STANDARD SPECIFICATIONS

FOR THE CONSTRUCTION
OF
PUBLIC IMPROVEMENTS

THE CITY OF OKLAHOMA CITY

Department of Public Works

Engineering Division

THE CITY OF OKLAHOMA CITY

APPROVAL SHEET

STANDARD SPECIFICATIONS

FOR

THE CONSTRUCTION OF PUBLIC IMPROVEMENTS

Approved by:

September 12, 2023

Eric J. Wenger, P.E., ~~Director~~
Public Works/City Engineer

RECEIVED by the Council of the City of Oklahoma City this 12TH day of SEPTEMBER, 20 23.

ATTEST:

City Clerk

Mayor

TABLE OF CONTENTS
SECTION 100

SECTION 1 –STANDARD SPECIFICATIONS AND PREFACE

1.1 PREFACE

These Standard Specifications, with the exception of Section 100, are generally written in the imperative mood and active voice. In sentences using the imperative mood, the subject, “the contractor,” is implied. Reference to the contractor is also implied in this language by the use of “shall,” “shall be,” or similar words and phrases. For material specifications, the subject is the contractor and supplier, fabricator, or manufacturer supplying material, products, or equipment for use on the project.

Whenever “directed,” “required,” “prescribed,” or other similar words are used, the “direction,” “requirement,” or “order” of the City Engineer is intended. Similarly, whenever “approved,” “acceptable,” “suitable,” “satisfactory,” or other similar words are used, the words mean “approved by,” “acceptable to,” or “satisfactory to” the City Engineer.

1.2 PURPOSE, INTENT AND INTERPRETATION OF STANDARD SPECIFICATIONS

The purpose of these Standard Specifications is to establish, where applicable, minimum acceptable standards or a range for acceptable results in accordance with the Standard Specifications and the Contract Documents. It is the intent of these Standard Specifications that the contractor be fully and exclusively responsible for producing a compliant and acceptable end product, which meets the standards and requirements in the Standard Specifications and the Contract Documents.

In producing the work and project, the contractor shall exercise control of all work and the project. City personnel, except where specifically provided for herein, will make inspections for the benefit of the City and the Awarding Public Agency to document that compliant and acceptable work and project is being produced.

The contractor is responsible for performing and controlling all work to the greatest degree possible in producing the project, which must be in all respects fully compliant and acceptable. These Standard Specifications should not, however, be interpreted in any manner which allows a contractor to produce non-compliant or unacceptable work or project, or which work endangers the public. An acceptable and fully compliant product is the essential. Only projects in full conformance with the Standard Specifications, Standard Details, and approved plans and specifications will be accepted by the City or the Awarding Public Agency.

In order to avoid cumbersome and confusing repetition of expressions in these Standard 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 City.”

1.3 STANDARD SPECIFICATIONS FOR CONSTRUCTION OF PUBLIC IMPROVEMENTS

This document constitutes the City of Oklahoma City's "Standard Specifications for the Construction of Public Improvements," as amended, (“Standard Specifications”). These Standard Specifications may be viewed or downloaded at www.okc.gov/departments/public-works.

These Standard Specifications may be amended or revised in accordance with Oklahoma City Municipal Code Section 12-4.

These Standard Specifications are incorporated into the Bidding Documents and Contract Documents and into all work and projects to which these Standard Specifications are applicable.

These Standard Specifications also incorporate by reference any Standard Details.

These Standard Specifications also incorporate by reference any applicable requirements of City, local, state of Oklahoma, and federal regulations and laws. All projects, private and public, must comply with applicable laws both in its construction and as constructed.

Whenever possible, these Standard Specifications are to be read to not be conflicting and are to be read to be cumulative and are to be read such that all the work and the project meet each and all provisions, requirements and standards.

SECTION 10 – APPLICABILITY OF STANDARD SPECIFICATIONS

These Standard Specifications govern all work and all projects:

10.1 Performed on land owned or leased by City or by a Trust; and/or

10.2 Performed on easements and rights-of-ways granted to, held in trust for the public, the City or a Trust, or regulated by the City or by a Trust; and/or

10.3 Under the Oklahoma Competitive Bidding Act to which the City or a Trust is subject; and

10.4 Under the Public Trust Act to which a Trust is subject; and/or

10.5 Under contract with the City or a Trust to which these Standard Specifications are referenced and/or incorporated by reference; and/or

10.6 Authorized under the Oklahoma City Municipal Code and City Charter; and/or

10.7 Performed to improvements owned by or leased by the City or a Trust with City funds or with Trust funds; and/or

10.8 Performed by private or public entities for improvements, which in whole or in part, are to be donated or dedicated to the City or a Trust, regardless of whether performed, constructed, or provided, in whole or in part, with private funds or other non-City or non-Trust funds; and/or

10.9 Performed by private or public entities for which the improvements, in whole or in part, are to be donated or dedicated to the City or a Trust, regardless of whether performed, constructed, or provided, in whole or in part, with City funds or Trust funds.

SECTION 100 – GENERAL PROVISIONS

100.01– COORDINATION OF THE CONTRACT DOCUMENTS

Whenever possible the provisions, terms, requirements and standards in the Contract Documents will be read to not conflict and such that the work and project must meet each and all provisions, requirements, and standards. If a requirement or issue is not addressed in a Contract Document provision, silence will not be deemed to be a conflict and silence will not be deemed to be a waiver of another provision in Contract Document.

100.02 - CONFLICTS BETWEEN CONTRACT DOCUMENTS

100.02.01 In case of conflicts between provisions of Contract Documents, which conflicts cannot be met by meeting both or all provisions, these Contract Documents will have the following order of precedence, with each set of provisions, requirements and standards also controlling all subsequent sets:

A) Approved plans, and which approved plans will govern over conflicting provisions of
B) Special Provisions included in the approved Bidding Documents, and which Special Provisions will govern over conflicting provisions of
C) Standard Details, approved by the department that will operate and/or maintain the public improvement, and which Standard Details will govern over conflicting provisions of

D) Standard Specifications Sections 200-900, and which Standard Specifications Sections 200-900 will govern over conflicting provisions of
E) Standard Specifications Section 100, and which Standard Specifications Section 100 will govern over conflicting provisions of
F) approved contract Amendments and Change Orders, and which approved contract Amendments and Change Orders will govern over conflicting provision of
G) Contract Document forms, and which Contract Document forms will govern over conflicting provisions of
H) Contractor's bid.

100.02.02 Additionally, as between provisions within these Standard Specifications or a Contract Document:

A) actual quantities of unit price bid items will govern over quantities on plans and over the estimated quantities shown on the Bid Tab.
B) quantities on plans will govern over estimated quantities shown in the Bid Tab.
C) figured dimensions shall govern over scaled dimensions.
D) written figures will control over numerals.
E) pictures and diagrams on approved plans will govern over conflicting words on approved plans.
F) project specific terms will govern over general terms.

100.02.03 Provided, however, silence will not be deemed to be a conflict in terms or a waiver of provisions, requirements, or standards. Further, wherever any terms can both be satisfied, the terms will be deemed to not conflict and the contractor must satisfy both terms unless specifically directed otherwise in writing by the City Engineer.

100.02.04 Neither the Standard Specifications nor the Contract Documents will not be interpreted to impair, diminish, or defeat the purpose of a fully functional, compliant, and timely completed project.

