeting the requirements of AASHTO M 279 or wire of design number 832-6-12-1/2 with a Class 1 aluminum coating meeting the requirements of ASTM A 584.

1.2 *Barbed Wire.* Zinc-coated steel (galvanized) barbed wire shall consist of two strands of 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same direction, or in alternate directions, with 14 gage (0.080 inch dia.) full or half-round 4-point barbs spaced 5 inches apart, with a Class 1 zinc coating on the 12-1/2 gage (0.099 inch dia.) wire. Also acceptable is wire consisting of two strands of 15-1/2 gage (0.067 inch dia.) steel wire twisted in alternate directions, with 16-1/2 gage (0.058 inch dia.) full round 4-point barbs spaced 5 inches apart. The coating shall be a Class 3 zinc-coating on the 15-1/2 gage (0.067 inch dia.) wire. The wire described here shall meet all requirements of AASHTO M 280. Aluminum-coated steel barbed wire shall consist of two strands of 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same or in alternate directions, with 14-gage (0.080 inch dia.) full or half-round 4-point barbs spaced 5 inches apart. The wire may be furnished with aluminum coated steel wire bars, or with aluminum alloy bars. The strands (main wires) shall be aluminum-coated steel-barbed wire meeting the requirements of ASTM A 585. Any barbed wire furnished shall have a minimum assembly break strength of 950 pounds.

1.3 *Smooth Wire.* Smooth zinc-coated (galvanized) carbon steel wire of 11-gage (0.120 inch dia.) medium or hard temper, minimum 85,000 pounds per square inch tensile strength with a Class 1 Coating, or 9 gage (0.148 inch dia.) soft-temper, minimum 60,000 pounds per square inch tensile strength with a Class 1 Coating may be substituted for the top wire or any or all barbed wire shown on the Plans or in the Proposal, with the approval of the Engineer. The smooth wire shall meet the requirements of ASTM A 641.

1.4 *Barbless Wire.* Zinc-coated steel (galvanized) barbless wire shall consist of two strands of 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same direction, or in alternate directions, with a Class 1 zinc coating. Also acceptable is wire consisting of two strands of 15-1/2 gage (0.067 inch dia.) steel wire twisted in alternate directions with a Class 3 zinc coating. The wire described here shall meet all requirements of AASHTO M 280. Aluminum-coated steel barbless wire shall consist of two strands or 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same or alternate direction. The wires shall have a minimum Class 1 aluminum coating. Aluminum-coated steel barbless wire shall meet the requirements of ASTM A 585. All barbless wire furnished shall have a minimum assembly break strength of 950 pounds.

1.5 Tension Wire. Diagonal steel tension wire may be either size listed in Subsection 732.06 B. 1.3.

1.6 Fan, Corner, End, Stretchers and Gate Posts. These posts shall be treated wood of the length and nominal diameter as shown on the Plans. They shall be sound and reasonably straight and shall be treated in accordance with Section 731 of the Specifications. The minimum wood post quality standard grades are shown in ASTM F 537, Section 6.3.

1.7 Line Posts. Line posts shall be either preservative-treated wood or steel, of the nominal diameter (wood), or acceptable shape and weight (steel), and specified length shown on the Plans or in the Proposal. The kind of material selected shall be used throughout any one project except in cases where the Engineer approves a mixture of materials in writing. Wood line posts shall meet the post quality standards of ASTM F 537, Section 6.3 and shall be preservative-treated as covered in Section 731 of the Specifications. Steel posts shall meet the requirements of AASHTO M 281. They shall be furnished galvanized or painted and have an adequate number of deformable clip protrusions on the post, or be furnished with the same number of wire ties as the number of strands to be joined to the posts.

1.8 Post Ties (Wire Ties). Post ties shall meet the requirements of AASHTO M 281 and shall be furnished with a Class 1 zinc coating in minimum 11-gage (0.120 inch dia.).

1.9 Gates. Gates may be furnished with a pipe or tubular framework covered with the same type strand or woven wire as the fence. Pipe or tubing for the gate frames shall meet the requirements of ASTM A 53, standard weight steel pipe (Schedule 40) but the pressure testing (hydrostatic) requirement will be waived. The minimum size will be 1.66 inches outside diameter pipe with a wall thickness of 0.140 inch. The frame shall be covered and braced as indicated on the Plans. Fittings, latches, and hinges shall be a type approved by the Engineer. Pipe or tubing may be substituted for the pipe specified above. The substitution formulation will be as shown on the Plans or in Subsection 732.07 C. 2.2.

Commercially available ranch type metal panel gates may be furnished as an alternate unless otherwise shown on the Plans. Acceptance will be based on visual inspection by the Engineer. Aluminum-coated steel, aluminum alloy or galvanized steel, mill finish or painted, are all acceptable materials for this item.

1.10 Hardware. Various hardware items, hinges and gate latches shall be furnished as shown on the Plans or as recommended by the gate manufacturer. They shall be furnished galvanized in accordance with ASTM A 90 and AASHTO M 232, or with a protective coating compatible with the gate coating or alloy. Eye bolts for fastening fence to existing headwalls or wingwalls on culverts shall be furnished galvanized.

1.11 Staples. Staples used for fastening wire to wood shall be made of 9-gage (0.148 inch dia.) galvanized wire. They shall be minimum 1.5 inches long.

1.12 Nails. Nails shall be round or oval steel wire. They shall be 40 pwt. nails or 20 pwt. spikes, and furnished galvanized.

732.07 FENCE-STYLE CLF.

A. Description. This item covers the materials requirements for chain link fabric and other wire items, framework for the fence and gates, and all fastening and bracing hardware necessary for the construction of chain-link type fence. The height of the fence fabric, the width and height of the gate openings, the size, shape and length of posts and the size and shape of framework members shall be as shown on the Plans or in the Proposal.

B. Classifications. The following classifications and combinations of acceptable materials will be used throughout this Specification:

1. Fence, Style CLF, Type I shall consist of zinc-coated (galvanized) steel wire fabric on either a steel or aluminum mounting system.

2. Fence, Style CLF, Type II shall consist of aluminum-coated steel wire fabric on either a steel or aluminum mounting system.

3. Fence, Style CLF, Type III shall consist of aluminum-alloy fabric on either steel or aluminum mounting system.

4. Fence, Style CLF, Type IV shall consist of vinyl-coated or PVC plastic coated galvanized steel wire fabric on either zinc-coated steel or aluminum mounting system of the same color or a harmonizing color.

5. Fence, Style CLF, Type XX, NOBAR. This nomenclature indicates any of the four combinations of acceptable materials and NOBAR indicates no barbed wire climb barriers above the fence fabric.

6. Fence, Style CLF, Type XX, BARR. This nomenclature indicates any of the four combinations of acceptable materials and BARR indicates fence fabric topped by the number of strands of barbed wire climb barrier as shown on the Plans.

7. Nomenclature. The full nomenclature as shown in Subsection 732.07 B. 5. and 6. is for ordering information only. Unless otherwise specified on the Plans, the Type is optional with the Contractor. The fence pay item may not contain the full nomenclature.

C. Materials.

1. Wire Items.

1.1 Fabric. Unless otherwise specified, the fabric shall be 9-gage (0.148 inch dia.) wire woven in two inch mesh. Unless otherwise specified herein, or on the Plans and in the Proposal, all fabric shall meet the minimum requirements of AASHTO M 181 and references for the type fabric used.

1.2 Tension Wire. The tension wire shall meet the requirements of AASHTO M 181, Class 1 with a minimum zinc coating weight of 0.80 oz/sq ft.

1.3 Barbed Wire. Barbed wire shall meet the requirements of Subsection 732.06 B. 1.2.

1.4 Post Ties. Post ties shall comply with Subsection 732.07 C. 3.4.

1.5 Wire Ties. Wire ties shall comply with Subsection 732.07 C. 3.4.

2. Framework Items.

2.1 End (Terminal), Stretcher (Pull), Corner, and Gate Posts shall be the size, shape, and length as shown on the Plans or in the Proposal. Fan posts shall be the same type of post, shape and size and of a length necessary to provide a smooth top line on the fence. Pipe for round posts shall be Grade 1 steel posts or Grade 2 steel posts meeting the requirements of AASHTO M 181. Grade 1 steel posts shall be pipe meeting the requirements of ASTM A 53 with a minimum 1.8 oz./sq. ft. zinc coating. The post shall have the dimensions shown on the Plans for the height of fence specified. The hydrostatic tests will be waived on the pipe used for fence posts, and the pipe shall be furnished with plain ends.

Roll-formed shapes (other than round) shall be furnished in the size, shape and length shown on the Plans. Unless otherwise specified, they shall be furnished with a minimum 1.8 oz. sq. ft. zinc coating and be fabricated from steel sheet meeting the requirements of ASTM A 570, Grade 45. See Subsection 732.07 C. 2.2 for round roll-formed post shapes, materials and substitution formula.

2.2 Line Posts. Line posts shall be the size, shape and length as shown on the Plans or in the Proposal for the height of fence as specified, and as shown in Subsection 732.07 C. 2.1.

Grade 2 steel posts shall be round pipe or tubing manufactured by cold rolling and electric resistance welding of steel strip. Exterior and interior corrosion resistance coating shall conform to the requirements of AASHTO M 181. This applies to material used in Subsections 732.07 C. 2.3 and 732.07 C. 2.4.

Properties (dimensions, weight, and section modulus) for the round pipe as shown in the scheduled on the standard drawing are for Schedule 40 pipe, meeting the requirements of ASTM A 120, (galvanized) zinc-coated. Pipe meeting the requirements for Grade 2 pipe of AASHTO M 181 are acceptable substitutes. The pipe (or tubing) shall be tested to determine the tensile and yield strengths, and the following criteria shall be met. The product of the section modulus (from the scheduled on the standard drawing) multiplied by 25,800 (minimum yield strength in pounds per square inch for Schedule 40 pipe) shall be equal to or be exceeded by the product of the section modulus of the Grade 2 pipe multiplied by its tested yield strength in pounds per square inch. Steel used in Grade 2 pipe shall have a minimum 50,000 pounds per square inch yield strength. The outside diameters of the substituted pipes shall be within 0.1 inch of the Schedule 40 pipe and the section modulus of the Grade 2 (cold-formed process) pipe shall be determined by the formula:

SM = pi (OD4 – ID4) / 32xOD)
Where: SM = Section Modulus
OD = Outside Diameter
ID = Inside diameter
pi = 3.1416 (a constant)

Thickness measurement of the pipe shall be made with micrometers accurate to 0.001 inch.

2.3 Rail (Braces and Top Rail). Material for top rail and braces shall meet the requirements of ASTM A 501 or ASTM A 53 and be furnished in the size and shape as shown on the Plans or in the Proposal. They shall be furnished galvanized to comply with ASTM A

53. See Subsection 732.07 C. 2.2 for round roll-formed brace and rail materials and substitution formula. Dimensions, weight and section properties shown on the Plans are those of ASTM A 501. When substituting for ASTM A 53 pipe, use the same outer diameter pipe. Hydrostatic testing on ASTM A 53 pipe shall be waived.

2.4 Gate Frame. Material for gate frames shall be the size and shape as shown on the Plans or in the Proposal. They shall meet the requirements of ASTM A 501 or ASTM A 53 and be furnished galvanized to the requirements of ASTM A 120. See Subsection 732.07 C. 2.2 for round roll-formed framework materials and substitution formula. Dimensions and section properties shown on the Plans are those of ASTM A 501. When substituting for ASTM A 53 pipe, use the same outer diameter pipe. Hydrostatic testing on ASTM A 53 pipe shall be waived.

3. *Fence Fittings.* The materials requirements, coating specifications and inspection procedures of the following items necessary for chain link fence erection is covered in ASTM F 626, as amended herein:

3.1 Post and line post caps.
3.2 Rail and brace ends.
3.3 Sleeves for top rail.
3.4 Tie wire and clips, minimum 12-gage (0.106 inch dia.) with 0.8 oz./ sq. ft. zinc coating, or aluminum wire as shown.
3.5 Tension and brace bands.
3.6 Tension bars.
3.7 Truss rods.
3.8 Barb arms.

732.08 GABION WIRE BASKETS. Gabion baskets shall be constructed of wire mesh. The wire mesh shall be made of heavily galvanized steel wire having a minimum size of 0.120 inch diameter (U.S. Wire Gage No. 11). The selvage wire shall be made of heavily galvanized steel wire having a minimum size of 0.148 inch diameter (U.S. Wire Gage No. 9). The tie and cross connection wire shall be made of heavily galvanized steel wire having a minimum size of 0.092 inch diameter (U.S. Wire Gage No. 13). All mesh, selvage tie and cross-connection wire shall equal or exceed Federal Specification QQ-W-461H for wire, steel, carbon, (round, bare and coated) including the following specific requirements: finish 5 and class 3 weight of zinc coating.

Gabion basket dimensions shall be subject to a tolerance limit of +3 percent of manufacturer's stated sizes.

The wire mesh shall be twisted to form openings of uniform size generally hexagonal in shape. The maximum linear dimension of the mesh opening shall not exceed 4-1/2 inches, and the area of the mesh opening shall not exceed 8 square

inches. The mesh shall be fabricated in such a manner as to be non-raveling. Non-raveling is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single strand in a section of mesh is cut.

Gabion baskets shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into rectangular baskets of the specified sizes. Gabion baskets shall be of single unit construction; the base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

The gabion baskets shall be equally divided by diaphragms, of the same mesh and gauge as the edges of the gabion, into cells the length of which does not exceed the base width. The diaphragms shall be secured in proper position on the base in such a manner that no additional tying at this junction will be necessary.

All perimeter edges of the mesh forming the gabion shall be securely selvaged or bound so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

Tie and connection wire shall be supplied in a sufficient quantity to securely fasten all edges of the gabion baskets and diaphragms, and to provide four cross-connecting wires in each cell whose height is 1/3 or ½ the base width of the gabion if the gabion is placed on its base or eight connecting wires in each cell if it is placed so that the side height becomes the base, and eight connecting wires in each cell whose height equals the base width of the gabion. Double the ordinary number of internal and external tie wires shall be used in gabions which are a part of the bridge abutments, including wingwalls, or in gabions which are designated on the Plans to require double tie wires.

The Contractor shall furnish a Type A Certification for the wire in accordance with Subsection 106.12 of the Standard Specifications.

733.00 MISCELLANEOUS MATERIALS

General. All materials for pipe, fittings, valves, valve boxes, hydrant risers, and other miscellaneous materials covered shall comply with the requirements of the individual materials set out in this Section.

733.05 REFLECTIVE SHEETING FOR GUIDE POSTS. This item covers reflective sheeting to be used in reflectorized guide posts, or any other post or barrier which requires reflectivity, and shall be in accordance with the requirements for reflective sheeting as provided in Subsection 719.04., Type A. Reflective sheeting for use on the underdrain outlet post (guide post) shall meet the same requirements. Metal backing plates (sheet) for these posts shall conform to the requirements of ASTM A 526, in minimum 30-gage (0.0157 inch thickness) for galvanized sheet, or ASTM B 209 Alloy 1060-H12 in minimum 0.016 inch thickness. Metal bands shall be prepared to receive the reflective sheeting by degreasing and fully cleaning or caustic etching. Wording on band shall be as shown on the current Standard Drawing.

733.07 NONSTICK GROUT.

A. General. Non-shrink grout shall consist of a mixture of portland cement, fine aggregate, water and an approved non-shrink admixture.

B. Materials.

1. *Portland Cement, Water and Aggregate.* Portland cement, mixing water, and aggregate shall conform to Section 701. The gradation requirements of the aggregate will conform to the following:

SIEVE SIZE	PERCENT PASSING
No. 16	100
No. 50	20-50
No. 200	0-10

2. *Non-shrink Admixture.* Non-shrink admixture shall be the type manufactured under a trade name for use in non-shrink grout and approved by the Materials Engineer prior to use.

3. *Premix.* Manufacturer's premix formulations may be used when approved by the Materials Engineer prior to use.

C. Non-shrink Mortar.

1. *Proportioning.* Unless otherwise specified by the manufacturer of the non-shrink admixture, the dry materials shall be proportioned on a 1:1:1 basis by weight, or as follows:

1 sack portland Cement
100 pounds sand
200 pounds non-shrink admixture

2. *Mixing.* The proportioned materials shall be combined and mixed until thoroughly blended. If the sand is noticeably wet, the quantity of free moisture shall be determined as a percentage of the dry weight and the weight of sand adjusted accordingly. Water shall be added in increments until the desired consistency has been obtained. The mixing water will be estimated as a percentage of the total weight of the dry materials. Mortar not used within 20 minutes after completion of mixing shall be discarded. Re-tempering the mortar will not be permitted.

733.08 WATERSTOPS.

A. General. This item covers the requirements for plastic waterstops and rubber waterstops to be used in construction joints of structural concrete, when shown on the Plans, in reasonably close conformity with the dimensions and location shown on the Plans or established by the Engineer.

Waterstops shall have a dense, homogeneous cross-section and shall be produced in continuous lengths not to exceed 100 feet. If any field splices are necessary, they shall be made in accordance with the manufacturer's instructions.

B. Materials. When a particular type of material is not shown on the Plans, either type of material will be acceptable.

Subject to visual inspection and approval by the Engineer, material from an approved source will be accepted on the basis of the manufacturer's identification markings showing the appropriate grade of material.

1. *Plastic Waterstops.* The waterstops shall be extruded from an elastomeric plastic compound, the basin resin of which shall be a polyvinyl chloride (PVC). The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to insure that when the material is compounded, it will meet the performance requirements given in this Specification.

   Sampling shall be in accordance with ASTM Designation D 15 Methods of Sample Preparation for Physical Testing of Rubber Products and Federal Test Method standard No. 601 Rubber, Sampling and Testing.

The material shall meet the following requirements:

PROPERTY	TEST METHOD	PHYSICAL REQUIREMENT
Tensile Strength (die III) min.	4111 a/	1750 psi
Ult. Elongation (die III) min.	4121 a/	350 percent
Low Temp. Brittleness, no failure such as cracking or chipping at	ASTM D 746	-35° F
Stiffness in flexure, ½ in. Span, min.	ASTM D 747	400 psi
a/ Federal Test Method Standard No. 601.		

2. *Rubber Waterstops.* The material for rubber waterstops may be a natural rubber, suitable synthetic rubber, or a blend of natural and suitable synthetic rubber.

   Sampling shall be in accordance with ASTM Designation D 125 Methods of Sample Preparations for Physical Testing of Rubber Products and Federal Test Method Standard No. 601 Rubber; Sampling and Testing.

   The material shall meet the following requirements:

PROPERTY	TEST METHOD a/	PHYSICAL REQUIREMENTS
Tensile Strength (die III) min.	4111	2500 psi
Hardness, Shore Diameter, Type A	3021	60-70
Ult. Elong. (die III) Min.	4121	450%
300% Modulus, min.	4131	900 psi
Water Absorp., 7-day immersion, 73.4° 2° F, by wt. max.	6631	5%
Compression Set, max.	3311 or ASTM D 395, Method B	30%
Tensile Strength after aging Oxygen bomb method, min.	7111	80%
a/ Federal Test Method Standard No. 601.		

C. Acceptance. A Type D Certification in accordance with Subsection 106.12 shall be required.

735.00 MATERIAL FOR ROADSIDE DEVELOPMENT AND EROSION CONTROL

735.01 DESCRIPTION. These Specifications establish the material requirements for roadside development and erosion control.

735.02 SODDING AND SPRIGGING MATERIALS.

A. General. Bermuda grass sod or sprigs to be used as source material shall be a thick stand of common bermuda grass growing on fertile topsoil. Types of bermuda grass other than Common may not be used unless specified or approved by the Engineer. The vegetative parts (rhizomes, stolons, and roots) of bermuda grass shall be viable as indicated by a dense, deep-rooted stand.

The source for sod and sprigs shall be free of reproducing parts of weeds classified as Prohibited Noxious and shall be as free of other legally Restricted Noxious plant materials as required by the Oklahoma Department of Agriculture Seed Law. The proposed source of sod or sprigs will be approved by the Engineer before the beginning of sodding or sprigging operations. Prior to approval, the area shall not be tilled or mowed. However, all vegetative growth exceeding 3 inches in height shall be mowed and the residue removed prior to harvesting the sod or springs.

The sod or sprigs shall be moist when excavated from the source and shall be kept moist until planted. Watering of the sod source, if to be measured for payment, shall be performed when and as directed by the Engineer. Sod in storage which becomes dry, shall not be remoistened and used, but shall be discarded.

B. Sodding. This material shall consist of vegetative parts (rhizomes, stolons, and roots) of bermuda grass with an appreciable quantity of adhering soil.

1. Solid Slab Sod shall be rectangular slabs of bermuda grass having minimum dimensions designated on the standard detail. Bermuda grass vegetative parts shall exist throughout the slab and shall be obtained from soils with a minimum P. I. of 3 and with a soil depth of ¾" to 1" thickness. The slab must have a dense vegetative growth and be capable of being transported in a condition closely resembling its original state.

2. Mulch Sod shall consist of fertile topsoil that contains bermuda grass vegetative parts which have not been harvested within the previous 12 months. Before excavation, the sod shall be disked in different directions to the depth of planned excavation. Each disking shall be at right angles to the preceding disking until the Bermuda grass vegetative parts have been cut into small pieces. The depth of excavation shall be limited to 6 inches unless otherwise determined by the Engineer. The sod shall be excavated immediately after being disked. The sod may be windrowed or otherwise stored for short periods and shall be kept in a moist condition in a manner approved by the Engineer.

3. Mulch Sprigging shall conform to the Specifications for mulch sod, except the depth of excavation shall not exceed 4 inches.

C. Sprigging. This material shall consist of vegetative parts (rhizomes, stolons, and roots) of the Bermuda grass which has been separated from a majority of the adhering soil.

The sprigs for row sprigging and broadcast sprigging shall be removed from the soil with an approved automatic sprig harvester which digs, cleans, and loads the sprigs in one continuous operation. The vehicle in which the sprigs are loaded for transportation shall not have open sides.

As soon as the vehicle is loaded, the sprigs shall be wet thoroughly with water and covered with a heavy canvas or other approved cover to reduce moisture loss. They shall be kept moist and covered until planted, and shall be planted within 48 hours after removal from the soil.

735.03 PLANTING MATERIALS.

***A.* Plant Materials.** The grading tolerances, quality definitions, balling and burlapping Specifications, container and bare-root requirements of plant materials, shall meet the requirement of ANSI Specification Z-60.1, Nursery Stock, except as modified by these Specifications, the Plans or in the Proposal.

All plant materials shall be nursery-grown stock unless collected plant materials are specified or permitted by the Engineer.

Plant material shall be well-grown, health, representative samples of their normal species or variety with a vigorous and well-developed root system. Trees shall have reasonable straight stems and shall be well-branched and symmetrical in accordance with their natural habits of growth. The branch system shall be free from disfiguring knots, sun scald injuries, abrasions of the bark, dead or dry wood, broken terminal growth or other objectionable disfigurements.

Nursery-grown stock are those plants which have been grown by proper cultural treatment and have been transplanted or root-pruned two or more times according to approved nursery practices. All evergreens shall be either balled and burlapped (B & B) or containerized (canned). Deciduous plants are to be bare-rooted (BR), (B & B), or (canned) as specified by the Engineer. (B & B) plant materials shall have solid, firm balls, which have been dug from firm soil that contains a minimum amount of sand.

When nursery grown plants of the species, size and grade specified are not available, collected plant material meeting the Specifications may be substituted if approved in writing by the Engineer. Collected plant material

shall be dug by an approved nursery doing the collecting. The Contractor shall notify the Engineer in writing at least 2 weeks in advance of the time and place of digging collected plant materials so that an inspection of the work and material can be made. Any additional cost for materials, equipment, labor and incidentals required to acquire and use the substitute collected material shall be at the Contractor's expense.

The spread of roots and minimum ball size for collected plant material shall be at least 1/3 greater than that for nursery-grown plant material as specified in ANSI Specification Z-60.1.

Plant materials shall be packed to insure adequate protection against climatic, seasonal or other injuries during transit. Bare rooted (BR) plants shall have their roots kept in a moist, healthy condition, with a suitable material.

Plant materials may be inspected for provisional approval, at any time during the life of the contract. Plant materials not meeting Specifications shall be rejected, and if on the project, removed immediately and replaced at the Contractor's expense.

At the time of delivery all plant materials shall be accurately and legibly tagged with their names and sizes. The Contractor shall furnish the Engineer a written statement, giving the origin of each shipment; an invoice showing quantities, sizes and varieties, and inspection certificates, as required by Federal and State laws, certifying the plant materials to be free from plant diseases and insect pests.

B. Planting Soil Mix. The planting soil mix shall contain one part sand*, three parts sandy loam*, and one part peat moss by volume. These materials shall meet the following requirements:

Sand. Sand is defined as soil material that contains 85 percent or more of sand. The percentage of silt, plus 1-1/2 times the percentage of clay, shall not exceed 15 percent. Included are coarse sand, fine sand, and very fine sand.

Sandy Loam. Sandy loam shall meet one of the following definitions:

1. Soil material that contains 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30 and contains 52 percent or more sand.

2. Soil material that contains less than 7 percent clay, less than 50 percent silt, and between 43 and 50 percent sand.

Peat Moss. Peat moss shall consist of at least 75 percent of partially decomposed stems and leaves of sphagnum, hypnum, polytrichum and other mosses in which the fibrous and cellular structure is still recognizable. It shall

be brown to black in color. Humus peat shall not be acceptable. Peat moss shall have the following characteristics:

- Moisture content shall not exceed 60 percent by weight.
- Ash content shall not exceed 20 percent, based on the oven dry weight of the material.
- The pH value shall be between 3.2 and 7.0 at 77° F.
- Water holding capacity shall be not less than 400 percent, by weight, on an oven dry basis.

The Contractor shall furnish the Engineer with a certificate stating the type of peat moss, the brand name and the place of origin. The certificate shall also contain the cubic feet of compressed material, the compression ratio and the approximate weight per cubic foot. A certificate will not be required if this information is marked on the bales.

(*Textures as determined by U. S. Department of Agriculture Soil Classifications. The materials shall be well-blended until homogenous in texture and composition.)

The planting soil mix shall be free from subsoil roots, brush, refuse and other offensive or deleterious materials that would interfere with proper planting procedures or with future maintenance. It shall be free from harmful quantities of toxic salts or other material that might retard establishment or interfere with the future growth of the specified plant. The mix shall be free from the seeds, roots and other reproducing parts of weeds classified as "Prohibited Noxious" and shall be free of other legally "Restricted Noxious" plant materials as required by Oklahoma Department of Agriculture regulations.

The planting soil materials shall be stockpiled and mixed at a predetermined location approved by the Engineer.

C. Vegetable Compost. The material shall consist of cotton seed hulls, peat moss, chopped peanut hulls, partially decayed and chopped cotton burrs or any combination of these, and shall be free from seeds or other reproducing parts of noxious or objectionable weeds.

D. Orange Shellac. An approved commercial material, manufactured especially for use on pruning cuts.

E. Tree Wrap. The wrap shall be an approved commercial wrapping material made from 2 sheets of 30-pound crepe draft paper that are held together with a suitable asphalt adhesive.

735.04 SEEDING MATERIALS. The kind and quantity of seeds to be planted per acre will be indicated on the Plans or in the Proposal. A list of seeds and the Specifications for them are given in table of seed specifications.

The seed shall be furnished in sealed bags, with each "lot" in separate bags even though mixtures may be called for on the Plans. All labeling required by law shall be intact and legible.

The Contractor shall furnish the Engineer 2 copies of the invoices for the seed. The invoice shall described each species by name, variety, if any, and treatment (hulled, scarified, etc.), if any.

Each "lot" of seed furnished shall have been officially sampled and tested by the Oklahoma State Board of Agriculture, and 2 copies of the report shall be supplied to the Engineer by the Contractor. Each seed test shall have been completed not more than 9 months prior to delivery of the seed.

The information furnished in the seed report for a particular "lot number" shall agree with information appearing on the seed tags having the same "lot number", or the seed of that "lot" will be rejected.

The seed and tags shall not be removed from the original tagged and sealed bag until approved by the Engineer. After approval, the seed may be mixed, sacked and batched as required to facilitate planting, but shall be tagged for identification and weight. The mixing or sacking into batches shall be performed under supervision of the Engineer.

TABLE OF SEED SPECIFICATIONS				
Kind of Seed Common and Botanical Name	**P.L.S. Index Minimum (Note 1.)**	**Purity: Minimum (percent)**	**Germination: Minimum (percent)**	**Weed Seeds: Maximum Permitted (percent) (Note 4.)**
Bermuda grass, common (Cynodon dactylon) unhulled	80			0.2
Bermuda grass, common (Cynodon dactylon) hulled	82			0.2
Bermuda grass, Guymon variety (Cynodon dactylon) unhulled	80			2.0
Bermuda grass, Guymon variety (Cynodon dactylon) hulled	82			2.0
Bluestem, big (Andropogon gerardi) (Note 2)	20			
Bluestem, Caucasian (Andropogon caucasicus)	15			
Bluestem, little (Andropogon scoparious) (Note 2)	15			
Bluestem, Plains (Bothrichloa ischaemum)	30			1.0
Bluestem, sand (Andropogon halli) (Note 3)	20			
Bluestem, yellow (Andropogon ischaemum)	18			
Brome, smooth (Bromus inermis)	70			2.0
Buffalograss (Buchloe dactyloides) (Note 2 & 3)	55			
Burclover (Medicago hispida, arabic or rigidula)		98	85	1.0
Clover, large hop				

(Trifolium procumbens) (Note 5)		95	85	0.5

TABLE OF SEED SPECIFICATIONS (CONTINUED)

Kind of Seed Common and Botanical Name	P.L.S. Index Minimum (Note 1.)	Purity Minimum (percent)	Germination Minimum (percent)	Weed Seeds Maximum Permitted (percent) (Note 4.)
Clover, small hop (Trifolium dubium) (Note 5)		95	85	0.5
Dropseed, sand (Sporobolus cryptandrus)	70			2.0
Fescue, tall (Festuca arundinacea)	80			0.5
Grama, blue (Bouteloua gracilis) (Note 2)	25			
Grama, side-oats (Bouteloua curtipendula) (Note 2)	30			
Indian grass (Sorghastrum nutans) (Note 2)	35			2.0
Lespedeza, striata (Lespedeza straita)		97	90	0.5
Lespedeza, Korean (Lespedeza stipulacea) (Note 5)		97	90	0.5
Lespedeza, sericea (Lespedeza cuneata) (Note 5)		98	90	0.5
Lovegrass, sand (Eragrostis trichodes) (Note 2)	65			0.5
Lovegrass, weeping (Eragrostis curvula)	80			0.3
Millet, German foxtail (Setaria italica)		98	80	0.5
Native grasses				

(Predominately little bluestem) (Note 2)	15			

TABLE OF SEED SPECIFICATIONS (CONTINUED)				
Kind of Seed Common and Botanical Name	**P.L.S. Index Minimum (Note 1.)**	**Purity Minimum (percent)**	**Germination Minimum (percent)**	**Weed Seeds Maximum Permitted (percent) (Note 4.)**
Oats (Avena sativa) Rye (Secale cereale)		95 90	80 70	0.5 0.3
Ryegrass, annual (Lolium multiflorum)	85			0.2
Ryegrass, perennial (Lolium perennial)	85			0.2
Sudangrass (Sorghum vulgare sudanense)		98	80	0.5
Switchgrass (Panicum virgatum)	60			2.0
Wheat (Triticum aestivum)		96	80	0.1
Wheatgrass, western (Agropyron smithii) (Note 2)	56			1.0

Note 1. The P.L.S. Index (Pure Live Seed Index) shall be calculated from information given on the seed tag, as follows: P.L.S. Index = % Purity x (% Germination + % Firm Seed)/100. The pounds of seed shown on the Plans are stated as pounds of bulk seed. If the P.L.S. Index of any seed lot furnished exceeds the minimum P.L.S. index specified by 25 percent or more, the pounds of bulk seed to be planted will be adjusted by using the following formula:

$$P = (SxC)/F$$

Where:

P = Pounds of bulk seed to be planted
S = P.L.S. Index specified
C = Pounds of bulk seed specified
F = P.L.S. Index furnished

Note 2. The seed source shall be Oklahoma, Texas, Kansas, or New Mexico.

TABLE OF SEED SPECIFICATIONS (CONTINUED)
Note 3. The seed shall have been pre-chilled and treated with potassium nitrate in accordance with the Hays Treatment Technique.
Note 4. The seed shall contain no Johnson grass seed. (This note applies to all seed.)
Note 5. The seed shall be treated with an approved nitrogen fixing inoculant, such as manufactured by commercial commercial laboratories suitable for the particular legume. The inoculants shall be stored and handled in accordance with the manufacturer's directions.

735.05 MULCHING MATERIALS.

A. Vegetative Mulch. This material shall consist of straw or hay as specified below. It shall be free from mold or rot and shall be in a good state of preservation when used. It shall be primarily long, heavy-stemmed material. The material shall be delivered dry, in bales and shall be kept dry until applied. The mulch shall contain no seeds which are classified as "Prohibited Noxious" and shall be as free of "Restricted Noxious" as is legally allowed by the Oklahoma Department of Agriculture.

1. Straw shall be the mature stems of barley, oats, rye, or wheat from which the grain has been harvested.

2. Hay shall consist of mature weeping lovegrass, caucasian bluestem, K.R. bluestem or pure stands of the other bluestem hays. The hay shall be free from appreciable quantities of annual grass, short grass or immature tall grass.

B. Fiberglass Roving. This material shall be formed from continuous fibers drawn from molten glass, coated with a chrome complex sizing compound, collected into strands and lightly bound together into a roving without the use of clay, starch, or other deleterious substances. The roving shall be wound into a cylindrical package approximately one foot high in such a way that the roving can be continuously fed from the center of the package through an ejector driven by compressed air and expanded into a mat of glass fibers on the soil surface. The material shall contain no petroleum solvents or other agents known to be toxic to plants or animals.

The fiber glass roving shall meet the following requirements:

PROPERTY	LIMITS	TEST METHODS
Strands per Rove	56 to 64	End Count
Fibers per strand	184 to 235	
Fiber diameter	.00035-.00040 inc.	ASTM D578
Yards per pound of strand	13,000 to 14,000	ASTM D578
Yards per pound of rove	210 to 230	ASTM D578
Organic content (Percent max.)	0.75	ASTM D578
Package Weight	30-35 pounds	ASTM D578

C. Asphalt Mulch. Asphalt mulch shall be MS-2 emulsified asphalt conforming to Subsection 708.03. Before application, the mulching asphalt shall be diluted with water, in the proportion of one gallon of emulsified asphalt to 3 gallons of water.

D. Excelsior Mat. This material shall consist of a machine produced mat of wood excelsior, with the excelsior fibers interlocking to form a continuous web. At

least 80 percent of the fibers shall be 8 inches or longer in length. The web of fibers shall be distributed uniformly throughout the mat, resulting in a mat of uniform thickness and density. The mat shall be covered on one side with extruded plastic netting which shall not exceed a mesh size of 1 inch x 2 inches. The dimension of the mat shall be as follows:

Length:	not less than 150 feet
Width:	48 inches or 60 inches + 1 inch
Dry weight:	0.8 lbs./sq. yd.

The mat shall be smolder resistant. The smolder resistant treatment shall be non-leaching, and shall be non-injurious to vegetation, animals and humans. The leaching resistance test shall be in accordance with Federal Test Method 191, Method 5830. The smolder resistance test shall be conducted after the leaching test and on the air-dried sample. The Contractor shall furnish a Type D Certification for excelsior mat material furnished.

Fasteners meeting the requirements of Subsection 735.06 B. shall be used for anchoring the mat.

E. Jute Mesh. This material shall be a uniform, open, plain weave of new and unused single jute yarn. The yarn shall be loosely twisted and shall not vary in thickness by more than one-half its normal diameter. Jute mesh shall be furnished in strips as follows:

Length: not less than 150 feet
78 Warp ends per width approximately.
41 Weft ends per yard approximately.
Weight: not less than 0.9 lb./sq. yd.

F. Excelsior Mulch. The material shall consist of wood fibers cut from sound green timber. The cut shall be made at a slight angle to the natural grain of the wood, so as to cause splintering of the fiber when weathered.

The excelsior mulch shall have the following properties: Burred wood fibers, major portion shall be approximately 4 inches long. The fiber size shall be 0.024 inches x 0.031 inches + 20 percent.

The total volatile content (moisture, etc.) at the time of manufacture shall not exceed 45 percent, as expressed by the following formula:

$$V = (a-b) \times 100/a$$

Where:

V = Percent volatile content
a = Weight of original sample

b = Weight of dry sample

The material shall be delivered in bales. Each bale shall weigh 80-90 pounds and shall be tagged with the weight at the time of manufacture. Density of the baled material shall be 11-15 lb./cu. ft.

G. Wood Cellulose Fiber. The material shall be composed of natural wood fiber produced from wood chips. It shall contain no growth- or germination-inhibiting factors and shall contain a water soluble, non-toxic coloring agent.

H. Nylon Erosion Control Mat. Nylon erosion control mat shall consist of a bulky structure of entangled nylon monofilaments, melt-bonded at their intersections, forming a stable mat of suitable weight and configuration. The mat shall be resilient, permeable and highly resistant to environmental deterioration and ultraviolet degradation. The color of the mat shall be black and comply with the following physical properties:

1. Material Type. Nylon 6 plus a minimum content of 0.5% by weight of carbon black.

1.1 Dimensions:

Filament diameter	0.0157 in. min.
Weight	0.747 lb./sq. yd. + 7%
Thickness of mat	0.71 in. min.
Width	38.2 in. + 3%
Roll length	109 + 3.3 yd.

1.2 Tensile Properties:

STRENGTH	
Length dimension	282 lb./yd. min.
Width dimension	161 lb./yds. min.
ELONGATION	
Length direction	50% min.
Width direction	50% min.

Note: ASTM D 1682 strip test procedure modified to obtain filament bond strength used to indicate tensile properties.

1.3 Resiliency: Compression load cycling of 100 psi on a 2 in. x 2 in. sample size, crosshead speed of 2 in. per minute.

30 minute recovery (3 cycles) 80% min.

2. Certification. The manufacturer shall furnish a Type D Certification with each shipment of the mat material.

3. *Mat Fasteners.* Mat fasteners meeting the requirements of Subsection 735.06 B. shall be used for anchoring the mat.

4. *Seed.* Common bermuda grass seed, unhulled, shall meet the Specification requirements of Section 735.04 of the Standard Specifications.

I. Inspection of Materials. Prior to delivery of mulching materials, the Contractor shall notify the Engineer of the sources from which he expects to obtain the materials and quantities he expects to obtain from each source. He shall furnish the Engineer with representative samples of the materials proposed for use. The Engineer may use the samples for provision approval prior to delivery. Evidence of wetting, caking or other deterioration at any time before use shall be cause for rejection.

If during application or after placement, the character or action of any mulching material indicates that the material cannot be applied or fastened in accordance with Specifications, it will be rejected and shall be promptly removed from project.

735.06 MULCH FASTENING MATERIALS.

A. Adhesive Fastener. The adhesive fastener shall conform to Specifications for emulsified asphalt, SS-1, Section 708.

B. Mat Fasteners. The mat fasteners shall meet the requirements for the type specified on the standard drawings.

735.07 FERTILIZER AND AGRICULTURE LIMING MATERIALS.

A. Fertilizer. This material shall be a commercial fertilizer composed of the standard materials and conforming to the grade specified. The term grade shall mean the percentages of total nitrogen, available phosphoric acid, and soluble potash, per one hundred weight respective, in accordance with the requirements of the Oklahoma Department of Agriculture.

Fertilizer furnished in standard, factory-sealed containers shall have all labeling required by the Oklahoma Department of Agriculture. The label shall be intact and legible until the contents are used.

Each vehicle load of fertilizer furnished in bulk form shall be accompanied by 2 copies of the purchase receipt, which shall be given to the Engineer upon delivery of the fertilizer. Each receipt shall show the weight, the brand name, grade of the fertilizer and the guaranteed analysis showing the minimum percentage of plant food in the fertilizer. The name and address of the person, firm, or corporation registering or guaranteeing the fertilizer with the Oklahoma Department of Agriculture shall also be shown.

The fertilizer to be broadcast dry shall be in a pelleted or other approved granula form, and the material to be applied by power spray shall be soluble in water and uniform in suspension.

A fertilizer with an identical NPK ratio but of a higher grade than specified may be furnished, provided the application rate is adjusted to the equivalent number of pounds of each plant food element per unit of area as would have been applied with the specified grade.

In the event such a substitution is made, the following formula shall be used in determining the new application rate:

$$a = (b x c) / d$$

Where:

a = New application rate
b = Grade of specified fertilizer (N.P.K.)
(converted from percent to decimal)
c = Specified application rate
d = Grade of new fertilizer (N.P.K.)
(converted from percent to decimal)

B. Agricultural Liming Material. This material shall consist of either agricultural limestone or hydrated lime and shall meet the requirements of Section 706. When agricultural limestone is called for, 70 pounds of hydrated lime may be substituted for 100 pounds of agriculture limestone. Agriculture limestone shall not be substituted for hydrated lime.

Liming material furnished in standard factory-sealed containers shall have all labeling required by the Oklahoma Agricultural Liming Materials Act intact and legible until the contents are used.