100.03 – CONFLICT BETWEEN REQUIREMENTS AND STANDARDS

In case of conflicts between provisions, requirements and standards for work or projects, not constructed as part of a contract awarded by an Awarding Public Agency, the following order of precedence will apply:

A) expressly and explicitly stated exceptions to Standard Details or Standard Specifications on project plans, approved by the department that will operate and/or maintain the public improvement, which approved project plans will govern over conflicting provisions of
B) applicable Standard Details, approved by the department that will operate and/or maintain the public improvement, which Standard Details will govern over conflicting provisions of
C) applicable provisions of the Standard Specifications Sections 200-900, which Standard Specifications Sections 200-900 will govern over conflicting provisions of
D) the applicable provisions of the Standard Specifications Section 100.

100.04 - APPARENT DISCREPANCIES.

The contractor shall take no benefit from any apparent discrepancy, error or omission in the Standard Specifications, the Bidding Documents, or the Contract Documents. Contractor shall immediately notify the City Engineer in writing of any apparent discrepancies, errors, or omissions. The City Engineer is authorized to and will make any necessary interpretations of the intent of the Standard Specifications, Bidding Documents, or Contract Documents.

100.05 - COOPERATION OF CONTRACTOR

100.05.01 Contractor must give consistent and continuous attention to the work and must cooperate with the City Engineer and cooperate with other contractors with project sites or work sites in the vicinity of its project site and work sites. Contractor must at all times during work on the project provide a full-time, experienced, skilled and competent superintendent on the project

site and each work site. Such superintendent must also be capable of reading, and thoroughly understanding the Contract Documents. Contractor's onsite superintendent must be fully authorized by the contractor and in control of the work thereon.

100.05.02 Contractor must provide all reasonable and all necessary equipment and facilities to enable the City Engineer and Engineer/Architect to inspect the project, the work, and all workmanship, materials and equipment incorporated or to be incorporated into the work and project.

100.06 – LEGAL REQUIREMENTS

100.06.01 All work and projects must comply with applicable City, local, state of Oklahoma and federal laws and regulations. These Standard Specifications will not relieve the contractor of compliance with applicable laws and regulations. No compensation or time will be granted to the contractor for such compliance unless specifically provided otherwise in the Contract Documents, Bidding Documents, or these Standard Specifications. Contractor must include the time to obtain any such compliance in contractor's Project Schedule and any cost or expense to comply in its bid. If no bid item is provided therefor, the cost and expense will be deemed incidental and included by the contractor in its bid.

100.06.02 Contractors performing work and projects must obtain, at contractor's cost and expense, all required permits and licenses and must include the time to obtain any such license or permit in contractor's Project Schedule.

100.07 – DEFINITION OF TERMS

100.07.01 With respect to all gender related references: where it is stated, "he" or "his" will be taken to apply whether the authorizing individual is female or male. Dual gender references were avoided to simplify the understanding of the subject matter. For purposes of these Standard Specifications, the single shall include the plural and the plural shall include the singular.

100.07.02 The definitions set forth in these Standard Specifications are applicable to all work and all projects described in **Section 10** above.

A.A.S.H.T.O. - American Association of State Highway and Transportation Officials.

Acceptance – after completion of all work and the project, acceptance of the work and project is by the formal recorded action of the governing body of the Awarding Public Agency, or in the case of a private project to be dedicated to the City or the Awarding Public Agency acceptance is by the formal recorded action of its governing body. After completion of work or projects completed pursuant to a contract that is bid, awarded, and approved through an informal bid process, acceptance of the work and project is by the formal recorded action of the governing body of the Awarding Public Agency.

Addendum (addenda) – written or graphic instruments issued by the City Engineer prior to the bid date which modify or interpret the Bidding Documents by additions, deletions, clarifications, or corrections.

Advertisement – all publications pertaining to the project.

Alternate Bid (add-alternate bid, deduct-alternate bid, or other alternate bid) – the amount stated in the bid to be added to or deducted from the amount of the Base Bid, if the corresponding change in the work or the project as described in the Bidding Documents, is accepted. The scope of each Alternate Bid will be described in the Bidding Documents.

Amendment – a change to the Contract Documents where the unit quantity bid is increased or decreased, and the unit price and unit description are unchanged. Amendments shall be a part of the Contract Documents upon their approval by the Awarding Public Agency. The contractor is obligated to

provide all quantities required and to execute any Amendment to revise the bid item quantities to match the actual quantities installed in accordance with the Contract Documents.

A.N.S.I. - American National Standards Institute.

Approved plans – plans approved by the City Engineer and by all City Departments which review such plans.

Architect – licensed professional architect or architectural firm or entity engaged under contract with the Awarding Public Agency to design any work or project, prepare the Bidding Documents, supervise construction of the work or project, administrate the work or project, inspect the work or project, and/or to provide such other services as set forth in the contract for professional services regarding the work or project.

A.S.T.M. - American Society for Testing Materials

Award – the formal action of the Awarding Public Agency awarding the contract to the bidder for the project, subject to the execution and approval of a contract and provision of the required insurance and bonds, and satisfaction of such other conditions as may be specified in the Standard Specifications or Bidding Documents or otherwise required by law. Informal contracts may be awarded by the City or the Awarding Public Agency or their respective authorized representative.

Awarding Public Agency - the public entity or entities, identified in the Notice to Bidder, contracting for the project and the performance of the work described in the Bidding Documents. Awarding Public Agency also includes the public entity approving a contract pursuant to an informal bid process.

Base bid – the sum stated in the bid for which the bidder offers to perform the work and provide the project described in the Bidding Documents without any Add Alternates or Deduct Alternates or Alternate Bid.

Bid date and bid time - the date and time for the receipt of bids for a particular project as provided in the Notice to Bidders.

Bid bond – the security submitted with the bid which shall either be a certified check, cashier's check or bid bond in the amount required by the Public Competitive Bidding Act of 1974, as amended. (Also known as bid security.)

Bid – required documents or statements duly submitted in accordance with the Notice to Bidders and the Bidding Documents by the bidder offering to perform the work contemplated and provide the project as described in the Bidding Documents. A bid is the complete and properly signed firm offer to do the work and provide the project for the sums stated therein. A submission shall not be considered a bid if it is untimely or fails to provide any required document. A submission by a bidder who is not prequalified for the class of work as stated in the Bidding Documents shall not be considered a bid unless prequalification was specifically waived in the Bidding Documents.

Bid Committee – committee as established in the Oklahoma City Municipal Code, as amended.

Bid item – that item and work and all incidental items, work, materials, and equipment necessary to complete that work or portion of the project for which a separate unit price is included in the Bid Tab.

Bid security – the security submitted with the bid which shall either be a certified check, cashier's check or bid bond in the amount required by the Public Competitive Bidding Act of 1974, as amended. (Also known as bid bond).

Bid Tab – form included in the Bidding Documents upon which a bid for work or the project is to be prepared and submitted by the bidder to the Awarding Public Agency.

Bidder – any person or persons, partnership, company, firm, corporation, or other entity acting directly or through a duly authorized representative submitting a bid for the project and work contemplated in these Standard Specifications and the Bidding Documents.

Bidding Documents – documents upon which a bidder bids, and which are incorporated by reference in the Contract Documents and contract, consisting of:

A) approved project plans,
B) Standard Specifications,
C) Standard Details,
D) Special Provisions,
E) Documents Required for this Bid,
F) Notice to Bidders,
G) Signature Requirements for Bidding Documents,
H) Noncollusion Affidavit Form,
I) Business Relationship Affidavit Form,
J) Local Business Utilization Affidavit Form,
K) any documents listed in the Bidding Documents,
L) addenda,
M) example Contracts and Bonds Forms, and
N) any other documents included in the Documents Required for this Bid.

Bonds – Bid Bond, Performance Bond, Statutory Bond, and Maintenance Bond and any other bond required by the Bidding Documents.

Calendar day – every day of the calendar year without exception.

Calendar Day Completion Projects - project which must be completed within the number of calendar days stated on the Notice to Bidders with the counting of calendar days starting on the date for commencement of work as stated in the work order issued by the City Engineer.

Change Order – a change in the Contract Documents; other than Amendments (changes in quantities of unit price bid items) which will be separately processed and tracked from Amendments; and other than Alternate Bids which will be awarded with the contract and not considered Change Orders.

City – the City of Oklahoma City, Oklahoma, a municipal corporation, acting through its duly authorized representatives, agents, or employees.

City Auditor – the City Auditor of the City of Oklahoma City, Oklahoma, or duly authorized representatives or agents.

City Clerk – the City Clerk of the City of Oklahoma City, Oklahoma, or duly authorized representatives or agents.

City Engineer – the City Engineer of the City of Oklahoma City, Oklahoma and when so designated by the City Engineer, duly authorized employees of the City, acting severally or individually within the scope of the particular duties specifically entrusted by the City Engineer.

Completed – the project and all work has been constructed and fully completed and the contractor has performed all responsibilities in and in accordance with the Contract Documents, also including the Punch List items.

Completion Date Projects - project which must be completed on or before the completion date stated in the Notice to Bidders regardless of the date for commencement of work stated in the work order issued by the City Engineer.

Contract – executed agreement, and any amendment thereto, covering the performance of the work and provision of the project in accordance with these Standard Specifications, the Bidding Documents, and the Contract Documents and any Amendment or Change Order or awarded Alternate Bid.

Contract Documents – documents which constitute the contract between the Awarding Public Entity and the successful bidder as the contractor that sets forth the responsibilities and obligations of the Awarding Public Agency and the contractor consisting of:

A) Contract,
B) Bonds
C) Performance Bond,
D) Statutory Bond,
E) Maintenance Bond,
F) any other Bond required by the Bidding Documents,
G) Contractor's Certificate of Insurance, and all renewals thereof,
H) Certificate of Nondiscrimination,
I) Work Order,
J) Approved Submittals and Substitutions,
K) Approved Amendments,
L) Approved Field Changes,
M) Approved Change Orders,
N) Awarded Alternate Bid,
O) Bidding Documents, and
P) Other documents required by the Bidding Documents.

Contractor – person or persons, partnership, company, firm, corporation, or other entity who performs work or provides a project to which these Standard Specifications apply.

Council – City Council of the City of Oklahoma City, Oklahoma.

Defective bid – bid submission found to not comply with the Bidding Documents, applicable law, or the City Resolution 93-01 approved June 22, 1993, as amended. Also known as irregular bid.

Electronic bidding system - the electronic bid system as provided in the Notice to Bidders.

Emergency bid – bids solicited, received, opened, and awarded in accordance with the Awarding Public Agency's then current policies and procedures and any Notice to Bidders and Bidding Documents issued, therefore.

Engineer – licensed professional engineer or engineering firm or entity engaged under contract with the Awarding Public Agency to design any work or project, prepare the Bidding Documents, supervise construction of the work or project, administrate the work or project, inspect the work or project, and/or provide such other services as set forth in the contract of professional services for the work or project.

Engineer/Architect – the licensed professional engineer or licensed professional architect, as the case may be, engaged under contract with the Awarding Public Agency to design any work or project, prepare the Bidding Documents, supervise construction of the work or project, administrate the work or project, inspect the work or project, and/or provide such other services as set forth in the contract of professional services for the work or project.

Equipment – Any tool or operable machinery used in the performance of work or provided and incorporated into the work or project.

Extra work – any work performed by the contractor not provided for in the Contract Documents even though provided by the contractor in performance of the contract and/or included in the project. Contractor is neither compensated nor granted additional time for extra work unless compensation or time was specifically and expressly approved by the Awarding Public Agency in a Change Order.

Field Change – a formal method of authorizing the contractor to perform work or implement a project change where there is no additional cost to the project and no additional compensation or time to the contractor. Field Change requires written approval by the City Engineer.

Final Inspection – inspection performed after the contractor informs the Awarding Public Agency that all work, the project and all Punch List items are completed in accordance with the Contract Documents.

Grade – slope of the land, pavement, channel, pipe, structure, or any other item as determined by the rise over the run of the item.

Holiday – any day so designated by the City of Oklahoma City's City Council.

Inspector – representative of the City Engineer and/or the Awarding Public Agency authorized to make inspections of the work, the project and/or the contract performance.

Incidental cost – any cost or expense for which there is not a specific and separate unit price in the Bid Tab. Contractor will not be compensated for incidental costs except as such costs may have been included by the contractor in a bid item, unit price or other item on the Bid Tab.

Incidental work – any work necessary to complete the project but for which a bid item or a unit price is not separately included in the Bid Tab, and for which separate compensation is not paid and for which the project completion time and date are not extended.

Informal bid – bids solicited, received, opened, and awarded in accordance with the Awarding Public Agency's then current policies and procedures and any Notice to Bidders and Bidding Documents issued, therefore. Further informal bid processes result in a contract approved by the City or the Awarding Public Agency, or their authorized representative.

Irregular bid – the bid is not in compliance with the Bidding Documents, applicable law, or the City Resolution 93-01 approved June 22, 1993, as amended. (Also known as defective bid.)

ITE – Institute of Transportation Engineers.

Labor – effort employed by the contractor and its subcontractors to perform work or provide the project.

Liquidated damages – stipulation or condition for the payment of an amount as provided in the Bidding Documents, which shall be presumed to be the amount of damage sustained by a breach of such contract because, from the nature of the contract, it is impracticable or extremely difficult to fix the actual damage. Liquidated Damages to be paid by the contractor to the Awarding Public Agency or may be deducted by the Awarding Public Agency from retainage and/or any payments due or to become due to the contractor. Liquidated Damages are not a penalty to the contractor. Contractor must include in its bid sufficient costs and expenses to timely complete the project and to pay any liquidated damages for untimely completion as a contract cost, not as a penalty. Liquidated damages do not preclude the recovery of actual damages.

Maintenance Bond – approved agreement executed by the contractor and its surety as a guarantee that the work and project will be properly maintained by the contractor against any failure due to defective

workmanship or material for the required maintenance period.

Materials – items placed, used, or included in the work or project to complete the project and also including any purchased equipment or supplies.

MUTCD – Manual on Uniform Traffic Control Devices.

No collusion Affidavit – affidavit signed and timely submitted by the bidder as a necessary part of the bid that affirms the bidder has not colluded with the Awarding Public Agency, their officers or their staff or any other bidder.

Performance Bond – the approved agreement executed by the contractor and its surety as a guarantee that the work and project will be properly and timely performed, and the project will be timely completed in accordance with the Contract Documents.

Permit – document issued by the City or another public entity or agency with jurisdiction authorizing or necessary for the authorization of the work or project to be performed.

Person – any individual, company, corporation, association, partnership, limited liability company, limited liability partnership or any other legal entity.

Plan or plans – all of the illustrations, drawings, and design showing or illustrating details of the work or project prepared and sealed by an Architect or Engineer. Plans must be approved by the City Engineer; however, approval of the plans is an administrative function and relieves neither the Architect nor Engineer of any professional responsibilities. Additionally, approval of plans for private projects, even those projects intended to be dedicated to and accepted by the City or its Trust, neither warrants that the plans meet these Standard Specifications, Standard Details or applicable laws, nor that the plans are adequate for the intended purpose, nor that the project will be accepted by the City or its Trust, nor relieve the contractor or the person on whose behalf the plans were submitted of compliance with these Standard Specifications, Standard Details, or applicable laws.