Each vehicle load of liming material furnished in bulk form shall be accompanied by two copies of the purchase receipt. This receipt shall be given to the Engineer upon delivery of the liming material. Each receipt shall include: the name of the liming material, the brand or trade name, the net weight, the percent ECCE (Effective Calcium Carbonate Equivalent) and the name and address of the manufacturer, producer, or distributor.

The Engineer will obtain a one-quart sample from each vehicle load of bulk material to be submitted to Materials Laboratory for testing.

736.00 PAVEMENT MARKERS

736.01 CLASS A REFLECTIVE PAVEMENT MARKERS.

A. Design and Shape. The prismatic reflectorized marker shall conform to the shape and dimensions shown on the Plans and shall be so constructed that moisture and road grime will not penetrate or damage the element. Reflector units shall be smooth throughout and made of methylmethacrylate conforming to the requirements of the Standard Specifications for Methacrylate Molding and Extrusion Compounds ASTM Designation, D788. Grade 8 shall be used unless otherwise specified. The reflector shall show no change in shape or color when subjected to the requirements of Test Method OHD-L-24 at a temperature of 140° F with the marker in the vertical position.

The marker shall be molded of methylmethacrylate conforming to Federal Specification L-P-380a, Type 1, Class 3. Filler shall be a potting compound selected for strength, resilience, and adhesion adequate to pass the necessary physical requirements. The marker shall withstand a load of 9000 pounds without breaking or being significantly deformed when tested according to Test Method OHC-L-23.

Horizontal incidence angle means the angle, in a plane parallel to the base of the marker, between a line in the direction of the incident light and a line perpendicular to the leading edge of the reflective surface.

Divergence angle means the angle at the reflector between observer's line of sight and the direction of the light incident on the marker. Specific intensity shall mean candle-power of the returned light at the chosen divergence and incidence angle for each foot-candle of incident light. Federal Test Method Standard 370 will be used to determine specific intensity.

The specific intensity of the reflector at 0.2° divergence angle shall not be less than the following when the incident light is parallel to the base of the marker:

	SPECIFIC INTENSITY		
HORIZONTAL ENTRANCE ANGLE	**CRYSTAL**	**AMBER**	**RED**
0°	2.5	1.5	0.6
20°	1.0	0.6	0.2

B. Sampling and Testing. A minimum of five pavement markers of each type to be used on the project shall constitute a sample. Testing shall be in accordance with testing procedures indicated in this Specification.

A Type A Certification shall be the basis of acceptance of the reflector unit.

736.02 CLASS B NON-REFLECTIVE PAVEMENT MARKERS.

A. Design and Shape. Traffic Buttons shall be round and dome-shaped with a uniform curvature. The top and sides of the buttons shall be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration, and any other defects which adversely affect appearance and application. The bottom of the buttons shall be rough-textured, free from gloss, glaze or any other substances that may reduce its bond to the adhesive.

Each traffic button shall be 4 + 1/8 inch in diameter at the base. Height of the button shall be 11/16 + 1/16 inch. The base of the button shall not deviate from a flat plane by more than 1/16 inch.

B. Physical Requirements. The water absorption of the button shall not exceed 1.0 percent of the original dry weight when tested in accordance with ASTM C 373.

The glazed surface of the button shall not craze, spall or peel when subjected to one cycle of the autoclave test at 250 pounds per square inch in accordance with ASTM C 424.

A random sample of 5 buttons shall be subjected to the compressive load test. The average compressive strength of the 5 buttons shall not be less than 1500 pounds and no individual button shall have a compressive strength less than 1200 pounds.

The button shall be centered, base down, over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be one inch high with an internal diameter of 3 inches and a wall thickness of ¼ inch. A load necessary to break the button shall be applied at a speed of 0.2 inch per minute to the top of the button through a one inch diameter solid metal cylinder centered on the top of the button. Should any of the samples tested for strength fail to comply with this Specification, 10 additional samples will be tested. The failure of any one of the resamples shall be cause for rejection of the entire lot or shipment represented by the samples.

The button shall not break, chip, or crack when subjected to the impact of a one pound steel ball falling freely from a height of 24 inches. Impact tests shall be performed at a temperature of 40 to 45° F with the button resting on but not bonded to a flat steel plate. Buttons shall be heat-aged a minimum of 10 days at 150° F before testing for impact resistance.

C. Color. The color of the buttons shall be as designated on the Plans, shall be uniform, and shall be determined by visual comparison with calibrated standards having C.I.E. Chromaticity Coordinate limits determined in accordance with Federal Methods of Tests TT-T-141, Method 4252 falling within an area having the following corner points:

	1		2		3		4		Brightness
	X	Y	X	Y	X	Y	X	Y	(% MgO)
White	.290	.316	.310	.296	.330	.321	.310	.342	80 min.
Yellow	.470	.460	.515	.485	.545	.455	.190	.425	40 min.

D. ***Glaze Thickness.*** The glazed surface shall have a mean thickness not less than 0.005 inch when measured not closer than ¼ inch from the edge of the button. The glaze thickness shall be measured on a fractured edge of the button to the nearest 0.001 inch by a calibrated scale microscope.

E. ***Sampling and Testing.*** A minimum of ten traffic buttons selected at random will constitute a sample.

736.03 CLASS C REFLECTIVE ALL WEATHER PAVEMENT MARKERS.

A. ***Design and Shape.*** Pavement markers shall consist of an iron casting to which are attached replaceable prismatic reflectors of the type shown on the Plans and as further described in these Specifications. The forward portion(s) of the casting shall be so shaped that the blade of a snowplow, maintainer, or other highway maintenance equipment will be deflected without snagging or damaging the marker. The bottom of the casting shall incorporate anchoring devices designed to fit into the slots or grooves cut in the roadway surface. The marker shall be bonded to the roadway pavement with an approved adhesive. It shall be anchored so that the marker will not be dislodged by traffic, snowplows or other highway maintenance equipment. The casting shall be designed so that the reflector-mounting surface will be 30° to the horizontal and contain provisions for securely attaching replaceable reflectors. Provisions shall be made for fast, easy replacement of reflectors with common hand tools without disturbing the anchorage of the casting. The marker shall withstand a load of 9000 pounds without breaking or being significantly deformed when tested according to test method OHD L-23.

B. ***Casting.*** The casting of the marker shall conform to the shape and dimensions shown on the Plans and shall be a clean substantial casting, free from sand or blow holes or other defects. Surface of the castings shall be free from burnt-on sand and shall be reasonably smooth. Runners, risers, fins and other cast-on pieces shall be removed from the casting and such areas ground smooth. All corners and edges exposed to traffic shall be rounded. Casting shall be made of ductile iron and shall conform to the requirements of ASTM A 536. Grade 65-45-12 shall be used unless otherwise specified. The top of the forward rails of the casting shall have a hardness of 50-55 RC when tested by ASTM E18.

C. ***Reflector.*** The reflectors of the marker shall conform to the shape and dimensions shown on the Plans and shall be so constructed that moisture and road grime will not penetrate or damage the element. Reflector units shall be smooth throughout and made of methylmethacrylate conforming to the

requirements of ASTM D 788. Grade 8 shall be used unless otherwise specified.

The reflector shall show no change in shape or color when subjected to the requirements of test method OHD-L-24. The temperature shall be 140° F with the marker in a vertical position.

The specific intensity of the reflector shall meet the requirements of Subsection 736.01 A.

D. Sampling and Testing. Sampling and testing shall be in accordance with Subsection 736.01 B.

736.04 ADHESIVES FOR USE WITH PAVEMENT MARKERS.

A. Epoxy Resin Adhesives. Epoxy resin adhesives used for securing Class A and Class B pavement markers to the roadway surface shall meet the requirements of AASHTO M 237. The epoxy resin adhesives used for securing Class C pavement markers shall meet the requirements of AASHTO M 237 except the viscosity may be a lower viscosity in accordance with the pavement marker manufacturer's recommendation.

B. Bituminous Type Hot-Melt Adhesives. Bituminous type hot-melt adhesives used for securing Class A and B pavement markers to the roadway surface shall meet the requirements specified on the Plans or in the special Provisions.

C. Sampling and Testing. The Contractor shall furnish a Type D certification for each batch or lot of the materials.

737.00 CONCRETE SURFACE FINISH FOR STRUCTURES

737.01 DESCRIPTION. This Section covers materials and testing requirements for concrete surface finishing compounds for structures.

737.02 OPTION I – HEAVY CEMENT BASE MORTAR.

A. Materials.

1. Heavy cement base packaged in dry powder form for mixing with water.

a. Plaster mix for plaster gun application.
b. Brush and float mix for brush and float application.

2. *Bonding Agent.* A formulation of acrylic polymers and modifiers in liquid form for use as an additive with portland cement mixes to assure adhesion.

B. Proportioning and Consistency. The bonding agent and water shall be proportioned in accordance with the manufacturer's recommendations. A copy of those recommendations shall be furnished to the Engineer.

737.03 OPTION II – PAINT TYPE SPRAY FINISH.

A. Materials. Material for paint type spray finish shall be a textured commercial product designed specifically for this purpose.

B. Testing and Certification. Products must be qualified by the submission of a Type A Certification. The City reserves the right to discontinue approval of products that prove unsatisfactory when used in accordance with the manufacturer's instructions.

Each shipment of the satisfactorily tested product shall be accompanied by a Type C Certificate from the manufacturer.

Material to be furnished for spray finish (Option II) shall conform to the following requirements.

1. *Freeze-Thaw Cycle.* Cast and cure three concrete specimens, not less than 4 inches x 6 inches x 6 inches of the mix designed for the structure. Apply the surface finish after moist curing the specimens for 14 days and dry-crying them for 24 hours in room air at 60° - 80° F. for three hours. Caution shall be taken that there be no excessive oil on specimen forms. Coat sides of specimens (brush permitted) as hereinafter set out and cure at room temperature for 48 hours, after which:

a. Immerse in water at room temperature 60° to 80° F. for three hours.

b. Place in cold storage at -15° F. for one hour.

c. Thaw at room temperature 60° to 80° F for one hour minimum.

d. Repeat steps *b.* and *c.* to complete a total of 50 cycles.

At the end of 50 cycles of freeze-thaw test, the specimens shall show no visible defects.

2. *Accelerated Weathering.* The material shall be subjected to a 5000 hour exposure test in a twin-arc-weatherometer at an operating temperature of 145° F. The test shall be made at 20 minute cycles consisting of 17 minutes of light and 3 minutes of water spray plus light. At the end of said exposure test, the exposed sample must not show any chipping, flaking or peeling.

3. *Flexibility.* The material, when applied to a thin metal plate at a spreading rate to 45 + 5 square feet per gallon shall bend without breaking the film at an angle of 180 degrees over a one-inch mandrel.

4. *Fungus Growth Resistance.* The material to be used shall pass a fungus resistance test as described by Federal Specification TT-P-29b with a minimum incubation period of 21 days where no growth shall have been indicated after the test.

5. *Abrasion Test Cu. Cm./Sq. Cm. When tested for abrasion resistance in accordance with ASTM C418, the loss shall not be greater than 0.5 cu. cm./sq. cm.*

6. *Salt Spray Resistance.* The material, when applied to concrete at a rate of 50 square feet per gallon and tested in accordance with ASTM B117 with the coating exposed to a 5 percent sodium chloride (salt solution) for 300 hours and maintained at 90 + 2° F. during the period of exposure, shall show no loss of adhesion or deterioration at the end of the 300 hours exposure to the salt spray.

738.00 ELECTRICAL CONDUCTORS

Description. This section covers the requirements of materials for electrical conductors of the size, type and the locations shown on the Plans or established by the Engineer in section 811 and 834.

738.01 TRAFFIC SIGNAL WIRE AND CABLE.

A. Traffic and Signal Electrical Cable shall comply with the requirements of the International Municipal Signal Association (IMSA) Specifications No. 19-1 or No. 20-1. The conductors shall be copper No. 14 AWG, unless otherwise shown on the Plans.

B. Shielded Loop Detector Lead-In Cable shall comply with the requirements of IMSA No. 50-2. The conductors shall be copper No. 14 AWG, unless otherwise shown on the Plans.

C. Loop Detector Wire shall comply with the requirements of IMSA No. 51-1 or IMSA No. 51-3 except, when specified on the Plans, IMSA No. 51-5 shall be used. The conductors shall be copper No.1 4 AWG, unless otherwise shown on the Plans.

738.02 BUILDING AND SECONDARY DISTRIBUTION WIRE AND CABLE.

A. ***General.*** All conductors shall be copper and standard AWG sizes, unless otherwise shown on the Plans.

B. Building Wire and Cable shall comply with the applicable requirements of ASTM B 3, ASTM B 8, ASTM B 33, the National Electric Code (NEC) and be rated for 600 volts, unless otherwise specified on the Plans.

C. Underground Secondary Distribution Wire and Cable shall comply with the requirements of the Insulated Cable Engineers Association (ICEA)/National Electrical Manufacturer's Association (NEMA) Standard Pub. No. S-61-402/WC5 or ICEA/NEMA Standard Pub. No. S-66-524/WC 7, unless otherwise shown on the Plans.

D. Outdoor Aerial Neutral-Supported Secondary Distribution Wire and Cable shall comply with the requirements of ICEA/NEMA Standard Pub. No. S-66-524/WC 7, unless otherwise specified on the Plans.

739.00 PULL BOXES

739.01 PRECAST CONCRETE PULL BOXES. Concrete pull boxes shall conform reasonably close to the dimensions shown on the Plans and to the following materials requirements.

Portland Cement. Portland cement shall meet the requirements of Subsection 701.02.

Aggregate. Aggregate shall meet the quality requirements of Section 701 or of ASTM C 330 for Lightweight Aggregate.

Reinforcement. Welded wire fabric shall comply with subsection 723.03.

Gray Iron Casting Cover. Gray iron casting covers shall comply with Subsection 725.04. The cover shall have a non-slip surface and two 3/8 inch pent head brass bolts and nuts to secure it to the box.

Concrete. The concrete mixture shall be designed to produce 3,000 pounds per square inch strength in accordance with AASTHO T 23 and AASTHO T 22.

739.02 PRECAST REINFORCED PLASTIC PULL BOXES.

A. General. Plastic pull boxes shall conform reasonably close to the dimensions shown on the Plans and to the following materials requirements.

The reinforced plastic mortar shall be composed of a borosilicate type glass fiber in the form of woven fabric, chopped strand or mat, catalyzed polyester resin and an aggregate.

Plastic pull boxes shall have the following design characteristics. The cover shall have an embossed nonskid surface and be equipped with two 3/8 inch pent head brass bolts and nuts to secure it to the box. The box and cover shall be concrete gray in color. The pull boxes shall be capable of withstanding the following loads.

1. *Cover:* 5,000 pounds distributed over a 10-inch x 10-inch area centered on the cover and shall withstand without puncture or splitting, a 75 ft./lb. impact load from a 12 lb. weight having a "C" tup in accordance with ASTM D 2444.

2. *Box Walls:* 5,000 pounds vertical load distributed over a 10 inch x inch area centered over an exposed edge of the box with the cover place.

3. *Lateral Loads:* 5,000 pounds distributed over a 10-inch x 10-inch area of backfill immediately adjacent to the box with the box in the installed condition and without the cover in place.

Deflections resulting from loads imposed under the above-mentioned tests shall in no case cause binding of the cover or displacement from the extension.

B. Plastic Material. Plastic materials shall be self-extinguishing when tested in accordance with ASTM D 635 and show no appreciable change in physical properties when exposed to the weather.

C. Certification. A Type A Certification shall be submitted for each lot or shipment of pre-cast reinforced plastic pull boxes.

740.00 TRAFFIC SIGNAL BACKPLATES

740.01 DESCRIPTION. This section covers the material requirements for traffic signal backplates.

A. Materials. Backplates shall be constructed from sheet material of polycarbonate or acrylonitrile-butadiene-styrene (ABS).

1. Polycarbonate sheet material shall conform to the requirements of ASTM D 638, D 695, D 790 and D 1822.

2. ABS sheet material shall conform to ASTM D 1788.

3. The thickness of the backplates shall be as shown on the Plans.

B. Finish. The backplate shall be black in color with a haircell finish on the front side and smooth finish on the back side.

C. Certification. A Type A Certification shall be submitted for each lot or shipment of backplates.

800.00 TRAFFIC CONTROL FACILITIES

801.00 LIGHTING AND SIGNALS

801.01 DESCRIPTION. This work consists of furnishing all labor, equipment, appliances and materials, and performing all operations in connection with the installation of lighting systems and traffic signal systems in accordance with these Specifications and the Plans, or as established by the Engineer.

All electrical work shall conform to the requirements of the National Electric Code (NEC) except where superseded by these Specifications.

The lighting system shall be complete with all necessary accessories for proper operation. Transformers, disconnecting devices, protective devices, luminaries, and all other equipment shall be coordinated to secure the required result.

The traffic signal system shall be complete with all necessary accessories for proper operation. Controllers, signal heads, detectors, push buttons, synchronizing devices, time clocks, and all other equipment shall be coordinated to secure the required result.

801.02 MATERIALS. Within 30 days after receiving notice to proceed, the Contractor shall submit five copies of a complete schedule of materials and equipment proposed for installation to the Engineer for review and approval. This schedule shall include catalog cuts, diagrams, drawings, and such other descriptive data as may be necessary to satisfy the Engineer that the requirements of the Specifications will be met.

Upon completion of the work on traffic signal systems, the Contractor shall deliver the manufacturer's instruction manual for the maintenance, timing, and operation of all traffic control equipment to the Engineer.

A complete wiring diagram of the signal system and components and a parts list sufficient for the ordering of any part of the equipment furnished shall be included with each controller.

Where galvanizing on hardware is specified, such galvanizing shall comply with AASHTO M 232, Class C coating.

The electrical and mechanical equipment furnished and used shall be new, standard, manufactured products. All units of the same class of equipment shall be products of a single manufacturer.

The Contractor shall supply guarantees and warranties as specified in Subsection 106.11.

801.03 CONSTRUCTION METHODS.

A. General. The locations of the electrical energy supply shown on the Plans are approximate only. Exact locations will be determined in the field. The Contractor shall make the necessary arrangements with the serving utility to complete the service connections. The connection to the primary system will be made by The City of Edmond or an authorized representative.

The lighting electrical energy supply and circuits will be, unless otherwise specified, 60 cycle, 480 volt, single phase and multi-grounded neutral for multiple connection of luminaries, with automatic photoelectric control to turn the lights on at dusk and off at dawn. The 480 volt lighting circuits will each be supplied from a primary system through a distribution transformer and control equipment.

The traffic signal electrical energy supply and circuits will be, unless otherwise specified, 60-cycle, single-phase 120-volt power.

B. Bonding and Grounding. Conduit, poles and cabinets shall be mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bonding and grounding jumpers shall be minimum no. 10 AWG copper wire or better for all systems.

Grounding of poles shall be by means of a copper wire, minimum no. 8 AWG, securely attached to the pole and attached to the ground rod as shown on the Plans.

Grounding conductors of conduit and neutral at service location shall be minimum no. 6 AWG copper wire.

C. Existing Traffic Signal Equipment Removal. All existing traffic signal equipment shall be removed by the Contractor and stored at a site designated by the owner. Such equipment shall be removed with as little damage as possible. Poles shall be removed wholly; anchor bolts, protruding conduit and the like may be cut flush with the final ground level. Footings, pull boxes, and underground conduit are to remain in place. Wiring shall be removed from underground conduit.

Labor and equipment necessary to complete such removal shall be included in the contract unit price for other items unless otherwise provided for on the Plans.

Normally existing signal equipment shall not be removed or made wholly inoperative until the satisfactory completion of the 24-hour test period of the new equipment. Old equipment is to remain in at least a minimum operating condition until the new system is approved for continued use.

D. Covering of Signal Indications. Prior to the placing of the new signal equipment into operation, all signal heads installed but not lighted, shall be completely covered with an all-weather bag with the exception of pedestrian WALK-DON'T WALK indications. At no time shall the new system and existing system be visible to traffic at the same time.

E. Testing. Equipment shall be tested in accordance with Section 805.

802.00 ELECTRICAL CONDUIT

802.01 DESCRIPTION. This work shall consist of furnishing and installing all the electrical conduit, junction boxes, fittings, expansion devices, and miscellaneous hardware necessary to complete the electrical conduit system in accordance with these Specifications and the Plans. The location of the conduit, junction boxes and etc., as shown on the Plans, is diagrammatic and may be subject to adjustment as the Engineer may direct in order to conform to existing field conditions.

802.02 MATERIALS.

A. Conduits and Fittings. Conduits and fittings shall meet the requirements of section 709.

B. Junction Boxes. Junction boxes shall be of the size and type shown on the Plans and shall be furnished with gasket and cover. Oversized condulets may be used in lieu of junction boxes when installed in conjunction with exposed conduit systems if an adequate splicing chamber can be provided and when approved by the engineer. Condulets may not be used when the branch circuit is shown to be fused.

All materials furnished shall be new and of approved quality and workmanship.