Prequalification or prequalified – prequalified means that the bidder or contractor has been qualified by the Prequalification Review Board to bid the contract or the contractor or subcontractor has been prequalified to perform the class or classes of work required for the contract, public improvement, or project.

Prequalification Review Board – City board which grants, conditions, limits, revokes, or denies a contractor the status which authorizes the contractor to bid a contract or perform a class or classes of work.

Project – all work, labor services, materials, supplies, tools, equipment, incidentals, contract alterations, licenses, permits, tests, studies, and activities necessary to comply with these Standard Specifications, the Bidding Documents and the Contract Documents and to comply with every work order, ordinance, permit requirement, applicable law, license, or other requirement to make or construct an improvement, utility or structure.

Project Manager - representative of the City Engineer and/or the Awarding Public Agency authorized to provide administrative of the work, the project and/or the contract performance for the benefit of the City and/or the Awarding Public Agency.

Project site – any site where the project is constructed, or work is performed for the project.

Punch List Inspection – inspection performed at the request of the contractor and performed at the discretion of City Engineer to determine whether all work and the project is complete and to create the

Punch List prior to the Final Inspection for the completion of the project. This inspection is performed after the Inspector, Engineer/Architect and Project Manager agree the project could be complete.

Public improvement – any beneficial or valuable change or addition, improvement, betterment, enhancement or amelioration of or upon any real property, or interest therein, belonging to the City or its Trust(s), intended to enhance its value, beauty or utility or to adapt it to new or further purposes including but not limited to any building, highway, street, sewer, pavement, waterline, sidewalk, or any other improvement or structure which is constructed, altered, or repaired under contract or any instrument with an Awarding Public Agency or constructed, altered or repaired by a person which will donate or dedicate same to the City or Trust(s). Public improvements are subject to these Standard Specifications. Public improvements are the responsibility of the contractor until the improvement is accepted by the express formal action of the governing body of the Awarding Public Agency, the City and/or the Trust, whichever is last.

Small Local and Minority Business Subcontracting Plan – the Small Local and Minority Business Subcontracting Plan submitted by the contractor in accordance with the Small and Disadvantaged Local Business Utilization Program.

Small Local and Minority Business Subcontracting Program – On December 22, 2020, the City Council approved and re-established the Small Local and Minority Business Utilization (LBU) Program. The LBU program encourages and promotes the use of small, local and minority business subcontractors on public construction contracts. The goal is to provide assistance, guidance, and opportunities for small and disadvantaged local businesses to work on City projects. The Small Local and Minority Business Utilization Program was formerly called the Local Business Utilization Program.

Standard Details – requirements established and adopted by the department that regulates, operates and/or maintains the improvement. Standard Details, and any amendment or revision thereto, are incorporated herein by reference. Standard Details, if any, are available on the official City website.

Standard Specifications – these Standard Specifications for Construction of Public Improvements, as amended and/or revised.

Special Provisions – special clauses in the Bidding Documents setting forth conditions or requirements for the specific project supplementing the Standard Specifications and the Standard Details.

Statutory Bond – the approved agreement executed by the contractor and the surety as a guarantee that all bills and accounts will be paid for all equipment, material, services, tests, and labor used or provided by a subcontractor, materialman, or supplier in the performance of the work and/or the provision or construction of the project.

Submittal – drawings and/or documents submitted by the contractor for review and approval by the Engineer/Architect as specified in the Standard Specifications, Contract Documents, or the Bidding Documents.

Substantial completion – a formal decision of the Awarding Public Agency, to utilize the project, though the project is not complete as required by the Contract Documents. Unless otherwise expressly defined and set forth in the Special Provisions, substantial completion will mean provisional and conditional acceptance of all the work and the project by the express formal action of the governing body of the Awarding Public Agency. Substantial Completion may trigger certain rights, duties, and obligations for the parties.

Substitutions – a contractor submitted request to modify the Standard Specifications or Contract Documents. A substitution may not impair or diminish in any manner the characteristic of the work or project including but not limited to:

A) service life or usable life,
B) economy of operations,
C) ease of maintenance,
D) desired appearance or design,
E) safety standards, and
F) functionality.

Surety or Sureties – the corporate body or legal entity authorized by law to issue Bonds in the state of Oklahoma and which entity is bound by the respective Bonds.

Trust – any public trust(s) of which the City is a beneficiary.

Unit price – an amount stated in the bid as a price per unit for a bid item as described in the Bidding Documents.

Work – all the activities specified, indicated, shown, or contemplated in the Standard Specifications, Bidding Documents, and/or Contract Documents or otherwise required to construct the project or public improvement, also including all labor, services, materials, tools, equipment, supplies, contract alterations, licenses and permits. Work also includes also including all incidental labor, services, materials, tools, equipment, supplies, contract alterations, licenses, permits and activities incidental or necessary to the performance of the work and the completion of the project.

Work order - the document issued by the City Engineer directing contractor to commence the work or the project and stating the date for the commencement of work.

Work site – area wherein work under the responsibility of the contractor is performed for the project.

SECTION 101 – NOTICE TO BIDDERS

The Awarding Public Agency will receive bids in accordance with the Notice to Bidders and the Bidding Documents for the work and/or project. Informal bids will be received in accordance with the Awarding Public Agency's current informal bidding policy and procedures, as amended. Emergency bids will be received in accordance with the Awarding Public Agency's current emergency bidding policy and procedures, as amended.

SECTION 102 – PREQUALIFICATION OF BIDDERS

102.01 – PREQUALIFICATION TO BID

Prequalification requirements for bidding on a contract, if any, are set forth in the Notice to Bidders. Bidder must be prequalified by the Prequalification Review Board for the class of work listed on the Notice to Bidders, if any, to bid on a contract with an Awarding Public Agency.

102.02 – PREQUALIFICATION TO PERFORM WORK

Any person performing work for which the Prequalification Review Board has established a prequalification classification must be prequalified by the Prequalification Review Board before performing such work, including but not limited to work to which these Standard Specifications are applicable as described in **Section 10** above and any public construction contract, work on public property, or work on a public improvement, as defined by Chapter 13, Article XII of the Oklahoma City Municipal Code. Regardless of whether prequalification is required to bid, any contractor and any subcontractor performing work for which a prequalification class has been established must also have obtained any prequalification and must also obtain any permit or permits and any license or licenses required by the City of Oklahoma City or any government agency having jurisdiction or authority, which is/are necessary to perform work for the accomplishment of the project. The Bidder must include in its bid the cost of having a prequalified contractor or prequalified subcontractor perform any work for which

a prequalification classification has been created.

SECTION 103 – BID REQUIREMENTS AND CONDITIONS

103.01 – PRE-BID CONFERENCE

103.01.01 ADA COMPLIANCE.

It is the policy of the Awarding Public Agency to ensure that communications with participants and members of the public with disabilities are as effective as communications with others. Anyone with a disability who requires an accommodation, a modification of policies or procedures, or an auxiliary aid or service to participate in a meeting should contact Awarding Public Agency staff or TDD 405-297-2850 as soon as possible but not later than 48 hours (excluding weekends or holidays) before the scheduled meeting. The Awarding Public Agency will give primary consideration to the choice of auxiliary aid or service requested by the individual with disability.

103.01.02 PRE-BID CONFERENCE.

The Awarding Public Agency may invite prospective bidders to attend a Pre-Bid Conference. The purpose of this Pre-Bid Conference is to present general information about the project to potential bidders; however, no comments made in the Pre-Bid Conference will revise, amend, or interpret the Bidding Documents. If the bidder requests a clarification, interpretation, or requests an amendment or revision to the Bidding Documents, such requests must be made through the electronic bidding process and any response, if any, will be made only by written addendum made available through the electronic bidding system. Questions and answers in the electronic bidding system do not constitute an addendum.

103.01.03 – MANDATORY PRE-BID CONFERENCE

103.01.03.01 When specified in the Notice to Bidder, attendance at the Pre-Bid Conference is a prequalification requirement. If there is a virtual meeting option, the virtual address will be provided in the Notice to Bidders. When the Notice to Bidders specifies that the Pre-Bid Conference is mandatory, the contractor who plans to submit a bid must attend the Mandatory Pre-Bid Conference. Failure of the prospective bidders to attend a Mandatory Pre-Bid Conference will cause the bidder's submission to be rejected. Whenever required, a Mandatory Pre-Bid Conference is a prequalification requirement to bid on the contract.

103.01.03.02 A Mandatory Pre-Bid Conference will begin at the designated time; a sign-in sheet will be passed to all attendees; only full-time employees of the prospective bidder will be considered as eligible representatives for mandatory attendance; and, five minutes after the Mandatory Pre-Bid Conference is called to order, the sign-in sheet will be closed and collected (late arrivals will not be allowed to sign in). The official timekeeper for closing the sign-in sheet shall be the Awarding Public Agency staff member chairing the Mandatory Pre-Bid Conference.

103.01.03.02 The following will not be eligible to bid on the project: (1) prospective bidders leaving the Mandatory Pre-Bid Conference prior to adjournment of the Mandatory Pre-Bid Conference; (2) prospective bidders whose names have been placed on the sign-in sheet but were not in attendance; or (3) anyone arriving at the Mandatory Pre-Bid Conference after the sign-in sheet has been closed.

103.01.03.03 In the case of a joint venture, an eligible representative from each of the organizations participating in the joint venture must be prequalified and in attendance. Sub-contractors are not required to attend unless specifically required as a requirement stated in the Notice to Bidders.

103.02 – CONTENT OF BIDDING DOCUMENTS

103.02.01 – BIDDING DOCUMENTS

Copies of addenda will be made available for inspection through the electronic bidding process. The electronic bidding process shall be considered proof that the Awarding Public Agency made the addendum available to all bidders and is included in and incorporated into the Bidding Documents upon which bidder has bid.

103.02.02 – ADDENDA

The City Engineer may issue addenda as may be necessary in the best interest of the Awarding Public Agency. Addenda may amend the bid date and/or bid time for receipt of bids or amend or revise any plan, specification, item, document, or requirement in the Bidding Documents. Addenda will only be made in writing and made available through the electronic bidding process. The bidder has the obligation to ascertain through the electronic bidding process whether an addendum has been issued and to read and comply with all addenda prior to the bid date. Bidder has the obligation to read and comply with the terms of the Bidding Documents, as amended by written addenda, if any, prior to bidding. Bidders will be bound by any addenda issued in accordance herewith.

103.02.03 - CORRECTION OF BIDDING DOCUMENTS

The Bidder shall at once report to the City Engineer and the Engineer/Architect any errors, inconsistencies or ambiguities discovered in the Bidding Documents through the electronic bidding system.

103.02.04 – SUBSTITUTIONS PRIOR TO BIDDING

The items including but not limited to labor, materials, supplies, systems, services, products, equipment, tests, and processes described in the Bidding Documents establish a standard of required function, dimension, appearance, life expectancy, and quality for the project. Any proposed substitution must meet the same standard of the required function, dimension, appearance, life expectancy, and quality of the item in the Bidding Documents.

103.02.04.01 – PRE-BID CONSIDERATION; ADDENDUM REQUIRED.

No substitution will be considered prior to the receipt of bids unless a written request for approval has been received by the City Engineer and the Engineer/Architect through the electronic bidding system at least seven (7) days prior to the bid date. Substitution requests must be submitted through the electronic bidding system. Oral, telephone, email, or fax approval of substitutions are invalid and shall not receive any consideration. Substitution requests must include the name of the item to be substituted (including the bid item number and the location where the item is discussed in the Bidding Documents) and a complete description of the proposed substitution including drawings, performance and test data, and other information necessary for an evaluation of the requested substitution. A statement setting forth any necessary or related changes in other items or other portions of the work or project, including changes in the work or project of other contracts that incorporation of the proposed substitution would require, must be included in the request. The burden of proof of the merit of the proposed substitution is upon the bidder.

103.02.04.02 If a proposed substitution is approved prior to bid date, such approval will be set forth in a written addendum issued by the City Engineer and approved or ratified by the Awarding Public Agency. Bidders may not rely upon approvals made in any other manner.

103.02.04.03 If a substitution request is not responded to by written addendum, then the request will be deemed denied, and the Bidder must bid the item as described in this Bidding Documents.

103.03 – BIDDER'S REPRESENTATIONS

103.03.01 The Bidder by making a bid, represents that the bidder has:

A) scrutinized, compared, carefully read, and understands the Bidding Documents; and
B) inspected the project site and become familiar with local conditions under which the work is to be performed; and
C) informed itself by independent research of the difficulties to be encountered and personally judged the accessibility of the work, work site, and project site and all attending circumstances affecting the cost of doing the work and providing the project and of the time required for its timely completion; and
D) correlated the Bidder 's personal observations with the requirements of the Bidding Documents and ensures the Bid is made in accordance therewith; and
E) become familiar with and understands all other projects which may affect the work, or access to the work site, project site or project; and
F) based its bid upon the items, labor, services, supplies, materials, tools, equipment, systems, processes, services, and incidentals required by the Bidding Documents without exception; and
G) has obtained firm fixed prices and delivery commitments from all subcontractors, suppliers, materialmen, laborers, system providers, process providers and services providers to fix the costs and to require the timely performance of the work and completion of the project.

103.03.02 EXAMINATION OF DOCUMENTS AND WORK SITE

Bidder acknowledges the bidder prepared its bid and, before preparing the bid, carefully read and examined the Bidding Documents and any other documentation or information. Bidder acknowledges that bidder is familiar with and able to comply with all the provisions of the Bidding Documents and all applicable regulations and laws. Bidder agrees that if this bid is accepted, bidder will enter into the contract with the Awarding Public Agency and properly submit the required contract, bonds, Small, Local and Minority Business Subcontracting Plan, and certificates of insurance within seven (7) calendar days following the Awarding Public Agency's notification of its intent to award contract to the bidder, unless such time is extended by the City Engineer. Bidder hereby agrees to commence work on the project on the date stated in the work order is issued by the City Engineer and to complete the project within the number of calendar days or by the calendar date specified in the Notice to Bidders.

103.04 – PREPARATION AND FILING OF BID

Bids must be completed and timely submitted in accordance with the Bidding Documents and must contain all required bid security, documents, and affidavits.

103.04.01 - INCOMPLETE BIDDING DOCUMENTS

Bidders must use complete sets of Bidding Documents in preparing bids. Neither the Awarding Public Agency nor the Engineer/Architect assumes responsibility for bidder's errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents obtained, circulated, or shared by or between bidders or contractors, materialmen, service providers, laborers, and subcontractors. All prices must be stated as numerals such as $XX.xx to indicate dollars and cents per bid item. All Base Bid items must have a price indicated.