802.03 CONSTRUCTION METHODS.

A. General. Conduit shall be installed in accordance with the codes and regulations listed in Section 801 and these Specifications, but if in conflict, the installation shall be carried out in compliance with the requirements herein stated and the details shown on the Plans. Conduit runs shall be made as directly as possible.

Conduit shall be of the minimum sizes shown on the Plans. The Contractor may, at his option and expense, use conduit of a larger size provided the larger size is used for the entire length of the run from outlet to outlet.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt together for the full circumference. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used for coupling metal type conduit, an approved threaded union coupling shall be used. All couplings for metal type conduit shall be tightened until the ends of the conduits are brought together. No exposed threads will be permitted. Non-metallic type conduit connections shall be of the solvent weld type.

Galvanized conduit surfaces which have been damaged to the extent that bare metal is exposed shall be re-galvanized, metalized or painted with an approved zinc dust-oxide paint.

All metal type conduit ends shall be threaded and shall be capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with conduit bushings. Non-metallic type conduit ends shall be capped until wiring is started. All conduit installed for future use shall be capped, unless terminating in a junction box or other electrical enclosure.

Factory conduit bends shall be in accordance with requirements of the NEC. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using the longest centerline radius practicable but not less than six times the inside diameter of the conduit.

Conduit installed in concrete pole bases, in structures, or pedestals, shall extend not more than 2 inches vertically above the footing. Conduit entering through the side of pull boxes shall extend not more than 2 inches inside the box wall and not be less than 4 inches above the bottom, and shall be sloped toward the top of the box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall extend a minimum of 4 inches above the bottom and shall be located a minimum of 4 inches above the bottom and shall be located near the end walls to leave the major portion of the box clear.

Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. No conductor shall be installed in the conduit system until all other work that might damage the conductors has been completed.

Existing underground conduit to be incorporated into a new system shall be cleaned and blown out with compressed air.

B. Pushed or Bored Conduit. The conduit shall be placed under existing pavement by approved pushing or boring methods. The pavement shall not be disturbed without permission from the Engineer. Pushing or boring pits shall be kept at least 2 feet clear of the edge of any type of surfaced area whenever possible. Use of water will not be permitted. Pits to be left overnight shall be covered with substantial planking and marked in a manner approved by the Engineer.

All pushed conduits shall be rigid metal. Bored conduit may be rigid metal or non-metallic. For rigid non-metallic type conduit a hole larger than the conduit shall be pre-drilled and the conduit installed by hand.

Unless otherwise shown, conduits bored or pushed shall be installed a minimum depth of 30 inches below top of ground line.

Where conduit passes under a surfaced area, an "X" shall be cut in the curb and/or surfacing above the conduit crossings for future relocating purposes.

C. Trenched Conduit and Backfilling. Conduit installed in a trench shall be of the type specified on the Plans. Trenches shall be excavated to such depth as necessary to provide for 30 inches minimum cover over the conduit, unless otherwise specified.
The trenches shall not be excavated wider than necessary for the proper installation of the electrical conduits or cables. Excavating shall not be performed until immediately before installation of conduit. The material from the excavation shall be placed in a position where the least damage and obstruction to vehicular and pedestrian traffic and the least interference with the surface drainage will occur.

All surplus excavated material shall be disposed of by the Contractor, in a manner approved by the Engineer.

When rock is encountered during trenching and the required trench depth cannot be attained, the trench depth or location may be altered at the discretion of the Engineer. The minimum trench depth shall be 12 inches.

Cinders, broken concrete, or other hard or abrasive materials will not be permitted in backfilling. The trench shall be free of such materials before the conduit is placed. Conduit shall not be placed prior to inspection of the trench by the Engineer. All trenches shall be backfilled with acceptable material as soon as possible after installation of conduit. Backfill material shall be deposited in the trench in layers not to exceed 6 inches in depth. The first layer shall be free of rocks and compacted, and each successive layer shall be compacted before the next layer is placed. Backfill shall be compacted to not less than 95 percent standard density in accordance with Subsection 106.03.

All surfaced areas, base materials and sodded areas disturbed by the Contractor shall be reconstructed and/or replaced with materials of equal or better quality at the expense of the Contractor and to the satisfaction of the Engineer.

Whenever a part of an existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed unless otherwise specified by the Engineer, and the concrete reconstructed as above specified. Pavement removal shall be in accordance with Section 619.

D. Exposed Conduit. Conduit to be installed on the surface of structures, poles, or other exposed locations shall be rigid metal type unless otherwise specified.

Conduit which is surface-mounted shall be run straight and true, horizontal or vertical on the surface of the structure or pole and shall be supported at intervals of not more than 5 feet, unless otherwise specified. The supports

shall consist of galvanized malleable iron conduit clamps and bolts with expansion shield anchor devices approved by the Engineer. Lag or machine bolt shields and percussion driven anchors in concrete or masonry will not be accepted.

Conduit attached to structural steel members shall be attached with approved supporting devices.

E. Conduit in Concrete Structures. Conduit installed in concrete structures shall be rigid metal type, unless otherwise specified. An expansion device of the type and size shown on the Plans shall be installed when the conduit crosses an expansion joint in the structure.

Junction boxes installed in or on structures shall be of the size and type shown on the Plans.

802.04 METHOD OF MEASUREMENT. Electrical conduit of the size and type specified will be measured by the linear foot along the centerline of the installed conduit from end to end, and shall include all flexible steel conduit, fittings, outlets, entrance caps, pull wires, condulets, expansion devices, and other miscellaneous hardware necessary to complete the conduit system. Each size and type of conduit shall constitute a separate pay item, unless otherwise provided. Unless other provided, trenching and backfilling will not be measured for payment. Junction boxes installed in structures shall be measured by each unit installed, if so specified.

802.05 BASIS OF PAYMENT. Accepted quantities of electrical conduit, measured as provided above, will be paid for at the contract unit price for:

(A)	Galvanized Steel Electrical Conduit	Lin. Ft.
(B)	Plastic Conduit	Lin. Ft.
(C)	Aluminum Conduit	Lin. Ft.
(D)	Junction Box	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

803.00 PULL BOXES

803.01 DESCRIPTION. This work shall consist of furnishing materials and installing the pull boxes in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Engineer.

803.02 MATERIALS. Materials used shall meet the requirements specified in the following Subsections of Section 700 – Materials.

Concrete Pull Boxes	739.01
Plastic Pull Boxes	739.02

803.03 CONSTRUCTION METHODS.

A. General. Pull boxes shall be of the sizes shown on the Plans and as herein specified. The pull box locations may be revised to fit existing field conditions or to better facilitate the installation of the conduit system with approval of the Engineer.

The tops of pull boxes installed in the sidewalks or other surfaced areas shall be flush with the finished surface. When practical, pull boxes shown in the vicinity of curbs shall be placed adjacent to the back of the curb and flush with the top of the curb. Tops of pull boxes shall be flush with top of ground or no greater than one inch above the ground. All pull boxes shall be installed with concrete aprons unless installed in a surfaced area or otherwise specified by the Engineer. Aprons will be included in the cost of pull boxes.

All pull boxes shall be installed on a bed of crushed rock as shown on the Plans.

Conduits entering pull boxes shall be installed as shown on the Plans and in accordance with Section 802.

When called for on the Plans, pull box extensions shall be provided. The extensions shall be of the same material as the pull box and shall be attached to the pull box in a manner that will maintain the required depth without separation of the assembly.

B. Cover and Markings. Pull box covers shall be marked with the appropriate legend. The letters shall be between one and three inches tall. The legend shall be cast with the cover and shall be clearly defined, of uniform depth or height and placed parallel to one side of the cover. The words "High Voltage" shall be added when the conductor voltage is greater than 600 volts.

The cover shall be equipped with a recessed molded lifting eye and recess hold down bolts. The cover shall have a nonskid surface.

C. Ground Rod. If specified, a copperweld ground rod shall be installed in accordance with the details and at the locations shown on the Plans.

803.04 METHOD OF MEASUREMENT. The pull boxes of the size and type specified will be measured by each unit installed. Each pull box unit shall include cover, extension, ground rod, concrete apron, crushed rock, excavation, and backfilling, necessary to construct and install pull boxes as shown on the Plans.

803.05 BASIS OF PAYMENT. Accepted pull boxes, measured as provided above, will be paid for at the contract unit price for:

Pull Box	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals required to complete the work as specified.

804.00 CONCRETE FOOTINGS

804.01 DESCRIPTION. This work shall consist of furnishing materials and installing concrete footings for traffic control devices in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Engineer.

804.02 MATERIALS. Materials used shall meet the requirements specified in the following sections of Section 700 – Materials and AASHTO Specifications.

Portland Cement Concrete, Class A	701
Reinforcing Steel	723
Electrical Conduit	709
Anchor Bolts and Nuts	AASHTO M 183
Galvanizing (Bolts, Nuts & Washers)	AASTHO M 232

840.03 CONSTRUCTION METHODS.

A. General. Concrete footings constructed in accordance with Section 509 shall rest on firm ground. They shall be constructed in place as required on the Plans and to the grade established by the Engineer. When an obstruction prevents the construction of a footing at the planned location the Contractor shall construct the footing at the location established by the Engineer.

The footing shown on the Plans may be modified if conditions require. Such modification, if ordered by the Engineer, will be paid for according to Subsection 109.05 or by the adjusted quantities of materials required; i.e., concrete and reinforcing steel.

B. Anchor Bolts. Anchor bolts shall be of the size and quantity shown on the Plans. They shall be accurately and securely located in the footing by means of a template. Anchor bolts shall have the top exposed portion plus 6 inches galvanized and threaded as shown on the Plans. Each anchor bolt shall be supplied complete with galvanized hex head nuts and washers as shown on the Plans. Welding shall not be permitted on any portion of the body of the anchor bolt.

C. Conduits. When it is required that conduit be installed as part of the footing, it shall be of the quantity, size and type as shown on the Plans. Conduit couplings shall be located at least 6 inches from the face of the footing. The conduit required in the footing will be paid for in the cost of other materials in the footing.

D. Ground Rod. If required, the copperweld ground rod shall be of the size shown in the Plans.

E. Poles or Posts. Poles or posts shall not be erected until the foundation has set at least 72 hours unless the poles or posts are set directly in the footing.

When the footing has been completed, the surrounding area shall be restored to an acceptable appearance.

804.04 METHOD OF MEASUREMENT. Concrete footings of various sizes and shapes will be measured by the cubic yards of concrete and pounds of reinforcing steel required. The footing unit shall also include anchor bolts, nuts, washers, ground rod, conduit, all labor, tools, equipment, excavation, backfilling and incidental work necessary to construct the footing as shown on the Plans.

804.05 BASIS OF PAYMENT. Accepted concrete footings, measured as provided above, will be paid for at the contract unit price for:

Structural Concrete	Cu. Yd.
Reinforcing Steel	Lb.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

805.00 ELECTRICAL-MECHANICAL PERFORMANCE AND OPERATIONAL TESTS

805.01 DESCRIPTION. This work shall consist of furnishing all the necessary equipment, tools, and labor required to perform the tests specified within this Specification or as directed by the Engineer.

805.02 EQUIPMENT. The Contractor shall furnish all the necessary specialized test equipment, tools, electrical diagrams and labor required to perform the tests specified.

805.03 CONSTRUCTION METHODS.

A. General. The Contractor shall notify the Engineer not less than 48 hours prior to the beginning of the testing procedures. The Engineer shall coordinate with appropriate agencies for testing procedures.

B. Electrical Field Testing. Prior to the start of functional testing, the Contractor shall perform the following tests on all traffic signal and lighting circuits, in the presence of the Engineer, and the written results shall be included in the project file.

1. Each circuit shall be tested for continuity.

2. Each circuit shall be tested for grounds.

3. Ground rods, after installation, shall not have a resistance to ground in excess of 25 ohms.

4. An insulation resistance test at 50 volts DC shall be made on each circuit between the circuit and ground. The insulation resistance shall not be less than 10 megohms on all circuits.

The insulation resistance test shall not be performed on magnetometer detector devices. Splices in the condulet or junction box adjacent to the magnetometer shall not be made prior to performing the test on the lead-in conductors between said splices and the controller cabinet field terminals.

C. Electrical Functional Tests. The Contractor shall notify the Engineer at least 24 hours in advance of commencing the functional tests of a traffic signal system, in order that adequate precautions may be taken with respect to traffic service on the street system. Where traffic is being maintained through the project, every effort should be made to insure the safe movement of vehicles during this testing period. At no time shall the new system and an existing system be in operation at the same time.

Lighting systems, both conventional and high mast, and traffic signal systems shall be operated for a 24-hour continuous period, to determine that all parts of the system are functioning properly. The electrical system shall be put into service and patrolled immediately to ascertain if there are any defects. The system shall be inspected at intervals established by the Engineer during the test period. At some time during this test all safety switches shall be thrown to check their operation. All photoelectric controllers shall be switched from auto to manual and back to auto, sometime during the night time portion of the test to observe the action of the photoelectric controller.

At the end of the 24 hours of continuous operation, the complete electrical system shall again be inspected to see that everything is operating normally and prove to the satisfaction of the Engineer that all fixtures and equipment have been properly installed and are in operating condition.

D. Mechanical Test. Following the successful completion of the 24-hour functional test, all high mast lighting systems shall be allowed to operate normally for six days. During these six days the system shall be observed at night time for any defects in the luminaire or lamps. The Contractor shall demonstrate to the Engineer that each lowering device assembly is functioning properly by completing one lower and raise cycle on each assembly.

E. Defects. The above tests are to show that the luminaries, lamps, wiring, controllers, and related equipment have been properly installed and are in satisfactory operating condition. Any defects shall be corrected to the satisfaction of the Engineer.

805.05 METHOD OF MEASUREMENT. The tests specified will not be measured for payment. All costs of performing these tests shall be included in other items of work.

806.00 POLES AND MAST ARMS

806.01 DESCRIPTION. This Work shall consist of furnishing materials and installing poles, mast arms and pedestal poles for traffic signals, and lighting luminaries in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Engineer.

806.02 MATERIALS. Materials shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs, Luminaries and Traffic Signals, and Section 700 of these Specifications.

806.03 CONSTRUCTION METHODS.

A. General. The design of the poles and mast arms shall be the responsibility of the manufacturer. The poles and mast arms shall be designed for a minimum of 80 MPH wind velocity and shall meet all other design requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals.

Calculated stresses from design loading on poles and arms shall not exceed 50,000 pounds per square inch or 85 percent of ASTM yield strength, whichever is smaller. Certification shall be required that the material in poles meets the applicable ASTM specification for stress range the poles are designed to operate within. Minimum thickness of traffic signal steel poles and mast arms materials shall be 7-gauge.

The manufacturer shall submit shop and design drawings, and calculations in accordance with Subsection 105.02.

Mast arms may be mounted to the pole prior to erection of the pole. Care shall be taken not to damage the pole, mast arm or finish during erection. If the finish is damaged, it shall be repaired at the Contractor's expense in a manner approved by the Engineer.

Anchor base poles shall be leveled with nuts or shims. If double nut leveling is used, the space between the concrete foundation and the pole base shall be filled with a non-shrink grout.

All structural castings shall be cast in permanent molds.

B. Poles. The minimal mounting height of the luminaire or traffic signal shall be as shown on the Plans. All poles, except pedestal poles, shall be uniformly tapered from bottom to top and may be either round or multi-sided. Pedestal poles may be without taper. The pole shall be straight and centered on its longitudinal axis. Each pole shall be furnished with a reinforced handhole and weatherproof cover, unless otherwise specified. A removable pole cap shall be

installed on each shaft, except pedestal poles. All metallic poles shall be provided with a grounding connection inside the base of the shaft and shall be grounded as shown on the Plans. Anchor bases may be either cast or structural plate.

C. Mast Arms. The mast arm shall be of the length shown on the Plans.

Luminaire mast arms shall be designed to support the weight of a 75 pound luminaire with a projected area of 3.3 square feet, and shall provide a smooth raceway for the wiring, and shall be supplied with a slip fitter tenon. Traffic signal mast arms shall be designed to support the required signal heads, as shown on the Plans.

806.04 METHOD OF MEASUREMENT. Poles and mast arms or pedestal poles of various types, sizes and lengths will be measured by each unit installed.

806.05 BASIS OF PAYMENT. The accepted poles and mast arms, measured as provided above, will be paid for at the contract unit price for:

(A)	Pole and Mast Arm	Ea.
(B)	Pedestal Pole	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as shown on the Plans and these Specifications.

809.00 LUMINARIES

809.01 DESCRIPTION. This work shall consist of furnishing materials and installing roadway luminaries of various sizes and types in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Engineer.

809.02 MATERIALS. All materials furnished, fabricated, assembled or installed under these Specifications shall be in strict accordance with the details shown on the Plans. The luminaries shall consist of a housing, ballast, reflector, refractor and lamp of the type and lumen rating specified on the Plans.

The luminaries furnished by the manufacturer shall meet IES standards for the size and type of luminaire specified on the Plans. The manufacturer shall provide photometric test data for each size and type of luminaire to be installed certified to be conducted in accordance with testing procedures approved by IES.

809.04 CONSTRUCTION METHODS. The installation of the luminaries shall be carried out in conformance with the details shown on the Plans.

If specified on the Plans, the luminaries shall be equipped with a cut-off visor.

809.05 METHOD OF MEASUREMENT. Accepted luminaries, measured as provided above, will be paid for at the contract unit price for:

(A) Roadway Luminaire Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals required to complete the work as specified.

825.00 VEHICLE ACTUATED SOLID STATE TRAFFIC SIGNAL CONTROLLERS

825.01 DESCRIPTION. These Specifications and the latest revision of the NEMA (National Electrical Manufacturer's Association) standard specification describe the design and general requirements for a controller assembly which uses solid state digital circuitry (integrated or individual components) in modular type construction in the controller unit.

The controller unit when combined with the required modules shall be capable of providing full vehicle actuated control for any number of phases or movements as specified. The controller when used in minimum capacity shall be capable of providing a two-phase operation with one actuated phase and one non-actuated. All standard modules from one manufacturer and type equipment shall be interchangeable in the same manufacturer and type of mounting frame, so that logic and phase modules may be added or replaced to provide the movements required within the limits of the controller unit.

Functions provided by the controller unit shall be in accordance with the Plans and Specifications.

825.02 MATERIALS.

A. Modules. Each module shall be connected by means of an integral keyed plug-in connector to the master board or mounting frame. No connecting harness or wiring will be permitted other than programming connections on the mounting frame plug-ins.

Each module shall be fastened to the mounting frame by means of a captive nut and thumb screw arrangement or some other suitable latching arrangement. Also, each module and associated circuitry shall be removable from the front of the controller without the use of any special tools.

All timing circuits shall consist entirely of integrated and/or solid state digital electronic circuitry for timing. Vacuum tubes, gas tubes, relays, stepping switches and other assemblies with moving parts will not be allowed. Positive acting switches, program pins and/or keyboard units shall be used for control settings.

Each phase module shall consist of a printed circuit board with associated components, and a face plate having as a minimum the following function switches: Pedestrian recall, vehicle recall, locking, and non-locking switches. Switches provided by the manufacturer in addition to those mentioned above will be acceptable.

Each controller shall be equipped with a group of indicator lamps showing the status of the controller unit. The controller shall be capable of displaying a minimum of indicator lights on the front panel as follows:

RING 1 AND 2 STATUS

1	Phase On (Per Phase)
2	Phase Next (Per Phase)
3	Vehicle Memory (Per Phase)
4	Max 2 (One Per Ring)
5	Pedestrian Memory (One Per Phase)
6	Max/Force-Off (Per Ring)
7	Vehicle Recall (Per Phase)
8	Pedestrian Recall (Per Phase)
9	Locking Non-locking (One Per Ring)
10	Gap Termination (One Per Ring)

The indicator lamps to be furnished shall be the light emitting diode type with a minimum rated operating life of 100,000 hours or as approved.

The circuit reference symbols for each component shall be clearly marked on the circuit board and all electrical components shall be standard production type and readily identifiable and available from industrial electronic suppliers.

Combining circuitry of two or more component parts into one module so that each individual component part cannot be serviced or replaced individually will not be acceptable. Standard production hybrid and/or integrated circuit blocks which are commercially available and replaceable are acceptable.

The design life of all components shall not be less than 5 years based on 24 hours a day operating conditions in their respective circuit applications.

Each module, together with its associated switches and switch functions, control functions and indicator lights and all mounting frame openings, shall be properly identified and marked on the front panels for ease in maintenance and adjustment. All dial knobs and switches shall be color-coded and/or labeled providing quick identification and ease of association with sequence timings or phases.

All components shall be amply de-rated with regard to heat dissipating capacity and rated voltages, such that under operating conditions of maximum ambient temperature and maximum applied voltage, a significant shortening of life or shift in values shall not occur.

Module functions shall be accomplished through the use of solid state digital electronic circuitry. No electro-mechanical devices, such as: camshafts, rotary stepping or line switches, shall be used for switching functions.