103.04.02 – COMPLETE, SIGN AND SUBMIT

All forms all documents, certificates and affidavits must be completed, signed, and timely submitted through the electronic bidding system. All blanks on forms, documents, certificates, and affidavits must be filled and completed.

103.04.03 - Bidders must ensure that the bid is entered correctly through the electronic bidding

system. Neither the City nor the Awarding Public Entity is responsible for the failure of the bidder to fully and properly complete and execute the bid or for failure of the bidder to timely submit its bid.

103.04.04 – ALTERNATE BIDS

There may be one or more add alternates (additions to the base bid) or deduct alternates (deductions from the base bid) or other alternate bids (substitutions for item(s) in the base bid). If the electronic bidding system provides for an add alternate or deduct alternate and/or other alternate bid, the Alternate Bid should be completed in the same manner as the Base Bid and in accordance with the Bidding Documents, if any. Any Base Bid and all Alternate Bids, whether add alternates or deduct alternates or other alternate bids, must have a price indicated, unless expressly stated otherwise in the Bidding Documents. No additional completion time or change to completion date extension will be granted due to the selection of add alternates or deduct alternates or other alternate bid, if any, unless expressly stated in the Bidding Documents.

103.04.05 – BID SIGNATURE REQUIREMENTS

An authorized agent of the bidder must properly sign all bids, affidavits, and documents. The Awarding Public Agency reserves the right to require a bidder to subsequently provide any documentation it may deem necessary to verify the authorized signature or the authority of the signatory. The Awarding Public Agency has adopted an electronic docketing system for the review and approval of contracts, bonds, and other legal documents. The parties acknowledge that the Awarding Public Agency has authorized electronic signatures to be affixed to legal documents. The parties agree that legal documents with electronic signatures affixed by authorized representatives of the Awarding Public Agency, respectively, are deemed to be valid original documents enforceable by and binding upon the parties.

103.04.06 All bids and affidavits, the bid security and any other documents required to be submitted with the bid must be submitted through the electronic bidding system. Bids will only be accepted electronically in accordance with the Notice to Bidders.

103.04.07 All complete, properly submitted bids from bidders timely received may be considered by the Awarding Public Agency prior to a contract being awarded. Submissions will not be received after the bid time and bid date for receipt through the electronic bidding system.

103.04.08 Bidder shall assume full and sole responsibility for timely completion and submission of the bid through the electronic bidding system.

103.04.09 Any bid not submitted through the electronic bidding system, unless otherwise expressly stated in the Bidding Documents, is invalid and will not receive consideration.

103.04.10 No bidder shall divulge the sealed contents of a bid to any person whomsoever, except those having a partnership or other financial interest with the bidder in said bid, until after the sealed bids have been opened. A violation on the part of the bidder shall, at the sole discretion of the Awarding Public Agency, make voidable any contract made by the Awarding Public Agency with the bidder based upon such bid.

103.05 – BID AFFIDAVITS

Affidavits contained in the Bidding Documents must be properly completed and signed by an authorized agent of the bidder. The Awarding Public Agency reserves the right to require a bidder to subsequently provide any documentation the Awarding Public Agency may deem necessary to verify the authorized signature or the authority of the signatory. The bid must contain all required bid affidavits as listed in the Bidding Documents. Bids must be completed in accordance with the Bidding Documents. The bid affidavits must be properly completed, signed, sworn to, notarized,

and submitted electronically with the bid.

103.06 – BID SECURITY

103.06.01 Each bid must be accompanied by a bid security in the form of a bid bond and/or a certified check and/or cashier's check delivered by bid time on the bid date, in the amount of five percent (5%) of the amount of the Total Bid, unless otherwise waived by Informal Bidding Documents. . Bid bonds must be uploaded in the electronic bidding system and must be submitted electronically with the bid. For the purposes of this section, Total Bid shall mean the highest combination of the Base Bid plus all add/deduct Alternate Bids. The bid security is a guaranty that the bidder will enter into a contract with the Awarding Public Agency on the terms stated in the Bidding Documents and bidder will furnish bonds, Small, Local and Minority Business Subcontracting Plan, and insurance. Should the bidder refuse to enter into such contract or fail to furnish such bonds as required and/or the required certificate of insurance and other required documents, the amount of the bid security shall be forfeited to the Awarding Public Agency as liquidated damages, not as a penalty.

103.06.02 The Awarding Public Agency has the right to retain the bid security of bidders until either (a) the contract and bonds and other required documents have been executed or submitted by the successful bidder, or (b) the specified time to award bids has elapsed so that bids may be withdrawn in accordance with state law, or (c) all bids have been rejected, or (d) another bidder has been determined to be the successful bidder.

103.07 – NO WITHDRAWAL OR ALTERATION OR NON-CONSIDERATION OF BIDS

Bidder may withdraw or modify a proposed bid in the electronic bidding system at any time before the bid time on the bid date. Where informal bids or emergency bids permit paper bids, permission will not be granted to withdraw or modify any paper bid after it has been submitted.

103.08 - SALES TAX

103.08.01 Oklahoma sales and use tax exemptions may or may not be available to contractors on City and/or trust projects. Contractor pursues any available tax exemption at its own risk. The contractor is solely responsible for interpreting and determining the applicability and availability of these exemptions. The contractor should consult private legal counsel to determine whether purchases are exempt from applicable taxes. The contractor is solely responsible for obtaining all documents and for complying with all regulations and procedures applicable to its use of these exemptions.

103.08.02 Oklahoma sales and use tax exemptions are not available to contractors on Trust projects. However, Oklahoma sales and use tax exemptions may be available to the trust for direct purchases made by the Trust. The Trust will only make direct purchases related to a project if and as specifically and expressly stated in a Special Provision.

103.08.03 The contractor will be responsible for and bear the cost of all applicable sales and use taxes and all other applicable local, state of Oklahoma, or federal taxes pertaining to the project. Applicable taxes will be deemed a cost the contractor has included in its bid and contract price and by extension of such lump sum and unit prices in any subsequently issued amendment. Similarly, the contractor must include any applicable taxes in any Change Order. Sales tax laws are subject to revision, addition, or amendment by City voters or by the State Legislature at any time. The Awarding Public Agency will not be liable for any change in taxes or any new or additional taxes; such taxes will be and are a risk and liability of the bidder or contractor included in its bid and contract price and any such change in or new or additional tax will not be paid or reimbursed by the Awarding Public Agency.

103.09 – OPENING OF BIDS
Bids submitted and timely received will be opened and after opening bid tabulations may be available within a reasonable time through the electronic bidding system. Each bidder's bid and documents will be available, as required by law, and in response to an Open Records Request.

103.10 – IRREGULAR BIDS
Any bid that shows any omission, or any alteration of a form, or any addition, substitution or condition not specified authorized in the Bidding Documents shall be deemed irregular. Any unauthorized alternate bid shall be deemed irregular. However, the Awarding Public Agency reserves the right to waive these irregularities and make the award in the best interest of the Awarding Public Agency.

103.11 – REJECTION OF BIDS
Timely and properly submitted bids from qualified bidders will be considered by the Awarding Public Agency. Awarding Public Agency has the right to reject any or all bids. Awarding Public Agency has the right to waive immaterial defects or immaterial irregularities in a timely submitted bid received and to accept such bid, which, in the Awarding Public Agency's judgment, is in its own best interest.

103.11.01 A bid may also be rejected for any of the following specific reasons:

A) the Bid or Contract Documents are not signed by the bidder or bidder's authorized agent;
B) the Noncollusion Affidavit, as required by the City Charter or the Oklahoma Competitive Bidding Act, has not been submitted with the bid and/or the text of the affidavit has been altered; and/or the affidavit is not properly signed and/or notarized;
C) the Business Relationship Affidavit, as required by the Oklahoma Competitive Bidding Act, has not been submitted with the Bid and/or the text of the affidavit has been altered; and/or the affidavit is not properly completed, signed or notarized;
D) the bid security or bid bond as required by the Oklahoma Competitive Bidding Act, is not attached to the bid;
E) the bid fails to comply with any other requirements of City, state of Oklahoma, or federal law and/or any other forms required by the Bidding Documents are not properly completed, executed and submitted;
F) bidder is not prequalified unless prequalification is established by a prequalification questionnaire or prequalification is waived as stated in the Notice to Bidders;
G) the bid is received after the bid time on the bid date as stated in the Notice to Bidders; or
H) bidder has failed to include with the bid any documents required for this bid as stated in the Bidding Documents.

103.11.02 A bid may also be rejected based on the following reasons:

A) a bid price is determined by the Awarding Public Agency to be unbalanced;
B) total bid price is above the Architect / Engineer's estimate of total cost; or
C) bid is incomplete, such as required signatures or material irregularities or material defects.

103.11.03 A bid, not rejected, does not create a right of the bidder to award of the contract, even if the apparent low bidder.

103.12 – NONCOLLUSION
A Noncollusion Affidavit must accompany each bid. Bids will not be considered unless a properly and fully executed Noncollusion Affidavit accompanies the bid. The Noncollusion Affidavit is a sworn statement, which provides that the bidder has not made any agreement or colluded with the Awarding Public Agency or any bidders or prospective bidders in restraint of freedom or competition or has agreed to bid at a fixed price or to refrain from bidding. Violation of a provision of the Noncollusion Affidavit shall render the bids of such bidders void and persons willfully violating this requirement may be guilty of a

felony. Bidders must use the Noncollusion Affidavit provided by the Awarding Public Agency in the Bidding Documents. The text of the Noncollusion Affidavit may not be modified. Bidder may, however, adapt the signature block to provide for additional signatures.

103.13 – BUSINESS RELATIONSHIP

A Business Relationship Affidavit must accompany each bid. Bids will not be considered unless a properly and fully executed Business Relationship Affidavit accompanies the bid. The Business Relationship Affidavit is a sworn statement which discloses the following information: the nature of any business relationships then in effect or which existed within one (1) year prior to the date of such statement with the Engineer/Architect or any officer or director of the architectural or engineering firm or other party to the project; and the names and positions of all persons having any such business relationships. Bidders must use the Business Relationship Affidavit provided by the Awarding Public Agency in the Bidding Documents. The text of the Business Relationship Affidavit may not be modified. Bidder may, however, adapt the signature block to provide for additional signatures.

SECTION 104 – EMPLOYMENT PRACTICES

104.01 – NONDISCRIMINATION

104.01.01 Neither the contractor nor any subcontractors employed on this project may discriminate against any employee or applicant for employment because of race, religion, creed, sex, color, national origin, ancestry, gender, age, or disability as defined by the Americans with Disabilities Act. A Certification of Nondiscrimination must be properly signed and submitted with the contract. The requirements of the certificate must be included in any subcontracts connected with the performance of the contract. The contract may be canceled by the Awarding Public Agency for noncompliance with the provisions of the certificate and the contractor may be declared to be ineligible for further contracts until satisfactory proof of intent to comply shall be made by the contractor and/or any subcontractors.

104.01.02 The Certification of Nondiscrimination must be exhibited in a central and public location at the place of business by the contractor and each subcontractor while the contractor and any subcontractors are performing work on the project.

104.02 – SMALL, LOCAL AND MINORITY BUSINESS SUBCONTRACTING PROGRAM.

104.02.01 The City of Oklahoma City has adopted a program to encourage and promote the use of small and disadvantaged local businesses as subcontractors on public construction contracts as set forth in the Oklahoma Public Competitive Bidding Act. The contractor must provide the Awarding Public Agency a Small, Local and Minority Business Subcontracting Plan setting forth the contractor's internal and outreach strategies and efforts to provide and extend opportunities for small, local and minority business participation in the performance of subcontracts. The contractor must submit a preliminary Small, Local and Minority Business Subcontracting Plan to the City Engineer with the contract and bonds and before a contract will be awarded or approved by the Awarding Public Agency. The contractor must create and maintain records demonstrating its efforts and the success of its efforts.

104.02.02 The contractor must submit a Final Small, Local, and Minority Business Subcontracting Plan to the City Engineer seven (7) calendar days prior to the Pre-Work Conference. The City Engineer may provide comments and may request additional documentation from the contractor, responses to which the contractor must bring to the Pre-Work Conference. The Final Small, Local and Minority Business Subcontracting Plan will be reviewed at the Pre-Work Conference and must be approved by the City Engineer at the Pre-Work Conference before the contractor may commence work though a work order may already be issued.

104.02.03 The contractor must provide a written report to the City Engineer on the form provided by the City Engineer delineating and documenting its efforts, progress, and successes

of its Small, Local and Minority Business Subcontracting Plan as a condition precedent to final payment and release of retainage. This written report is a requirement of substantial completion and of acceptance. The project will neither be deemed substantially complete nor be accepted for final payment until the contractor submits and the City Engineer has accepted the written report on the progress and success of its Small, Local, and Minority Business Subcontracting Plan.

104.02.04 Provided, however, on emergency projects, the contractor may be permitted to submit its Small, Local and Minority Business Subcontracting Plan after the issuance of the work order and after commencing work on the emergency project. For emergency projects, the Small, Local and Minority Business Subcontracting Plan must be submitted within seven (7) calendar days of commencing work and the written report must be submitted and accepted as a requirement of substantial completion, release of retainage, and final payment.

SECTION 105 – AWARD AND EXECUTION OF PUBLIC CONSTRUCTION CONTRACTS

105.01 – AWARD OF CONTRACT

It is the intent of the Awarding Public Agency to award a contract, incorporating by reference the Bidding Documents, the bid, and the Contract Documents, to the lowest and best responsible bidder provided the bid has been submitted in accordance with the requirements of the Bidding Documents and applicable law. The Contract Documents incorporates the Standard Specifications, Standard Details, Bidding Documents, the bidder's bid and such certificates, affidavits, documents submitted with the bid, the Performance Bond, Statutory Bond, Maintenance Bond, certificates of insurance, approved submittals and substitutions, the work order, approved Project Schedules, approved Small, Local and Minority Business Subcontracting Plan applicable regulations and laws, and any subsequently approved Amendments, Change Orders and Field Changes.

105.01.01 The Awarding Public Agency reserves the right to award all, some, or none of the Alternate Bids. The Awarding Public Agency has the right to accept Alternate Bids in any order or combination and to determine the lowest and best responsible Bidder based on the sum of the Base Bid and such Alternate Bids accepted by the Awarding Public Agency, in its discretion, unless otherwise stated in the Bidding Documents.

105.01.02 Should a Bidder who is awarded a contract upon a bid fail to execute and provide the contract and bonds or to provide the required Small Local and Minority Business Subcontracting Plan, certificates of insurance and/or any other required documents, the Awarding Public Agency reserves the right to offer the contract to the bidder deemed to be the next lowest and best responsible bidder.