Where good design practices indicate a need, properly designed and located heat sinks shall be used to insure maximum life and efficiency of components.

Signal light circuits shall be controlled externally to each solid-state controller unit by three-circuit, solid-state, load-switching devices which shall be plug-in mounted to a base located at the lower part of the controller cabinet. The solid-state, load-switching circuits shall each have a minimum rating of ten amperes at 120 volts, 60-cycle, single-phase, alternating current at 160° F and zero-point switching. Each load-switching circuit shall be furnished with a handle or a gripping device for removal. An indicator light for each circuit shall be provided in each load switch. The indicator light shall be on when a "true" input to the load switch is present. The load switch, when plugged in, shall be capable of supporting itself firmly in place. Vehicle and pedestrian load switches shall be interchangeable.

The timing of any interval or portion of any interval shall not change by more than + 0.5 percent of its set operating value due to changes in the ambient temperature between the limits of -30° F to 160° F. All modules other than those used in the mounting frame or accessory frames shall be encased in a one-piece, lightweight aluminum housing which shall be readily removed, exposing the components for inspection and maintenance.

The copper track printed circuit board shall be epoxy-filled woven glass coated with a 2 ounce per square foot copper coating before etching. Intercomponent connections shall be made utilizing the latest military approved "wave soldering" or "dip soldering" techniques. Printed circuit design shall be such that components may be removed and replaced without permanent damage to the board or tracks. Printed circuit boards shall be permanently marked to facilitate identification and servicing. A pictorial diagram shall be provided in the maintenance manual for all controller units showing physical location and identification of each component. All modules shall be provided with gold-plated mating contacts.

Schematic drawings with all voltage measurements and wave shapes, where appropriate, functional descriptions and testing procedure shall be well-defined and illustrated in accompanying manuals for each module or accessory item contained in the controller cabinet.

Basic range of interval timing adjustments for each phase module shall be as follows:

INTERVALS	SECONDS	RANGE INCREMENTS
Initial	0 – 30	1.0
Extension (gap)	0 – 9.9	0.1
Maximum	0 – 99	1.0
Yellow clearance	0 – 9.9	0.1
Red clearance	0 – 9.9	0.1
Walk	0 – 30	1.0
Pedestrian clearance	0 – 30	1.0
Minimum green (semi operation)	0 – 99	1.0
Minimum red	0 – 6	0.1

B. Power. Electrical connections from the controller to the outgoing and incoming circuits shall be made by inserting a multi-terminal plug (MS Type) into the associated plug receptacle incorporated in the mounting frame or power supply panel. The controller unit shall be replaceable with a similar unit without the necessity of disconnecting and reconnecting any individual wires.

The controller assembly shall be designed to operate at 120 volts, 60-cycle single-phase alternating current + 15 percent voltage.

During a supply voltage interruption not exceeding 0.5 second duration, the solid state digital controller assembly shall continue in cycle operation and shall retain all actuations registered prior to the interruption. Following a supply voltage interruption exceeding 0.5 seconds duration, signal operations shall begin in the programmed start interval and calls shall be place on all phases.

The power supply unit shall be designed to supply the necessary power for the controller unit.

A thyrector unit or equally suitable device shall be used to protect the controller from line voltage surges and transient voltages.

C. Mounting Frame. Each controller unit shall be completely enclosed in a sheet metal case which serves as a mounting frame.

The case shall be designed to provide convenient access to the entire interior assembly and permit easy removal of printed circuit boards and modules with minimum use of tools. The mounting frame shall be equipped with sliding ways and receptacles to receive the modules without the use of any connecting harness or wiring except for programming on the mounting frame. Similar type plug-in assembles shall be mechanically and electrically interchangeable between controller units of the same manufacture and type. Dissimilar units or non-compatible units shall be keyed to prevent any erroneous insertion into

the mounting frame. The mounting frame shall contain the controller unit, power supply, all timing equipment, phase modules and sequencing units.

On a traffic signal project where it is planned to expand the control system in the future to an increased number of phase modules, the Plans may specify a larger mounting frame to accommodate this expansion. The cabinet and controller shall be wired and the number of load switch receptacles shall be provided for this expansion as shown on the Plans.

D. Signal Conflict Monitor. A solid-state monitoring device shall be installed in each solid-state digital traffic signal controller assembly. The conflict monitor shall meet the latest NEMA (National Electrical Manufacturer's Association) Standard Specifications, Part 6 for 3-, 6-, and 23-channel monitors. In the event of conflicting green signal indications (vehicular or pedestrian or both), the flashing operation shall lock-in and shall release only upon operation of a reset switch. All logic voltage power supplies shall be monitored and, if any voltage drops to a level where equipment does not work properly, the signal shall go into flashing operation.

E. Controller Assembly Cabinet and Wiring. The controller unit and all associated equipment shall be furnished completely housed in a sturdy aluminum cabinet. The cabinet shall have no sharp edges, corners or projections. The size of the cabinet shall be such as to provide ample space for housing the controller and all of the associated electrical and auxiliary devices which are to be furnished with it as specified on the Plans. A hinged door shall be provided permitting complete access to the interior of the cabinet. The door shall be sealed access to the interior of the cabinet. The door shall be sealed by neoprene gasketing material making the cabinet weatherproof.

The door shall be provided with a Corbin #2 lock and two keys. Pin for the door hinges shall be of non-corroding material.

The cabinet door shall be provided with a door catch that shall stop the door openings at 90 and 180 degrees + 10 degrees and will hold the door open securely until released.

At the lower part of the cabinet door a louvered vent system shall be furnished with a fiberglass air filter. This filter shall be secured to the door in such a way that it will permit the fan to pass the volume of air through the filter and not the fan to pass the volume of air through the filter and not around it. A thermostatically-controlled ventilating fan shall be furnished that shall have the capacity of moving at least 100 cubic feet of air per minute. The thermostatic controller shall be manually adjustable between 90° F and 150° F and shall automatically turn on and off within + 20° at the manual setting.

Receptacles for relays and shelves below all removable control equipment, switches, fuses, circuit breakers, and all other equipment shall be identified below each item with a permanent printed label.

All terminals shall be permanently identified in accordance with the cabinet wiring diagram. Where through panel solder lugs or other suitable connectors are used, both sides of the panel shall have the terminals properly identified. Identification shall be permanently attached and as close to the terminal strip as possible and shall not be affixed to any part which is easily removable from the terminal block panel.

Each input and output function shall be distinctly identified with no obstructions, at each terminal point in the cabinet, either by number of function terminology. The same identification shall be used consistently on the cabinet wiring diagrams.

Each load switch socket shall be identified by phase number and overlap number as applies. No cabinet equipment may obstruct these identifications.

Each flash transfer base and power relay base shall be properly identified with no possible obstructions.

Each harness within the cabinet shall be distinctly identified on the connector end.

The flasher socket shall be distinctly identified with no possible obstructions.

All other sockets needed within the cabinet to fulfill the minimum requirements of the Plans, or attachments thereof, shall be distinctly identified.

Except where soldered, all wires shall be provided with lugs or other approved terminal fittings for attachment to binding posts. Insulation parts and wire insulation shall be of suitable material and insulated for a minimum of 600 volts.

The cabinet back panel shall either have all of the wiring on its front, or the wiring shall be readily accessible by means of a hinge enabling the back panel to swing down or sideways. Readily accessible shall mean that it shall be possible to gain full access to inspect or modify the wiring in less than 2 minutes by the use of simple tools. If the wiring is on the back of the back panel, the panel and wiring shall be designed so as to prevent the wiring from being pinched or chafed when the panel is placed in its normal operation position after a change in wiring is made. If a side panel with through-panel solder lugs or other suitable connectors is provided, both sides shall also be readily accessible as directed above.

Wall-mounted auxiliary equipment and wiring shall be installed on removable panels. Plug-in equipment shall be removable from receptacles without removing any other equipment.

Machine screws and bolts shall not protrude beyond the outside wall of the cabinet.

Substantial shelves or brackets approved by the Engineer shall be provided to support controller unit and auxiliary equipment.

All solid-state digital traffic signal controller assemblies shall be furnished with a detector and pedestrian test switch panel. The switches shall be of the push button type and shall be installed and wired to the controller unit so that calls can be placed on each vehicle and pedestrian phase. This panel shall be so designed to be mounted approximately 4 to 6 inches from the top of the door and installed on the inside of the Controller cabinet door.

When an intersection display panel is specified it shall display a graphical representation of the intersection with display lights appropriately located and wired to indicate vehicle movements having the right-of-way. This display panel shall be mounted on the inside of the cabinet door below the detector switch panel. The controller assembly shall be furnished with a solid-state flasher conforming to Section 827.

There shall be an auxiliary police door provided in the main door with a standard police lock and two keys.

The panel behind the auxiliary police door shall contain the following switches:

1. Two-position switch – Auto and Flashing
2. Two-position switch – on and off

3. Phone type receptacle for manual control

On the inside of the controller cabinet door the following switches shall be furnished:

1. Two-position switch – Auto and Flashing

2. Three-position switch

a. Flashing and Stop Time – on

b. Off position

c. Stop Time position on

3. Two-position switch – on and off

4. Two Refrigeration-Type Switches

a. Cabinet Light

b. Indicator Lights on Controller

A convenience outlet and a fluorescent trouble light shall be furnished in the controller cabinet. The light shall be placed near the top of the cabinet above the door opening.

As a minimum, the following items shall be a part of the cabinet wiring:

1. A terminal with insulated fuse receptacle and fuse for power supply line input.

2. A terminal unfused for the neutral side of power supply line input.

3. Terminals for conductors of signal light cable; one for each signal output circuit specified plus future required terminals to maximum capable function of the controller assembly.

4. One or more terminals for the common conductors on signal loads.

5. Terminals for all detector cables as required for maximum functional needs.

6. Terminals for all pedestrian push-button cables as required by maximum functional needs.

All terminal blocks shall be rated 600 volts, minimum, alternating current and shall be provided with nickel, silver, or cadmium plated brass binder head screw terminals.

The controller assembly cabinet contents shall be functionally arranged within the cabinet such that they will not hinder the entrance, training and connection of the incoming conductors. Unnecessary overlapping of conductors will not be permitted unless approved by the Engineer.

Wiring within controller cabinets shall be neatly arranged and laced or enclosed in plastic tubing or raceway.

The outgoing traffic control signal circuits shall be of the same polarity as the line side of the power supply. The common return of the signal circuits shall be of the same polarity as the ground or neutral side of the line power supply.

The grounded side of the line power supply shall be grounded to the controller cabinet in an approved manner.

Field terminals shall be installed a minimum of 5 inches above the bottom of the cabinet and in such a manner that they are easily accessible without removal of any other equipment and oriented for screwdriver operation.

F. Radio Interference Suppressor. Radio interference suppressors shall be installed in each solid-state digital controller and shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilohertz to 75 megahertz when used in connection with normal installations. The interference suppressor shall be hermetically sealed in a substantial metal case filled with a suitable insulating compound. Terminals shall be long enough to provide space for connecting two No. 8 conductors and shall be so mounted that the terminals cannot be turned in the case. Suppressors shall be designed for 125 percent of the total connected load and shall meet standards of the UL and the Electronic Industrial Association. The minimum size suppressors shall be 25 amperes on 120 volts, 60-hertz, single-wire circuits.

G. Surge Arrestor. Surge arrestors shall be provided in each solid-state digital controller to protect the controller components from lightning and other power fluctuations. The surge arrestors shall meet or exceed the following specifications:

Peak current	20,000 amps (8 x 20 us waveshape)
Occurrences	20 times minimum @ peak current
Clamp voltage	340 volts @ 20KA.
Response time	Voltage never exceeds 340 volts during surge
Series Inductance	200 uH minimum
Continuous Service Unit	10 Amps maximum 120 VAC, 60Hz.
Dimensions (inches)	2.87 W x 5.25 L x 1.75 H
Temperature Range	-40° to 85° C
Weight	1.5 pounds

825.04 CONSTRUCTION METHODS. The vehicle actuated solid-state traffic signal controller shall be installed at the location shown on the Plans in accordance with the manufacturer's requirements and Specifications.

825.05 METHOD OF MEASUREMENT. Traffic vehicle actuated solid state digital traffic signal controller units with auxiliary equipment including cabinet and installation will be measured by the unit, complete in place.

825.06 BASIS OF PAYMENT. Traffic vehicle actuated solid-state digital traffic signal controller assemblies, measured as provided above, will be paid for at the contract unit price for:

Vehicle Actuated Solid-State Traffic Signal Controller Assembly	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete the work as specified.

826.00 PRE-TIMED SOLID STATE DIGITAL TRAFFIC SIGNAL CONTROLLER

826.01 DESCRIPTION. These specifications describe the design and general requirements for a controller assembly which uses solid-state digital circuitry, integrated or undivided components, in modular type construction in the controller unit.

This controller assembly shall consist of a solid-state, digital pre-timed traffic signal controller that shall be of multiple cycle length, offset and signal sequence design. The unit shall be capable of master-secondary operation. The controller unit shall meet all related terminology of NEMA (National Electrical Manufacturer's Association) Standard Publication of the latest revision for pre-timed controller unit.

The above-defined requirements are MINIMUM requirements, and the intent is to define signal operation and not internal design or method of accomplishment.

826.02 MATERIALS.

A. General. The controller unit shall comply with Part 2, Section 1 and Part 3, Paragraph 3.02 pertaining to DC logic levels of NEMA Standards Publication No. TS 1-1976 and any subsequent revisions of the publication.

Each signal sequence and the state of each implemented signal circuit (on, off or flash) shall be programmed in Read Only Memory. Timing for each movement of each signal sequence shall be programmable in Random Access Memory non-volatile read/write memory or by the use of switches or pins in non-keyboard-entry controllers. No external programming devices shall be used to set timing in the controller.

The controller unit circuit boards shall be modular in design. The modules shall be readily accessible for maintenance and shall plug-in by means of card guides. However, the power supply transformer, capacitors and power-dissipating components are excepted from this requirement. The design shall allow for removal or replacement of a module without unplugging or removing other modules or boards. Similar modules shall be interchangeable between like manufacturer's controller units.

If the controller unit utilizes a face plate and/or face plate PC boards, the displays and switches shall remain operable when the face plate is opened for maintenance. Special tools shall not be required to remove or replace a

module. The module shall not employ layered construction of PC boards that would prevent reasonable access to the components on the module.

All circuits shall consist entirely of solid-state electronic circuitry. Reed switches will not be permitted.

All printed circuits shall be made from FR-4 or G-10 glass epoxy, or equivalent, and shall have a nominal thickness of at least 1/16 inch with 2 ounces per square foot or more copper track.

All components shall be amply de-rated with regard to heat dissipating capacity and rated voltage so that, with maximum ambient temperature and maximum applied voltage, the controller assembly shall maintain its programmed functions.

When batteries are used, they shall be a rechargeable type. A charging circuit shall be provided to recharge and maintain a charge on the batteries and, a circuit shall be provided to protect any batteries subject to polarity reversal from this occurrence.

The design life of all components, except for the batteries, under 24-hour per day ordinary operating conditions in their circuit operation, shall not be less than 5 years. The battery(ies) shall be capable of withstanding and operating within the temperature and humidity requirements of the controller assembly and shall have a design life of at least 4 years under ordinary operating conditions.

Any RAM memory described above shall be maintained for 30 days in the event of a power failure. This RAM memory shall also be maintained for a minimum of two hours when the circuit board containing this RAM is removed from the main chassis.

B. ***Main Frames.*** The maximum chassis dimensions of the controller unit shall not exceed 12 inches in height, 17 ½ inches in width, and 12 inches in depth.

All exterior surfaces of the mainframe shall be coated with a suitable protective finish.

The model and serial numbers shall be shown on the mainframe of the controller unit.

The mainframe shall contain a Slo-Blo fuse for the 120 volts, 60 Hz AC supply to the unit. Also, a standard fuse shall be provided for the 24-volt DC external output from the unit. Fuses shall be of the proper value to protect the circuits involved.

A set of switches, pins, or a keyboard panel shall be provided for the purpose of programming the time for each movement, cycle length, and offset into the controller. Inputs to the unit shall determine which cycle length, offset, and signal sequence is to be in effect at a given time. The user shall be able to monitor and revise data stored memory without affecting the operation of the unit. The ability to manually select any combination of programmed cycle length, offset, or any signal sequence shall be provided. If the ability to do this manual selection is not provided in the controller unit it shall be provided in the cabinet.

A front panel display shall be provided. It shall be a direct reading display which displays, as a minimum, intervals, interval times, cycle lengths, offsets, signal sequence, and synchronization status. Any illuminated LED or LCD display shall have a minimum height of 0.30 inches and shall be visible when shaded from direct sunlight.

A press-to-test switch or continuous self-test shall be provided to test the main battery and indicate condition. It shall isolate the battery from the controller unit and apply a load to the battery simulating a power failure.

Circular, quick-disconnect connector(s) (a maximum of two) shall be provided for electrical connection to external input and output circuits. The minimum inputs and outputs shall be:

INPUTS	OUTPUTS
AC+	Sync
AC-	Signal Circuits 1-21
°FFSET 1	Interval 1 on (Begin Cycle)
°FFSET 2	(2 Sec. Min. Duration)
°FFSET 3	Chassis Ground (Second
Cycle 2	Connector if Furnished)
Cycle 3	Logic Common Voltage Monitor
Chassis Ground	+ 24 VCD
Signal Sequence 2	
Signal Sequence 3	
Phase 1 Call (If Required)	
Phase 5 Call (If Required)	
Indicator Disable (When Required)	
External, Start	
Internal Advance	
Manual Control Enable	
Stop Timing	
Interconnect Common (When Required)	

C. Cycle Length. Three independent cycle lengths may be provided as shown on plans. Transfer from one cycle length to another shall be programmable by the user to occur at any safe point in the cycle common to all signal sequences.

Cycle lengths shall be adjustable from 30-250 seconds in one second increments.

1. Offsets. Three separate offset shall be provided for each cycle length for a total of nine offsets. Each offset shall be programmable from either 0-250 seconds in one second increments or 0-99 in one percent increments.

The programmed offset defines either the number of seconds or percent by which the beginning of the local cycle follows the system sync pulse. A sync of 2 seconds minimum duration shall be imposed upon the offset line in effect.

Offset transfer shall be accomplished by either shortway or maximum dwell transfer procedures.

a. If the shortway method is used, the local cycle length shall be lengthened or shortened during selectable intervals to enable the controller to gradually assume the new offset without dwell or undue disruption of traffic.

b. If the dwell method is used, the controller unit shall dwell at the beginning of the local offset point for a programmed maximum time, 0-250 seconds in one second increments or until the end of the programmed offset, whichever occurs first.

2. *Signal Sequences.* There shall be three signal sequences provided as shown herein, and they shall each be able to be used with any of the cycle lengths.

   The timing for each signal sequence for each cycle length shall be individually programmable.

3. *Timing.* The minimum timing range for each signal indication shall be programmable as follows:

SIGNAL INDICATION	RANGE	INCREMENTS (Seconds)
Green	0-99	1
Yellow Clear	0-7	0.25
Red Clear	0-3	0.25
Walk	0-30	1
Flashing Don't Walk	0-30	1

   or programmable from 0-99 percent in one percent increments.

4. *Signal Circuits.* The controller unit shall provide for a minimum of 21 signal circuits.

   The flash rate of any signal circuit programmed to flash shall be 60 times per minute with a 50 percent + 2 percent duty cycle.

5. *Features of Operation.* The controller unit and associated equipment shall be designed to provide the operation and phasing shown herein.

   Pedestrian phasing shall consist of steady "Walk", flashing "Don't Walk" (pedestrian clearance interval) and solid "Don't Walk".

6. *Controller Cabinets.* Each pre-timed controller unit and auxiliary equipment shall be enclosed in an approved weatherproof aluminum alloy cabinet of the type regularly supplied by the manufacturer, unless otherwise specified. Size of cabinet shall be such as to provide ample space for housing, the control unit, and all of the associated electrical devices, including the additional expansible equipment for which provisions are made. A hinged door shall be provided permitting complete access to the interior of the cabinet. The door shall be sealed by neoprene gasketing material making the cabinet weatherproof. The door shall be furnished with a Corbin No. 2 lock and two keys. An

auxiliary police door shall be provided in the main cabinet door with a standard police lock and two keys. The panel behind the auxiliary door shall be furnished with a main power switch, a signal flashing switch, manual-automatic switch and phone type receptacle for manual control. The cabinet shall be equipped with a thermostatically controlled cabinet vent fan with intake and exhaust vent openings. All vent openings shall have a vent covering. Vent covers shall be screen or hardware cloth having square openings no larger than 0.0125 square inch. A panel with punched or drilled holes no larger than 0.025 square inch in area is acceptable provided that adequate cabinet ventilation is maintained.

The fan thermostat shall be mounted near the top of the cabinet and shall be a fixed type that turns on at 150° F and off at approximately 100° F.

The load switch supports shall be so designed and constructed to receive all load switches which may be manufactured to the maximum size requirements permitted under the latest revision NEMA (National Electrical Manufacturer's Association).

7. *Controller Inputs and Outputs.* Each input and output function shall be distinctly identified with no obstructions, at each terminal point in the cabinet, either by number or function terminology. The same identification shall be used consistently on the cabinet wiring diagrams.

Each load switch socket shall be identified by phase number and overlap number as applies. No cabinet equipment may obstruct these identifications.

Each flash transfer base and power relay base shall be properly identified with no possible obstructions.

Each harness within the cabinet shall be distinctly identified on the connector end.

The flasher socket shall be distinctly identified with no possible obstructions.

All other sockets needed within the cabinet to fulfill the minimum requirement of the Plans, or attachments thereof, shall be distinctly identified.

Except where soldered, all wires shall be provided with lugs or other approved terminal fittings for attachment to binding posts. Insulation parts and wire insulation shall be of suitable material and insulated for a minimum of 600 volts.

The controller equipment and terminals shall be so arranged in the cabinet that they will not upset the entrance, routing and connection of incoming conductors.

The outgoing traffic control signal circuits shall be of the same polarity as the line side of the power source. The common return of the signal circuit shall be of the polarity as the ground side of the power source. The grounded side of the AC power source shall be grounded to the controller cabinet in an approved manner.

8. *Terminal Identification.* All terminals shall be permanently identified in accordance with the cabinet wiring diagram. Where through-panel solder lugs or other suitable connectors are used, both sides of the panel shall have the terminals properly identified. Identification shall be permanently attached as close to the terminal strip as possible and shall not be affixed to any part which is easily removable from the terminal block panel.

9. *Auxiliary Equipment.* Unless otherwise called for on the Plans, two circuit breakers shall be mounted and wired in the cabinet. One 20 ampere breaker shall protect the base light, trouble light, flasher and duplex receptacle. The second breaker (30 ampere) for the back panel shall be so wired to protect the signal load circuits and controller circuits. The breakers shall be of the thermal magnetic or magnetic type rated at 120 volts single pole nonadjustable.

   The circuit breaker(s) are to be equipped with solderless connectors and installed on the sidewall or lower right-hand side of the back panel inside the cabinet in such a manner that their rating markings shall be visible and the breaker shall be easily accessible.

   The circuit breakers shall be capable of manual operation with the switch marked to indicate whether it is in the open or closed position.

   A duplex receptacle of the three wire grounding type shall be mounted and wired in the cabinet and it shall accept a standard two-pronged, non-grounding plug. This receptacle shall be wired on the load side of the 20 ampere breaker as specified.

   A switch shall be provided such that when the door of the cabinet is closed it shall automatically turn off all incandescent indicators of the controller unit.

   A fluorescent trouble light, with switch, shall be installed in the cabinet. This light shall be activated when the cabinet door is opened and turned off when the cabinet door is closed.

A radio interference suppressor shall be provided and installed on the load side of the signal circuit breaker and shall be protected by the surge protector specified above. This filter shall be rated at 30 amperes and shall provide a minimum attenuation of 50 decibels over the frequency range of 200 kilohertz to 75 megahertz.

A surge arrestor shall be furnished in each traffic signal controller. The arrestor requirements are as follows:

Peak Current	20,000 amps(8 x 20 us waveshape)
Occurrences	20 times minimum @ peak current
Clamp Voltage	340 volts @ 20KA
Response Time	Voltage never exceeds 340 volts during surge
Series Inductance	200 uH minimum
Continuous Service Current	10 Amps, maximum 120 VAC, 60 Hz
Dimensions (inches)	2.87 (W) x 5.25 (L) x 1.75 (H)
Temperature Range	-40° to +85° C
Weight	1.5 pounds

10. *Test Normal.* A switch shall be provided on the inside of the cabinet door, which when in the on position shall allow the controller unit and logic to operate during flash operation. When this switch is off, flash operation shall remove power from the controller unit and logic.

    A circuit shall be provided and wired to the conflict monitor output and it shall flash the signals when a conflict exists.

11. *Stop Time.* A flash transfer control switch shall be provided in the police panel, which when activated shall place the signals into the flash operation called for on the attached signal sequence diagram.

    The cabinet back panel shall either have all of the wiring on its front, or the wiring shall be readily accessible by means of a hinge enabling the back panel to swing down or sideways. Readily accessible shall mean that it shall be possible to gain full access to inspect or modify the wiring in less than 2 minutes by the use of simple tools. If the wiring is on the back of the back panel, the panel and wiring shall be designed so as to prevent the wiring from being pinched or chafed when the panel is placed in its normal operating position after a change in wiring is made. If a side panel with through panel solder lugs or other suitable connectors is provided, both sides shall also be readily accessible as described above.

    Transfer relays shall be plug-in type manufactured by Mid-Tex (Part No. 136-62T3A1) or AEMCO (Part No. 136-4992) or equivalent.

12. *Conflict Monitor.* The conflict monitor shall meet the NEMA (National Electrical Manufacturer's Association) Publication No. TS 1, Part 6, of the latest revision, for 3, 6 and 12-channel types.

    In addition to the above requirements, a light display shall be provided to indicate continuously when a channel is active due to green, yellow or walk inputs. It shall also continue to display the channels which were active at the time of a conflict, until the conflict monitor is manually reset.

    If the conflict was caused by a loss of red, the display array shall indicate loss of red.

    If the conflict was caused by the voltage monitor, the display array shall indicate a voltage error.

    The conflict monitor shall be preprogrammed for the operation called for on the Plans.

13. *Solid State Load Switch.* The solid state load switches shall meet the requirements set forth in Part 5 of the NEMA Specification of the latest revision and shall be "Triple-Signal Load Switch" type.

    The load switches shall have no moving parts. Load switches using reed relays will not be permitted.

    An indicator light for each circuit shall be provided in each load switch. The indicator light shall be on when a true input to the load switch is present.

14. *Two-Circuit, Solid-State Flasher.* The flasher shall meet the electrical and physical characteristics described in Part 8 of the NEMA Standards Publication latest revision and shall be "Triple-Signal Load Switch" type.

    The-two circuit flasher shall be of solid-state design and contain no electro-mechanical devices.

    The solid-state flasher shall conform to Section 827.

826.04 CONSTRUCTION METHODS. The pre-timed, solid-state, digital traffic signal controller shall be installed at the location shown on the Plans in accordance with manufacturer's requirements and specifications.

826.05 METHOD OF MEASUREMENT. The pre-timed, solid-state, digital traffic signal controller unit with auxiliary equipment including cabinet and installation will be measured by the unit, complete in place.

826.06 BASIS OF PAYMENT. The pre-timed, solid-state digital traffic signal controller assembly, measured as provided above, will be paid for at the contract price for:

Pre-timed, Solid-State, Digital Traffic Signal Controller Assembly	Ea.

which payment shall be full compensation for furnishing materials, equipment, labor and all incidentals necessary to complete the work as specified.

827.00 SOLID-STATE FLASHING CONTROLLER

827.01 DESCRIPTION. This work shall consist of furnishing materials and installing a solid-state flashing controller in accordance with these Specifications.

827.02 MATERIALS. The flasher shall be a solid-state electrical device with no contact points or moving parts, producing between 50 and 60 flashes per minute at 50 percent ON and 50 percent OFF periods. The flashing mechanism shall be mounted on a plug-in base with a plug-in mounting. The flasher shall utilize zero-point switching, with turn-on at the zero voltage point + 5 degrees, and turn-off at the zero current point + 5 degrees, of the power line sinusoid.

The flasher shall provide two output circuits to permit alternate flashing of signal heads and shall be capable of carrying a minimum of ten amperes per circuit at 60-cycle, single-phase, 120 volts alternating current + 15 percent voltage in ambient temperature between -30° to 160° F.

The flasher unit and associated equipment shall be enclosed in an approved weatherproof or aluminum alloy cabinet of the type regularly supplied by the manufacturer. The size of the cabinet shall provide ample space for housing the flashing unit and all of the associated electrical devices.

The cabinet shall be in accordance with Subsection 825.02.

A hinged door shall be provided permitting complete access to the interior of the cabinet. The door shall be sealed by neoprene gasketing material making the cabinet weatherproof. The door shall be furnished with a standard police lock and two keys.

Terminals shall be identified, accessible without removal of equipment contained in the cabinet, and connected to terminal boards.

A radio interference suppressor meeting the requirements of Section 825 shall be supplied.

The circuit breaker shall be in conformance with requirements of the NEC.

827.04 CONSTRUCTION METHODS. The solid-state, flashing controller shall be mounted on the signal pole and wired for operation.

827.05 METHOD OF MEASUREMENT. The solid-state, flashing controller and associated equipment, including cabinet, will be measured by the unit, complete in place, not including post and footings.

827.06 BASIS OF PAYMENT. The accepted solid-state flasher controller, measured as provided above, will be paid for at the contract unit price for:

Solid-State Flasher Controller	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete the work as specified.

828.00 SOLID-STATE, DIGITAL INDUCTIVE VEHICLE LOOP DETECTOR AND LOOPS

828.01 DESCRIPTION. This work shall consist of furnishing materials and installing a solid-state, digital inductive vehicle loop detector and loops in accordance with these Specifications, the latest NEMA Specifications, and as shown on the Plans.

828.02 MATERIALS.

A. Detector Loop. The detector loop wire that is embedded in the pavement for the detector loop shall be a number 14 AWG stranded copper cross-linked polyethylene insulated wire (Types XHHW, HAZ, XLP, XLPE, THHN and RHW), conforming to National Electrical Code and meet the requirements of Subsection 738.01 C. of Section 700.

B. Detector Unit. The detector unit shall be self-contained, self-tuning solid-state digital and shall compensate automatically for variations in temperature and environmental conditions.

1. Mechanical Requirements. The complete detector unit, including power supply, shall be completely enclosed in a sheet metal housing with a protective paint finish. The case shall be so designed to provide convenient access to the entire interior assembly to permit easy testing and servicing of parts. Each detector unit shall be supplied with a connecting cable. Electrical connection from the detector to the incoming and outgoing circuits shall be made by inserting a multi-terminal plug into the plug receptacle located on the face panel of the detector. The detector shall be replaceable with a similar unit without the necessity of disconnecting and reconnecting the individual wires leading therefrom.

2. Output Delay and Extend. The loop detector unit shall, when specified on the Plans, be supplied with programmable delay and extend output features.

2.1 Delay Output. A variable delay circuit shall be furnished to provide a delayed output. This circuit shall be variable from zero to at least 20 seconds in one-second increments. Detection of a vehicle shall be delayed for the amount of time selected, therefore providing no detector output until a vehicle has been present in the loop for this length of time. This timing shall reset each time the loop is vacated. However, the delay circuit shall be disabled immediately when 120 VAC is present on pin J of the MS 3106A-18 1P connector for this channel.

2.2 Extend Output. A variable extend circuit shall be furnished to provide a carryover output. This circuit shall be variable from zero to

at least 15 seconds in 0.25 second increments. Detector actuation shall be extended after the vehicle leaves the loop. The timing circuit shall reset after the extension has expired. However, the extend circuit shall not be disabled when 120 VAC is present at Pin J of the connector described again.

The timing shall be digital and all programming settings shall be accomplished by pins, thumbwheels or dip switches. The delay and extend features described herein shall not be required to function simultaneously unless otherwise specified on the Plans.

All programming (extend, delay, retention of presence, etc.) shall be external and located on the face of the unit.

3. *Operating Requirements.* The detector shall be designed so that environmental metal objects in the vicinity of the loop shall not affect its operation. The circuit design shall permit the lead-in cable described in Section 834 to be placed in a common conduit with signal and interconnect cable without any interference to the operation of the detector.

   The detector shall be designed to operate satisfactorily in temperatures ranging from -30° to 160° F. The detector shall be designed to operate satisfactorily on line voltage of single-phase, 120 volts, 60-cycle alternating current. This voltage may vary +15 percent without any noticeable effect of the operation or life of the detector equipment. The detector unit shall have a tuning range of loop inductance form 40 to 700 micro-henries. The defector shall be capable of detecting vehicles traveling at speeds ranging from 0 to 100 mph and shall detect only those vehicles that pass over any portion of the loop. Should power fail momentarily, the detector, when power is restored, shall return to its condition at the time of the power failure. If in the rest condition, it shall return to the rest condition or if in detect condition it shall return to the detect condition.

4. *Electrical Requirements.* Circuitry of the detector shall be all solid-state. The printed circuit board shall be as described in Section 825. Facilities for adjusting the detector shall be an integral part of the detector on the front panel. Loop tuning shall be a simplified procedure which may be performed without traffic activity and without the need of test apparatus. There shall be two operating modes, pulse and presence. The operating mode shall be independently selected for each detector by means of switches located on the front of the detector unit. Each detector unit shall be furnished with a surge protector to protect the detector unit from lighting or other like disturbance. The detector shall be provided with a multi-conductor color-coded harness and connector of the MS type. Each detector unit shall be provided with a fuse replaceable without tools,

located on the front panel. Each detector unit shall be permanently grounded internally. Visual indication of vehicle detection shall be provided by an indicator light located on the front panel.

828.04 CONSTRUCTION METHODS. The detection loop of the system shall be properly installed in order that it will perform reliably over a long period of time. The loop detection system shall be located as shown on the Plans. The exact location shall be marked on the roadway with chalk string, spray paint or some suitable marking device that can withstand weather and traffic until such time as the locations have been approved by the Engineer. The induction loop slot, including corner cuts, shall be cut to the exact width and depth as shown on the Plans. The slot shall be cleaned and dried with compressed air to remove all water and debris. All loop wires in any given location shall be wound in the same direction. All loop wire shall be one continuous length to the pull box or the junction condulet where it shall be connected to the lead-in cable. A blunt wood instrument shall be used for placing the wire into the slot so that the insulation is not damaged in any way. All connections that are made from loop wire to the lead-in cable shall be made only in the junction condulet or the pull box. The connection shall be soldered with a 60/40 alloy, rosin core solder. Care shall be taken while soldering not to damage the insulation of the wire and cable. When the connection has been completed, a resin-filled connector sealing pack shall be placed over it. If no lead-in cable is required, then the loop wire shall be connected directly to the terminal block that is located in the base of the traffic signal pole. After the loop wire has been carefully placed in the slot and circuitry checked by the contractor, the slot shall be sealed with a sealer as shown on the Plans.

828.05 METHOD OF MEASUREMENT. The solid-state digital inductive vehicle loop detector installed will be measured by the unit, complete in place, wired and connected to the controller. The loop detector wire will be measured by the linear foot installed and connected to the loop detector.

828.06 BASIS OF PAYMENT. The accepted solid-sate digital inductive vehicle loop detector and loop detector wire, measured as provided above, will be paid for at the contract unit price for:

A.	Solid-State Digital Inductive Vehicle Loop Detector	Ea.
B.	Loop Detector Wire	Lin. Ft.

which shall be full compensation for furnishing materials, labor, equipment and incidentals necessary to complete the work as specified.

830.00 PEDESTRIAN PUSH BUTTON

830.01 DESCRIPTION. The work shall consist of furnishing materials and installing pedestrian push buttons and signs on traffic signal installations in accordance with these Specifications and as shown on the Plans.

830.02 MATERIALS. The pedestrian push button switch shall be a phenolic enclosed precision snap acting single pole, single-throw unit with screw type terminals rated at 5 amperes at 125 volts AC.

Materials for pedestrian information signs shall be as shown on the Plans.

830.03 CONSTRUCTION METHODS. The pedestrian push button shall be constructed to be tamper proof. It shall be so designed in construction that it will be virtually impossible to receive any electrical shock under any weather condition.

The pedestrian push button and sign shall be attached to a traffic signal pole or steel pipe as shown on the Plans. The housing shall be shaped to fit the curvature of the pole or pipe and secured to provide a rigid installation.

830.04 METHOD OF MEASUREMENT. The pedestrian push button will be measured by the unit complete in place, connected, including signs and all hardware.

830.05 BASIS OF PAYMENT. The accepted pedestrian push button, measured as provided above, will be paid for at the contract unit price for:

Pedestrian Push Button	Ea.

which shall be full compensation for furnishing materials, labor, equipment and incidentals necessary to complete the work as specified.

831.00 TRAFFIC SIGNAL HEADS

831.01 DESCRIPTION. This item shall consist of providing and installing traffic signal heads and lamps on various types of supports at locations shown on the Plans and in conformance with these Specifications and the Institute of Traffic Engineers Standard Specifications.

831.02 MATERIALS. The traffic signal head or pedestrian head and all component parts can be either polycarbonate or die cast aluminum and shall conform to the ITE Standard for Adjustable Face Vehicular Traffic Control Signal Heads. All pedestrian signal heads shall meet the requirements of the ITE Standard Adjustable Face Pedestrian Signal Head Standard.

Traffic signal lamps furnished shall conform to the ITE Standard for Traffic Signal Lamp.

A minimum of 60 watt, 120 volt, clear, traffic signal lamps of 8000 hour minimum rated life shall be furnished with 8-inch heads and 9-inch pedestrian heads. A 150 watt, 120 volt, clear, traffic signal lamp of 6000 hour minimum rated life shall be furnished with both 12-inch traffic and pedestrian signal heads. All reflectors shall be specular alzak aluminum.

All die cast aluminum surfaces of the door, visors, and signal housing inside and outside shall be painted before assembly with three coats as follows:

First Coat – Primer: Shall be Oxide Baking Primer and shall meet or exceed the performance specifications of Federal Specifications TT-P-636.

Second Coat – Grey Enamel: Shall be medium Grey Alkyd Urea Exterior Baking Enamel and shall comply with Federal Specifications TT-E-489.

Third Coat – Yellow Enamel: Shall be Highway Yellow, best quality, synthetic resin enamel. The third coat on the inside and outside of the visors and the face of the signal doors shall be an Alkyd Urea Exterior Synthetic Baking Enamel, with minimum gloss reflectance meeting the performance requirements of TT-E-489, Enamel Heat Resisting Glycerol Phthalate, Type 4, Instrument Black.

831.04 CONSTRUCTION METHODS. Each signal head shall be a weather-tight assembly of one or more signal sections of the adjustable, incandescent type, together with all brackets and fittings necessary for proper mounting on the type of signal support designated on the Plans. Each signal head shall consist of one or more signal sections rigidly and securely fastened together, capable of being positively positioned to control the movement of one direction of traffic. Each signal section shall be a self-contained assembly consisting of an optical unit with housing, housing door, and visor.

831.05 METHOD OF MEASUREMENT. The traffic signal heads and lamps will be measured by the unit, complete in place including wiring and all hardware.

831.06 BASIS OF PAYMENT. The accepted traffic signal heads and lamps, measured as provided above, will be paid for at the contract unit price for:

Traffic Signal Heads	Ea.

which shall be full compensation for furnishing materials, labor, equipment and incidentals necessary to complete the work as specified.

832.00 OPTICALLY PROGRAMMED ADJUSTABLE TRAFFIC SIGNAL HEADS

832.01 DESCRIPTION. This work shall consist of providing and installing optically programmed adjustable traffic signal heads and lamps on various types of supports at locations shown on the Plans in conformance with these Specifications.

832.02 MATERIALS. The optically programmed adjustable traffic signal head shall permit the visibility zone of the indication to be determined optically and require no hoods or louvers. The projected indication(s) may be selectively visible or veiled anywhere within 15^Y of the optical axis and shall emanate from a single section. No indication shall result from external illumination nor shall one light unit illuminate a second.

A. Optical System.

1. The lamp shall be nominal 75 watt, 120 volt AC, three prong, sealed beam having an integral reflector with stippled cover and an average rated life of at least 6,000 hours.

2. The lamp collar including specular inner surface shall couple the lamp to the diffusing element.

3. The diffusing element may be discrete or integral with the convex surface of the optical limiter. The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects 900 to 1200 feet distance and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be composed of heat-resistant glass.

4. The objective lens shall be a high-resolution planar incremental lens hermetically sealed within a flat laminant of weather-resistant acrylic or approved equal. The lens shall be symmetrical in outline and may be rotated to any 90° orientation about the axis without displacing the primary image. The optical system shall accommodate projection from a single section of diverse selected indicia to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer.

5. The projected indication shall conform to ITE chromaticity standards.

B. Electrical. The lamp fixture shall comprise a separately accessible housing and integral lamp support, indexed ceramic socket and self-aligning, quick-release lamp retainer. Electrical connection between case and lamp housing shall be accomplished with an interlock assembly which disconnects lamp holder when opened. Each signal section shall include a covered terminal block for clip or screw attachment of lead wires. Concealed copper #18 AWG,

stranded and coded wires shall interconnect all sections to permit field connection within any section.

C. Photo Controls. Each signal section shall include integral means for regulating its intensity between limits as a function of individual background illumination. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1000 ft-c, and shall reduce to 15 percent + 2 percent of maximum at less than one ft-c. Response shall be proportional and essentially instantaneous to any detectable increase of illumination from darkness to 1000 ft-c, and damped for any decrease from 1000 ft-c.

The intensity controller shall comprise an integrated, directional light-sensing and regulating device interposed between lamp and line wires. It shall be compatible with 60-hertz input and responsive within the range 105 to 135 volts. Output may be phase-controlled, but the device shall provide a nominal terminal impedance of 1200 ohms open circuit and a corresponding holding current.

832.04 CONSTRUCTION METHODS. Die cast aluminum parts shall conform to ITE alloy and tensile requirements and have a chromate preparatory treatment. The exterior of the signal case, lamp housing and mounting flanges shall be finished with a high-quality prime baked enamel and finish paint. The lens holder and interior of the case shall be optical flat black. Signal case and lens holder shall be pre-drilled for backplates and visors. Hinges and latch pins shall be stainless steel. All access openings shall be sealed with weather-resistant rubber gaskets. The signal shall mount to standard 1½ inch fittings as a single section, as a multiple section face, or in combination with other signals. The signal section shall be provided with an adjustable connection that permits incremental tilting from 0-20 degrees below the horizontal while maintaining a common vertical axis through couplers and mounting. Mounting attachment shall permit external adjustment about the mounting axis in 5 degree increments. The signal shall be mountable and capable of being serviced with ordinary tools. Attachments such as visors, backplates or adapters shall readily fasten to existing mounting surfaces without affecting water and light integrity of the signal. The signal shall be installed, directed and veiled in accordance with manufacturer's instructions. Each section of the signal shall be masked with prescribed materials in an acceptable and workmanlike manner.

832.05 METHOD OF MEASUREMENT. Optically programmed adjustable traffic signal heads will be measured by the unit complete in place including masking, wiring and all hardware.

832.06 BASIS OF PAYMENT. Accepted optically programmed adjustable traffic signal heads, measured as provided above, will be paid for at the contract unit price for:

Optically Programmed Adjustable Traffic Signal Heads Ea.

which shall be full compensation for furnishing materials, labor, equipment and incidentals necessary to complete the work as specified.

833.00 TRAFFIC SIGNAL BACK PLATES

833.01 DESCRIPTION. This work shall consist of furnishing and installing backplates to traffic signal heads in accordance with these Specifications and as shown on the Plans.

833.02 MATERIALS. Backplates shall meet the requirement of Section 740.

833.03 CONSTRUCTION METHODS. The backplates shall consist of one-piece construction. The back plates shall be secured to the traffic signal heads with non-corrosive machine screws and lock nuts as shown on standard drawings.

833.04 METHOD OF MEASUREMENT. Backplates will be measured by the unit complete in place.

833.05 BASIS OF PAYMENT. Backplates, measured as provided above, will be paid for at the contract unit price for:

Backplates	Ea.

which shall be full compensation for furnishing materials, labor, equipment and incidentals necessary to complete the work as specified.

834.00 ELECTRICAL CONDUCTORS TRAFFIC SIGNAL

834.01 DESCRIPTION. This item consists of furnishing materials and installing electrical conductors for traffic signal systems as shown on the Plans.

834.02 MATERIALS. The electrical conductors shall meet the requirements specified in the following Subsections of Section 700. Traffic Signal Wire and Cables:

Traffic signal Electrical Cable	738.01 A.
Shielded Loop Detector Lead-In Cable	738.01 B.

834.04 CONSTRUCTION METHODS.

A. Traffic Signal Electrical Cable. Traffic signal electrical cable shall be installed from the heads on each traffic signal pole to the traffic signal controller. The electrical cable from the traffic signal pole to the controller shall be in conduit. The electrical cable to be furnished shall have a sufficient number of conductors and at least one spare conductor as shown on the Plans.

B. Shielded Loop Detector Lead-In Cables. The shielded loop detector lead-in cables shall be placed in conduit from each loop detector pull box location to the traffic signal controllers. At each of the loop detector pull box locations, the loop wire or the sensing element lead shall be spliced to the loop detector lead-in cable as shown on the Plans.

834.05 METHOD OF MEASUREMENT. The electrical conductors will be measured by the linear foot for each of the various types specified, installed, and shall include all connectors, splices and incidentals necessary to complete the traffic signal system as provided on the Plans.

834.06 BASIS OF PAYMENT. The accepted electrical conductors, measured as provided above, will be paid for at the contract unit price for:

A.	Traffic Signal Electrical Cable	Lin. Ft.
B.	Shielded Loop Detector Lead-In Cable	Lin. Ft.

which shall be full compensation for furnishing materials, labor, equipment and incidentals necessary to complete the work as specified.

835.00 SOLID-STATE TIME CLOCK

835.01 DESCRIPTION. This work shall consist of furnishing materials and installing a solid-state time clock in accordance with these Specifications.

Time of day, day of week, date, year and the operation of the relay output shall be easily settable from the integral keyboard. The functions of the keys shall be clearly marked on the keypad. All data required to properly set and program the unit and review the stored program shall be clearly displayed without the use of the auxiliary devices.

Changeover from standard time to daylight savings time or vice versa shall be accomplished automatically. This program shall be valid once the unit has been programmed with the time of day, month, date and year in which it is operating. From this entry, at the appropriate time each year the change will be made automatically for an indefinite time into the future according to current U. S. law. This feature shall be defeatable by a simple hardware change.

When the user is programming the unit, the display shall provide for verification of each piece of data prior to its being entered. Provisions shall be made for correcting any incorrect data prior to entering it. It shall be possible to alter any individual program step without disturbing any other step in the program.

When an instruction is given to turn the output on or off, that instruction time shall be settable to one minute, and the change shall take place at the zero second of that minute.

The time switch shall be capable of initiating a minimum of six program steps. A program step is defined as the time of day and the day or days of the week at which the output shall be turned on or off.

A set of clear operating instructions shall be furnished with each time switch.

The time switch shall be capable of executing five separate skip plans programmable at least one year in advance.

Programming for the skip plans shall be accomplished through the integral keyboard. Each plan shall be programmed by entering the beginning date (month/day/year) and the ending date for which the output of the time switch will not be activated. The time switch shall be capable of skipping as short a duration as one day or as long as six months. It shall be possible to begin a skip plan in one calendar year and end that same plan in the next consecutive year.

It shall not be necessary to enter the skip plan program in chronological order.

A means shall be provided to review the skip plan program without affecting the normal operation of the time switch. The display shall include the skip plan number, the beginning date and the ending date.

In addition to the skip plan as described above, the time switch shall also be capable of providing a one-day skip. The programming of this one-day skip may be entered at any time during the six days prior to the day that is to be skipped. After the execution of the one-day skip, the time switch will automatically reset and resume normal operation.

A means shall be provided to maintain timekeeping and the program when the line power source (115 VAC) is temporarily interrupted. This backup system shall maintain timekeeping and all programmed steps intact for not less than 48 hours at 25° C when fully charged and shall go on-line automatically upon failure of the line power. Upon resumption of the line power, the unit shall automatically resume normal operation and begin recharging the backup system. The charging system shall be capacitive. Batteries will not be accepted.

Should the program of the time switch be erased during an AC power outage, the unit shall display an indication of the program loss. The display shall be a discrete LED indicator and shall be resettable from the integral keyboard.

When the time switch is operating on the backup system, the displays shall be blanked and the output disabled to conserve backup power.

Integral with the time switch shall be a clear display of the time of day, day of week, date and the condition of the output relay. If time is kept on a 12-hour format, provisions shall be made to display AM/PM. The unit shall have the ability to switch to an alternate display of time that includes seconds. A single keystroke shall be all that is necessary to switch to this display or to return to the normal display.

A means shall be provided to review the program on the clock memory and such means shall be integral with the input. Such program review shall not affect the current operation of the time switch.

835.02 MATERIALS. This specification sets forth the minimum acceptable design requirements for a single-circuit, solid-state time clock. It is intended for use in traffic control systems and shall be of all solid-state construction except for the relay output. All components shall be made available to the purchaser for servicing for five years after expiration of the manufacturer's warranty or shall be so identified that they may be purchased from industrial electronics suppliers.

The time switch backpanel shall be equipped with a means for mounting to a suitable backplate. Mounting holes that provide clearance for at least a No. 10 screw will be acceptable.

The time switch shall not exceed 4 inches width x 7-3/8 inches height x 3-1/8 inches depth. A cover shall be provided to protect the time switch from dust. The cover shall fasten securely to the unit and must be easily removable for access to the field wiring terminals. The cover need not be rain tight since the time switch will be installed in an existing aluminum cabinet.

Interface to the power line and to the controlled device shall be provided by means of a terminal block capable of terminating wire sizes ranging from #20 to #12 AWG.

The time switch shall operate on a nominal 115 VAC, 60-hertz power source and shall operate satisfactorily between 95 and 135 VAC and from -30° to 75° C.

Timing shall be synchronous with the power line when such power is available. When commercial power is lost, the timing shall be maintained by a backup power source. Timing accuracy during such backup operation shall be +3 seconds per 24-hour period throughout its full temperature range.

No time shall be gained or lost during changeover from 115 VAC to the backup system and back to 115 A.C. voltage.

All programming shall be accomplished via a keyboard which is an integral part of the unit.

The time of day shall be accurately settable to one second.

835.04 CONSTRUCTION METHODS. The solid-state time clock shall be mounted in a controller cabinet and wired for operation.

835.05 METHOD OF MEASUREMENT. The solid-state time clock will be measured by the unit complete in place.

835.06 BASIS OF PAYMENT. The accepted solid-state time clock, measured as provided above, will be paid for at the contract unit price for:

Solid-State Time Clock	Ea.

which shall be full compensation for furnishing materials, labor, equipment and incidentals necessary to complete the work as specified.

850.00 SIGNS

850.01 DESCRIPTION. This work shall consist of furnishing and erecting, complete in place, signs in accordance with these Specifications and in reasonably close conformity with the dimensions and lines shown on the Plans or established by the Engineer. Included are signs of sheet aluminum and extruded aluminum panels, all with a reflective or non-reflective sheeting background and with steel or aluminum sign bracket arms, bolts and fittings.

850.02 MATERIALS. Materials shall meet the requirements of Section 719.

850.03 CONSTRUCTION METHODS.

A. Cleaning. Sheet aluminum and extruded aluminum panel signs shall be thoroughly cleaned to remove grease, oil and other contaminants prior to the application of reflective and non-reflective sheeting to insure proper bond of the sheeting adhesive.

B. Application of Reflective of Non-reflective Sheeting. Sheeting shall be applied to properly treated base panels with mechanical equipment in a manner as specified below. Class 2 adhesive-coated sheeting shall be pre-perforated.

1. Vacuum Application. Reflective or non-reflective sheeting shall be applied to all sheet sign faces by an approved vacuum applicator. The pre-coated adhesive on the back of the sheeting shall be activated by a minimum temperature of 185° F and the sheeting shall be evenly attached to the sign face by the diaphragm of the vacuum applicator which applies continuous even pressure and evacuates, with a minimum vacuum pressure of 25 inches of mercury, all air between the sheeting and the sign face to insure that there are no air pockets or bubbles. This operation shall be in accordance with the recommendations of the manufacturer of the reflective sheeting. After aging for 48 hours at 75° F, the adhesive shall form a bond equal to or greater than the strength of the reflective sheeting.

2. Continuous Roll Application. The sheeting with Class 1 adhesive coating shall be applied in a continuous operation over the entire surface of the sign and shall result in a surface free of air pockets or bubbles. The reflective sheeting for extruded panel signs shall extend approximately ¼ inch over each side of the panel and shall be adhered to each side. The sheeting on extruded panels shall not have more than one splice per panel.

3. Color Match. Sign faces comprising two or more pieces or panels of reflective sheeting shall be carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance, both day and

night. Non-uniform shading and an undesirable contrast between adjacent widths of applied sheeting will not be acceptable.

4. Splices. At splices, Class 1 adhesive-coated sheeting shall be overlapped not less than 3/16 inch. Class 2 adhesive-coated sheeting shall be butt-spliced, gap not to exceed 1/64 inch. Only butt splices shall be used on any sign face that is screen processed with transparent color.

Maximum allowable splices of reflective sheeting on sheet metal signs:

24-inch height sign and under – no splices
36-inch height sign and larger – one horizontal or one vertical splice

C. Finishing Signs. Following the application of the reflective sheeting background on sheet metal signs, the messages and border shall be applied by the silk screen process, or when specified by use of cutout legend.

All sign face splices and edges shall be sealed with materials supplied and in a manner specified by the sheeting manufacturer.

Demountable cutout legend, symbols and border shall be attached to the extruded panels with approved fasteners.

The finished signs shall show careful workmanship and have a smooth and uniform light surface. All letters and number shall be clear and sharp.

Sheet signs shall not be permitted to become wet in shipment or storage.

D. Location and Positioning of Signs. Signs shall be erected so the sign face is vertical and at a horizontal angle away from the direction of travel as shown on the Plans. Care shall be exercised in the erection of all signs to eliminate or minimize specular reflection.

After installation of the signs is completed, they shall be further inspected at night by the Engineer. If specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor at his expense to eliminate or minimize this condition.

Lower edge of extruded panel signs on over head trusses shall be aligned along the centerline of the lower horizontal chord member.

850.04 METHOD OF MEASUREMENT. Signs will be measured by the square foot of area of the vertical front face with no deduction for rounding off sign corners.

850.05 BASIS OF PAYMENT. Accepted signs, measured as provided above, will be paid for at the contract unit price for:

A.	Sheet Aluminum Signs	Sq. Ft.
B.	Extruded aluminum Panel Signs	Sq. Ft.
C.	Mast Arm Mounted Signs	Sq. Ft.

which shall be full compensation for furnishing all materials, labor, equipment and incidentals necessary to complete the work as specified.

851.00 GALVANIZED STEEL SIGN POSTS

851.01 DESCRIPTION. This work shall consist of furnishing materials and constructing galvanized steel sign posts in footings in accordance with these Specifications and in reasonably close conformity with the lines, dimensions, and locations shown on the Plans or established by the Engineer.

851.02 MATERIALS. Materials shall meet the requirements of section 721.

851.04 CONSTRUCTION METHODS. Should it be necessary to field cut a steel post, the cut end shall be placed in the concrete foundation. Any parts of steel posts from which galvanizing has been knocked or chipped off down to bare metal in transit, erection, or field alteration, shall be re-galvanized, metalized or painted with an approved zinc dust-oxide paint.

851.05 METHOD OF MEASUREMENT. Sign posts will be measured by the linear foot of the various sizes of galvanized steel posts erected in place as shown on the Plans or as directed by the Engineer.

On sign posts which require breakaway capabilities the breakaway design elements are considered a part of the sign post and are not measured separately.

Unless otherwise provided, footings will be measured and paid for in accordance with Section 804 and as shown on the Plans.

851.06 BASIS OF PAYMENT. Accepted sign post, measured as provided above, will be paid for at the contract unit price for:

A.	Galvanized Steel Wide Flange Beam Posts	Lin. Ft.
B.	Galvanized Steel Pipe Posts	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals necessary to complete the work as specified.

853.00 DELINEATORS

853.01 DESCRIPTION. This work shall consist of furnishing and installing delineators in accordance with these Specifications and in reasonably close conformity with the lines, dimensions and grades shown on the Plans or established by the Engineer.

853.02 MATERIALS. Materials shall meet the requirements of section 710.

853.04 CONSTRUCTION METHODS. Posts shall be installed so that the delineator units will be at the elevations specified on the Plans or established by the Engineer, and they shall be reasonably true to line and grade and plumb.

The posts may be either driven or set. If driven either by hand or mechanical devices, they shall be plumb and firm in the ground, spaced as specified, and driven to the required lines and grades. A suitable driving cap shall be used when posts are driven.

After driving, the top of the posts shall have substantially the same cross-sectional dimensions as the body of the post. Battered heads will not be permitted. Posts bent or otherwise damaged to the extent that they are unfit for use in the finished work shall be removed from the site and replaced by the Contractor at his own expense.

When posts are set, the post holes shall be dug to the correct depth and spaced as shown on the Plans. Post holes shall be backfilled with approved material placed in layers, not more than 6 inches in depth and each layer thoroughly compacted, care being taken to preserve the alignment of the posts. The post must be set to its final position before attaching the delineators.

All bolts and fasteners shall be of the type, length, diameter and material as called for on the Plans, or approved equal.

At bridges, the delineator post shall be fastened to the bridge handrail posts or parapet wall by utilizing brackets and fasteners for the various types as shown on the Plans or approved equal.

853.05 METHOD OF MEASUREMENT. Delineators will be measured by each delineator assembly, including galvanized steel posts. Each type of delineator will be measured separately.

Delineators shall be divided into types and coded for measurement and payment as follows:

Type 1 – Monodirectional
- Code 1 – One single reflector
- Code 2 – Two reflectors placed vertically

Code 3 – Three reflectors placed vertically

Type 2 – Bidirectional
Code 1 – Two single reflectors mounted back to back
Code 2 – Four reflectors with two on each side of the post, mounted back to back
Code 3 – Six reflectors with three on each side of the post, mounted back To back

The color of the reflectors will be as specified on the Plans or as established by the Engineer.

853.06 BASIS OF PAYMENT. Accepted delineators, measured as provided above, will be paid for at the contract unit price for:

A.	Delineators – Type 1, Code 1	Ea.
B.	Delineators – Type 1, Code 2	Ea.
C.	Delineators – type 1, Code 3	Ea.
D.	Delineators – Type 2, Code 1	Ea.
E.	Delineators – Type 2, Code 2	Ea.
F.	Delineators – Type 2, Code 3	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

854.00 TRAFFIC STRIPE (PAINT)

854.01 Description. This work shall consist of furnishing materials and placing a white or yellow paint stripe with glass beads applied by the drop-on method in accordance with these Specifications and in reasonably close conformity with the locations, lines and dimensions shown on the Plans or established by the Engineer.

854.02 MATERIALS. Materials shall meet the requirements of Section 711.

854.03 EQUIPMENT. The paint machine shall be capable of applying an even clean-cut line without excessive drifting of paint. The cutoff mechanism on the paint machine shall be capable of making a clean cut end section without dripping or stringing fine lines of paint.

The bead dispenser shall be equipped with an automatic cutoff control synchronized with the cutoff of the striping material.

854.04 CONSTRUCTION METHODS. In order to insure maximum adhesion, the Contractor shall clean all dirt, glaze and grease, road film, and all other foreign materials from the pavement area to be striped.

The material shall be applied to the pavement at a wet film thickness of approximately 0.015 inch.

The beads shall be distributed evenly over the wet paint at a reasonably accurate rate of 6 pounds per gallon of paint, unless a different rate is specified by the Engineer. Beads applied to the surface of the completed stripe shall be applied by an automatic bead dispenser attached to the striping machine in such a manner that the beads are dispensed immediately upon the completed line.

The completed line shall be a uniform cross-section. The paint traffic stripe shall not be applied when there is moisture on the pavement that would cause a poor bond between the paint and the pavement.

Application shall not be permitted when atmospheric temperature is below 40° F and falling.

854.05 METHOD OF MEASUREMENT. Traffic stripe (paint) will be measured by the linear foot of 4-inch wide traffic stripe placed or the equivalent 4-inch stripe necessary when a narrower or wider stripe is specified on the Plans.

854.06 BASIS OF PAYMENT. Accepted traffic stripe (paint), measured as provided above, will be paid for at the contract unit price for:

Traffic Stripe (Paint)	Lin. Ft.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

855.00 TRAFFIC STRIPE (PLASTIC)

855.01 DESCRIPTION. This work shall consist of furnishing materials and placing thermoplastic compound or pre-formed plastic tape markings on the roadway in accordance with these Specifications and in reasonably close conformity with the locations, lines, dimensions, and color shown on the Plans or established by the Engineer.

855.02 MATERIALS. Materials shall meet the requirements of Section 711.

855.03 EQUIPMENT.

A. Extruded Application (Thermoplastic). The material shall be applied to the pavement by the extrusion method wherein one side of the shaping die is the pavement surface and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. Extrusion of the material above the pavement surface will not be permitted.

All parts of the equipment which come in contact with the material shall be easily accessible for cleaning and maintenance. Conveying parts between the main reservoir and the shaping die shall not be allowed to clog up. All mixing and conveying parts up to and including the shaping die shall maintain the material at the plastic temperature and assure the continuous uniformity in the dimensions of the stripe. The equipment shall be so designed to insure uniform film thickness in the range of 3/32 inch minimum to 3/16 inch maximum.

The shaping die shall include a cutoff device remotely controlled to provide clean, square stripe ends and to provide a method of applying skip lines. The use of pans, aprons, or similar appliances which the die overruns will not be permitted. The top dressing of glass spheres shall be applied at the rate of approximately one pound per 100 feet of 4 inch wide line and in a manner which will firmly imbed them into the line surface at least ½ the diameter of the larger gradation sizes.

B. Mechanical Application (Preformed Plastic Tape). Preformed pavement line markings shall be installed with a mechanical applicator which shall be capable of placing pavement lines in a neat, accurate and uniform manner. The mechanical applicator shall be equipped with a film cutoff device and with measuring devices which automatically and accumulatively measures the length of each line actually placed to within a tolerance of +2 percent.

855.04 CONSTRUCTION METHODS.

A. Surface Preparation. In order to insure maximum possible adhesion, the Contractor shall clean off all dirt, glaze, grease, curing compound, or other foreign materials from the surface where lines are to be applied.

The removal of existing striping will be at the discretion of the Engineer and will be measured and paid for under Section 859.

The insure the satisfactory performance of plastic pavement markings, new portland cement concrete pavement shall be sandblasted to remove the curing compound from the surface on which pavement markings are to be applied. Sandblasting may be done seven days after placement of the concrete surface unless otherwise directed by the Engineer. Payment of this operation will be included in Subsection 855.06.

On all portland cement concrete surfaces and on asphalt surfaces in place over 12 months, a liquid seal coat shall be applied to the area which is to be striped. The seal coat shall be the type that is compatible with the plastic material used and the surface to which it is applied.

Plastic pavement markings shall not be placed over longitudinal joints unless special written authorization is given by the Engineer for necessary exceptions.

B. Application of Markings.

1. Hot Applied Plastic Pavement Markings. Hot applied pavement markings shall be applied straight and true by the extrusion die method. Lines shall have sharp edges, uniform thickness, good adhesion, and uniform reflectance of a high level. To insure the best possible adhesion, the compound shall be installed in a melted state at temperature of 400° F to 450° F, measured at the pavement surface, and in accordance with the manufacturer's recommendations.

The application of hot applied thermoplastic markings shall be done only on clean dry pavement having a road surface minimum temperature of 55° F and rising.

The drying time shall be defined as the minimum elapsed time after application when the stripe shall have and retain the characteristics required and after which time normal local traffic will leave no impression or imprint on the new stripe. The minimum drying time shall not exceed two minutes at 50° F at a maximum relative humidity of 70 percent when applied at 3/16 inch thickness or one minute when applied at 3/32 inch thickness.

Thermoplastic material used under this Specification shall be so compounded and applied as to retain for the life of the stripe, the original characteristics of the bond to the surface, ability to resist distortions by traffic impact or normal climate changes, and resistance to natural discoloration.

2. ***Cold Applied Plastic Pavement Markings.*** Pavement markings which are preformed of reflectorized plastic material and applied cold to the surface shall be coated with a factory-applied, pressure-sensitive adhesive.

   The material shall adhere to asphalt and concrete surfaces when applied according to the manufacturer's recommendations at surface temperature of 65° F and rising. If the markings must be applied when the surface temperature is below 65° F but not below 50° F, the markings are to be applied in strict accordance with the manufacturer's recommended procedures and/or other special instructions.

   The application of the reflectorized plastic markings shall be without the use of heat, solvents, or extra adhesives of any nature except that a surface sealer is required on portland cement concrete surfaces as indicated in these Specifications.

3. ***Inlaid Installation of Preformed Plastic Tape.*** When the inlaid method is to be used, the markings shall be applied after the newly placed bituminous concrete pavement has been adequately compacted and when the bituminous concrete pavement has attained a temperature range of 155° F to 125° F.

   The preformed pavement markings shall be inlaid into the bituminous concrete surface by means of a mechanical roller. The mechanical roller shall be of sufficient weight capacity to inlay the preformed pavement marking to a minimum depth of 65 percent of the material thickness and to not more than 80 percent of the material thickness while the temperate range of the bituminous concrete is within 155° F to 125° F. In the event the inlaid preformed pavement markings are distorted by the Contractor's operations, they fail to provide a uniform appearance or they are installed improperly, such inlaid pavement markings shall be repaired or replaced at the Contractor's expense in a manner approved by the Engineer. The inlaid preformed pavement markings shall be installed in the finished surface of the bituminous concrete pavement work prior to conclusion of each day's work.

855.05 METHOD OF MEASUREMENT. Traffic stripe (plastic) will be measured by the linear foot of 4-inch wide traffic stripe material actually placed or the equivalent 4-inch wide stripe when a narrower or wider stripe is specified in the Plans. Where arrows, words and symbols are placed, they will be measured by each unit.

855.06 BASIS OF PAYMENT. Accepted traffic stripe (plastic), measured as provided above, will be paid for at the contract unit price for:

A. Traffic Stripe (Plastic) (4-inch wide)	Lin. Ft.
B. Traffic Stripe (Plastic) (Arrows)	Ea.
C. Traffic Stripe (Plastic) (Words)	Ea.
D. Traffic Stripe (Plastic) (Symbols)	Ea.

E. Traffic Stripe (Plastic) (Tape) (4-inch wide)	Lin. Ft.
F. Traffic Stripe (Plastic) (Tape) (Arrows)	Ea.
G. Traffic Stripe (Plastic) (Tape) (Words)	Ea.
H. Traffic Stripe (Plastic) (Tape) (Symbols)	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

856.00 CONSTRUCTION TRAFFIC STRIPE

856.01 DESCRIPTION. This work shall consist of furnishing materials and placing traffic stripe on detours and roadways on which traffic is maintained during construction in accordance with these Specifications and in reasonably close conformity with the locations, lines and dimensions shown on the Plans or established by the Engineer. The use of paint with glass beads or reflective pavement striping tape for traffic stripe shall be optional, and they will be considered equal in measurement for payment. The use of removable pavement marking tape will be as specified on the Plans or as directed by the Engineer.

856.02 MATERIALS. Materials shall meet the requirements of Section 711.

856.03 EQUIPMENT. The paint machine and bead dispenser shall meet the requirements of Subsection 854.03. The application of reflective pavement striping tape and removable pavement marking tape shall be in accordance with the manufacturer's recommendation. During the period of application the pavement surface shall be dry and the atmospheric temperature shall be above 50° F.

856.04 CONSTRUCTION METHODS.

A. Detours. Striping of detours, including lane lines and edge lines, shall be completed before the detour is opened to traffic. When restriping of detours is necessary as determined by the Engineer, the restriping shall start within 24 hours (weather permitting) after the Contractor is notified by the Engineer.

B. Stage Construction. When roadways are being resurfaced in successive stages, striping shall be done prior to opening to traffic in a manner as shown on the Plans or as directed by the Engineer.

When on multi-lane divided highways, they shall be striped before opening to traffic as shown on the Plans.

Any detour striping that would conflict with the permanent striping shall be removed in a manner acceptable to the Engineer.

When additional striping is necessary due to overlays, redirection of traffic, or restriping due to wear, or other reasons as determined by the Engineer, the striping shall start within 24 hours after the Contractor is notified by the Engineer.

Removable pavement marking tape shall be installed in accordance with the manufacturer's recommendations as approved by the Engineer. The pavement

surface shall be dry at the time of pavement marking application. The Contractor shall remove all dirt, debris, loose particles and heavy oil residues from the road surface application areas immediately prior to the installation of pavement markings.

All removable pavement marking tape shall present a uniform appearance and shall be clearly visible during the day and night for traffic control. Pavement markings which fail to provide a uniform appearance or which fail to be clearly visible during the day or night shall be corrected by the Contractor in a manner acceptable to the Engineer and at no additional cost to the Department.

When removable pavement markings are no longer required, as approved or determined by the Engineer, the pavement marking film shall be neatly removed. Additional pavement markings may be installed as necessitated by traffic conditions, as approved or determined by the Engineer. Pavement marking tape removed shall be disposed of by the Contractor upon removal.

The removal of painted stripe and plastic stripe will be accomplished and paid for in accordance with Section 859. The removal of removable pavement marking tape will not be paid for separately and will be included in the unit price for that material.

856.06 BASIS OF PAYMENT. Traffic stripe, measured as provided above, will be paid for at the contract unit price for:

A.	Construction Traffic Stripe (Paint)	Lin. Ft.
B.	Removable Pavement Marking Tape (4 wide)	Lin. Ft.
C.	Removable Pavement Marking Tape (Arrows)	Ea.
D.	Removable Pavement Marking Tape (Words)	Ea.
E.	Temporary Pavement Marking Tape (4 wide)	Lin. Ft.

which shall be full compensation for road surface preparation, disposal of waste materials, and for all materials, labor, tools, equipment and incidentals to complete the work as specified.

857.00 PAVEMENT MARKERS

857.01 DESCRIPTION. This work shall consist of furnishing and installing pavement markers of the class and type specified on the Plans, at the locations shown on the Plans or directed by the Engineer, and in conformity with these Specifications.

857.02 MATERIALS. Materials shall meet the requirements of Section 736.

857.03 EQUIPMENT. The equipment used for mixing and application of epoxy resin adhesive shall meet the requirements of AASHTO M 237.

857.04 CONSTRUCTION METHODS. The portions of the highway surface to which the marker is to be attached shall be free from dirt, curing compound, grease, oil, moisture, loose or unsound pavement or any other material which might affect the attachment of the marker to the pavement. On portland cement concrete pavement, the area to which the marker is to be affixed shall be prepared by sand blasting or wire buffer immediately prior to placement of the marker.

The Contractor shall follow the installation procedure recommended by the manufacturer of the marker. The markers shall be firmly affixed to the surface in such a manner that they will not be displaced under traffic.

The installation of the markers shall be such that the color of the marker housing is compatible with the color of the traffic stripes they are to supplement or replace.

Reflective pavement markers shall be placed at the designated location in such a way that the color of the reflected light is in accordance with the Plans, details or as directed by the Engineer.

If the road is open to public travel during the progress of work, the Contractor shall operate his equipment and store his materials and supplies in such a manner as to cause a minimum of hazard and inconvenience to the traveling public.

Any damage to the pavement or other facilities caused by the operation of the Contractor's equipment shall be repaired by the Contract or at his expense.

857.05 METHOD OF MEASUREMENT. Pavement markers installed as directed and accepted will be measured by counting separately the number of various classes and types of markers.

Pavement markers shall be divided into classes and types for measurement and payment as follows:

Class A – Reflective
- Type 1 – Monodirectional
- Type 2 – Bidirectional

Class B – Non-reflective Ceramic
Yellow
White

Class C – Reflective, all weather
Type 1 – Monodirectional
Type 2 – Bidirectional

On reflective markers the color of the marker body other than the reflective face shall be neutral or match the reflector face. On bidirectional markers the color of the marker body shall be neutral or split to match the reflective faces.

The reflector unit for the Class C markers shall be affixed to the casting with an adhesive material which is molded to and is an integral part of the reflector unit. The section of the casting where the reflector unit is to be attached shall be brushed with a coat of primer furnished by the manufacturer immediately prior to attaching the reflector unit. The manufacturer's recommendations shall be closely followed.

The surfaces of the casting shall be free of rust, scale, dirt, oil, grease or other foreign material which might adversely affect the bond of the adhesive used to affix the marker to the pavement surface.

857.06 BASIS OF PAYMENT. Accepted pavement markers, measured as provided above, will be paid for at the contract unit price for:

A.	Pavement Markers, Class A, Type 1	Ea.
B.	Pavement Markers, Class A, Type 2	Ea.
C.	Pavement Markers, Class B, Yellow	Ea.
D.	Pavement Markers, Class B, White	Ea.
E.	Pavement Markers, Class C, Type 1	Ea.
F.	Pavement Markers, Class C, Type 2	Ea.

which shall be full compensation for furnishing all materials, preparation and installation and for all labor, equipment, tools and incidentals necessary to complete the work.

859.00 REMOVAL OF PAVEMENT MARKINGS

859.01 DESCRIPTION. This work shall consist of the removal of traffic stripe or other pavement markings in accordance with these Specifications at the locations shown on the Plans or as designated by the Engineer.

859.03 EQUIPMENT. Equipment used for this removal of the markings may be of any type that will not materially damage the surface or texture of the pavement material.

859.04 CONSTRUCTION METHODS. Pavement markings shall be removed to the fullest extent possible without damage to pavement surface. All sand or other material deposited on the pavement as a result of the removal operation shall be removed as the work progresses. Where blast cleaning is used for the removal of the pavement markings and such removal operation is being performed within ten feet of a lane under use by the traveling public, the residue including dust, shall be removed immediately by a vacuum attachment operated concurrently with the blast cleaning operation or by other methods approved by the Engineer.

Any damage deemed appreciable by the Engineer shall be repaired by the Contractor at his own expense by methods acceptable to the Engineer. Nothing in these Specifications shall relieve the Contractor from his public relations and responsibilities as set forth in Section 107.

Painting over or blotting out the existing pavement markings is not considered to be an acceptable method of removal and will not be considered for measurement as removal.

859.05 METHOD OF MEASUREMENT. Traffic stripe or pavement marking removal will be measured by the linear foot of 4-inch wide traffic stripe where a narrower or wider stripe is to be removed or by the each where an arrow, word, or symbol is to be removed.

859.06 BASIS OF PAYMENT. Except where otherwise specified on the Plans, removal of pavement markings, measured as provided above, will be paid for at the contract unit price for:

A.	Pavement Marking Removal (Traffic Stripe)	Lin. Ft.
B.	Pavement Marking Removal (Arrows)	Ea.
C.	Pavement Marking Removal (Words)	Ea.
D.	Pavement Marking Removal (Symbol)	Ea.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

880.00 CONSTRUCTION SIGNING AND TRAFFIC CONTROL

880.01 DESCRIPTION. This work shall consist of furnishing and erecting signs, lights, barricades and devices as shown on the Plans or as required by the Engineer or as proposed by the Contractor and approved by the Engineer.

880.02 MATERIALS.

A. Construction Signing and Traffic Control Materials. Materials for construction signing and traffic control shall meet the requirements specified as follows:

1. *Signs and Barricades.* The supports and sign blanks may be either metal, wood or plastic, the only requirement being satisfactory performance. All signs and barricades shall be reflectorized whether for day or night use. Reflectorization of signs and barricades shall be by means of wide-angle flat top reflective sheeting meeting the requirements of Subsection 719.04.

   All sign messages and symbols shall be constructed in accordance with the Manual on Uniform Traffic Control Devices and the Oklahoma Department of Transportation Sign Detail Standards.

2. *Signs 33.0 S.F. and Over.* Signs 33.0 square feet and over shall be constructed of extruded aluminum or galvanized steel. All signs in this item which are to be ground-mounted, shall be breakaway design and installed in accordance with the latest revision of the following standard drawings GMS-1, FGS-1, GFS-2 and SPA-1. Installation locations shall be approved by the Engineer prior to construction. Due to the temporary nature of these signs, no reinforcing steel will be required in the sign footings. Installation of this item may also include placement on existing overhead sign structures and will be shown on the Plans.

   All signs in this item shall be reflectorized in accordance with current specification. Sign color and specific design shall be as shown on the Plans.

3. *Barricade Warning Lights.* Barricade warning lights shall meet the requirements of Section 6E-5, Manual on Uniform Traffic Control Devices.

4. *Advance Warning Devices.* The advance warning devices shall consist of the following components:

   a. A sign panel with amber-colored, sealed-beam lamps attached, meeting the requirements of Section 6E-9, Manual on Uniform Traffic Control Devices.

b. A circuitry control unit.

c. A mounting frame.

The face of the panels which are exposed to oncoming traffic shall be a non-reflective black finish. The level of intensity of light displayed by the sealed beam units shall be changed through means of the control unit for either high intensity for day or reduced fro night operations. All sealed beam units shall display essentially the same intensity of light for a given intensity setting.

Larger panels may be substituted for smaller panels at the discretion of the Contractor, but smaller panels may not be substituted for larger panels.

The sign panel shall be supported on a mounting frame such that when displayed to oncoming traffic, the bottom edge of the panel shall be not less than 7 feet above the roadway surface.

The frame shall support the sign panel with sufficient strength to resist an 80-mile per hour sustained wind, with 104-mile per hour intermittent gusts from any direction. The advance warning device shall be mounted in such a manner that the panel can be rotated on a horizontal axis so as to be hidden from the view of on-coming traffic when not in use. All mobile advance warning devices shall be on pneumatic-tired vehicles.

The flashing lights on the advance warning device shall be operated from a dependable power source and shall have a separate auxiliary source of power immediately available. At least one power source on a mobile advance warning device shall be a self-contained source, either battery or electric generator operated.

The advance warning device shall contain a special circuitry control unit. The circuitry control unit shall be a solid-state electronic unit with four modes which shall contain switching controls for operator selection as follows:

1. Pass Right-sequential chevrons or flashing arrow.

2. Pass Left-sequential chevrons or flashing arrow.

3. Pass Either Side-the outermost chevrons, one at either end of the panel with the apex of each chevron pointing toward the nearest panel edge.

4. Caution-four or more lamps, arranged in a pattern which will not indicate a direction.

B. Sampling and Testing. Tests will not ordinarily be made by the laboratory on the above materials, but the materials furnished shall be recognized

standard products and the manufacturer of such products shall furnish the Engineer a certificate of compliance with these Specifications supported by the appropriate test reports.

880.03 CONSTRUCTION METHODS. Signs, lights and barricades may be placed on either portable or fixed supports as project requirements dictate.

Traffic control devices shall meet the requirements of the current Manual on Uniform Traffic Control Devices, published by the U. S. Department of Transportation, as pertains to shape, size, color, mounting height and placement.

When, in the opinion of the Engineer, any sign or other device which has been damaged, needs cleaning, or has deteriorated to the extent it is no longer effective, it shall be cleaned or replaced immediately as required. The Controller will designate at least one person to be on call 24 hours a day to respond to emergency traffic control needs.

880.04 CONSTRUCTION METHODS. Signs, lights and barricades may be placed on either portable or fixed supports as project requirements dictate.

Traffic control devices shall meet the requirements of the current Manual on Uniform Traffic Control Devices, published by the U. S. Department of Transportation, as pertains to shape, size, color, mounting height and placement.

When, in the opinion of the Engineer, any sign or other device which has been damaged, needs cleaning, or has deteriorated to the extent it is no longer effective, it shall be cleaned or replaced immediately as required. The Contractor will designate at least one person to be on call 24 hours a day to respond to emergency traffic control needs.

880.05 METHOD OF MEASUREMENT. Each sign, barricade, light, drum, advance warning device, or other traffic control device will be measured by the unit, complete in place, each calendar day the device is required and is in place in an acceptable condition and position to meet all of the above requirements. Measurement for payment will begin on the day that signs and other devices are in place for traffic control and direction. The Contractor will be required to furnish a log of the signing and other traffic control devices and this log will be updated throughout the life of the project to confirm the addition or deletion of individual traffic control items. Prior to each pay period the traffic control devices will be physically counted to substantiate the log. The traffic control devices will be monitored daily by the Contractor to evaluate their physical condition. When signs and devices are not needed for traffic control, they will not be measured, even though left in place. During non-working periods such as holidays, Sunday, etc., the log of signs in place and measured for payment on the day preceding and on the day following such down time will be used to determine the signs to be paid for. When it is necessary to move an item from one location to another, it will be measured for payment only one time on the day of movement.

The necessary flags, flagman signs and jackets, posts, traffic cones, and other incidental items included in a detour or other traffic control system or installation, as shown on the Plans or as required by the Engineer, will not be measured for payment, but their costs shall be included in the price of other bid items.

Signs and other traffic control devices will not be measured for payment during any time the Contractor is being charged for liquidated damages. This in no way relieves the Contractor from his responsibility for providing signing on the project or maintaining the required log until it has been completed and accepted. Such signing will be at his own expense.

During any period that contract time is suspended in accordance with Subsection 108.07, any traffic control devices required for the safety of the motoring public will continue to be measured and paid for.

Quantities included in the Plans for traffic control items are estimated quantities based upon a given sequence of construction and schedule of work and should not be considered as definite quantities for final payment. The quantities computed for final payment will be based on daily measurements recorded and approved by the Engineer.

880.06 BASIS OF PAYMENT. Signs and other traffic control devices, measured as provided above, will be paid for at the contract unit price for:

A.	Advance Warning Device (Type A)	Sign Day
B.	Advance Warning Device (Type B)	Sign Day
C.	Advance Warning Device (Type C)	Sign Day
D.	Signs 0 to 6.25 SF	Sign Day
E.	Signs 6.26 to 15.99 SF	Sign Day
F.	Signs 16.00 to 32.99 SF	Sign Day
G.	Signs 33.0 SF & Over	Sign Day
H.	Barricades (Type I)	Sign Day
I.	Barricades (Type II)	Sign Day
J.	Barricades (Type III)	Sign Day
K.	Wing Barricades	Sign Day
L.	Vertical Panels	Sign Day
M.	Type A Light	Sign Day
N.	Type B Light	Sign Day
O.	Type C Light	Sign Day
P.	Drums	Sign Day
Q.	Tube Channelizers	Sign Day

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified. Unless otherwise designated on the Plans or special provisions all traffic control devices under this item will remain the property of the Contractor upon completion of the project.