105.02 – NO RIGHTS BY CONTRACT AWARD

Except as provided by "Execution of Emergency Contract Documents," the award of a contract shall convey no rights or claims by the successful bidder because of award until the contract has been reduced to writing and duly signed by the Awarding Public Agency.

105.03 - EXECUTION OF CONTRACT DOCUMENTS (Non-Emergency).

Contractor must submit properly completed and executed Contract Documents, including but not limited to contract, bonds, certificate of insurance, Nondiscrimination Certificate, preliminary Small, Local and Minority Business Subcontracting Plan and Preliminary Project Schedule (with critical path) within seven (7) calendar days following notification by the Awarding Public Agency of its intent to award contract, unless said time is extended by the Awarding Public Agency. Unless expressly directed by the City Engineer, no work shall be commenced until the required bonds, insurance, and Contract Documents have been received by the City or Awarding Public Agency, written contract has been executed, the required Project Schedule has been approved, and, and a work order has been issued by the City Engineer.

105.04 – EXECUTION OF EMERGENCY CONTRACT DOCUMENTS.
The contractor will submit the properly executed Contract Documents including but not limited to contract, bonds, Nondiscrimination Certificate, and certificate of insurance, within seven (7) calendar days following notification by the Awarding Public Agency, unless said time is extended by the Awarding Public Agency. No contract shall be binding on the Awarding Public Agency until it has been executed or ratified by the Awarding Public Agency; however, work must commence upon notification of award of emergency contract and issuance of a work order by the City Engineer. Should the Awarding Public Agency not ratify the award of the Emergency Contract, then contractor will be paid for the actual costs incurred prior to the determination of the Awarding Public Agency to not ratify the contract award.

105.05 – RIGHTS UNDER THE CONTRACT.
Except as provided by "Execution of Emergency Contract Documents," the successful bidder shall have no right to action or claim upon such contract or the anticipation of the contract against the Awarding Public Agency until the contract has been reduced to writing and duly signed by the Awarding Public Agency.

105.06 – RESERVE RIGHT TO RESCIND AWARD AND AWARD TO NEXT LOWEST BIDDER
Should a bidder who is awarded a contract fail to timely execute and provide the required contract and bonds, certificates of insurance, Nondiscrimination Certificate, and/or execute and submit any other required documents required by the Bidding Documents, the Awarding Public Agency reserves the right to rescind the award and award the contract to another bidder deemed to be the next lowest and best responsible bidder.

105.07 – FAILURE TO EXECUTE CONTRACT

105.07.01 Failure of the bidder to properly execute and timely submit the required Contract Documents is considered a default. By reason of such default by the bidder, the Awarding Public Agency at its option may: (1) award the contract to another bidder; and/or (2) enforce and collect the bid bond as liquidated damages not as penalty, and/or (3) seek other legal or equitable relief as the Awarding Public Agency deems appropriate.

105.07.02 Notwithstanding any other or additional rights of the Awarding Public Agency, should the successful bidder fail to fully and properly execute and timely return the contract. Nondiscrimination Certificate, and bonds or fail to provide the required Small Local and Minority Business Subcontracting Plan and insurance certificate within seven (7) days of notification of the award, the Awarding Public Agency may rescind the award and re-advertise for new or different bids.

105.08 - NO WORK UNTIL WORK ORDER
No Work shall commence, and no compensation will be due, or payment obligation accrue until the Contract Documents are properly executed and submitted, and a work order has been issued by the City Engineer. Provided, however, the contractor must timely provide the required Contract Documents, plans, and schedules as provided in these Standard Specifications, at the contractors cost and expense.

106 – CONTRACT BONDS REQUIRED

106.01 - SUCCESSFUL BIDDER SUBMITS BONDS.
The successful bidder must timely furnish all required bonds. Bonds must be submitted on the forms, or photocopies thereof, provided in the Bidding Documents. All bonds must be provided by a surety authorized to do business in the state of Oklahoma. Bidder must require the attorney-in-fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of the power of attorney. The cost of all bonds shall be deemed included by the contract in the amount of the bid as an incidental cost.

106.02 - BONDS
The bonds include Performance Bond, Statutory Bond and Maintenance Bond and any other bond required by the Bidding Documents. Successful bidder must timely submit bonds on forms included in the Bidding Documents.

106.02.01 – PERFORMANCE BOND
Performance Bond in the amount of the contract amount will be effective and enforceable until final formal acceptance of the project by the Awarding Public Agency. Performance Bond shall be executed in favor of the Awarding Public Agency.

106.02.02 – STATUTORY BOND
Statutory Bond in the amount of the contract amount will be effective and enforceable until the contractor has documented and verified all claims of all subcontractors, materialmen and suppliers on the project have been fully paid and/or all claims and liens have been released. Statutory Bond shall be executed in favor of the state of Oklahoma and all subcontractors, materialmen, and suppliers.

106.02.03 – MAINTENANCE BOND
Unless otherwise provided in the Bidding Documents, the Maintenance Bond will be equal to one hundred percent (100%) of the contract amount and for a period of two (2) years from the acceptance of the completed project. Maintenance Bond must be executed in favor of the Awarding Public Agency.

106.02.04 – UNSATISFACTORY BONDS
Awarding Public Agency may, by formal action, reject / not accept any bond if the surety issuing the bond is: (1) now in default or delinquent on any demand on any bond for any project with or in favor of the Awarding Public Agency; (2) is an adverse party to the Awarding Public Agency in any litigation involving enforcement of the bonds issued in favor of the Awarding Public Agency; or (3) is not licensed or otherwise permitted to do business in the state of Oklahoma.

Awarding Public Agency shall notify the contractor that a surety is rejected / not accepted prior to approval of the contract. Upon notice to the contractor, the contractor must substitute the bonds from a new surety satisfactory to the Awarding Public Agency. No payment will be made under the contract until the new surety and bonds, as required, have been accepted by the Awarding Public Agency. No compensation will be due the successful bidder/contractor for procurement of a bond rejected or not accepted as provided herein.

SECTION 107 – PRE-WORK

107.01 - PRE-WORK CONFERENCE The Awarding Public Agency will hold a Pre-Work Conference. The City Engineer will schedule the Pre-Work Conference, which will be conducted at a time and place established by the City Engineer. Contractor must be ready for the Pre-Work Conference within seven (7) calendar days of notice of contract award. Contractor's superintendent for the project must attend the Pre-Work Conference. Contractor's subcontractor(s) may attend the Pre-Work Conference. Engineer/Architect or its representative will attend the Pre-Work Conference. City Engineer or a representative of the City Engineer will attend for the Awarding Public Agency.

107.01.01 – Required Documents for Pre-Work Conference.
Contractor must have timely submitted the following documents prior to the Pre-Work Conference:
A. Small, Local and Minority Business Subcontracting Plan, and
B. Project Schedule, and
C. Lay Schedule (as applicable), and
D. Traffic Control Plan, Street Closings, Detour Routes, and
E. Erosion Control Plan, Storm Water Activities Permit, and
F. Schedule of Values (as applicable), and

G. List of Subcontractors and their prequalification status.

107.02 – WORK ORDER

107.02.01 Except for emergency contracts, no work order will be issued until the required Contract Documents have been executed and submitted by the contractor and approved by the Awarding Public Agency and the contractor has met the other requirements of the Bidding Documents. If the contractor has provided the Contract Documents and met all the other requirements of the Bidding Documents, then upon approval of the Project Schedule, Lay Schedule (as applicable), List of Subcontractors, Traffic Control Plan, Erosion Control Plan, Schedule of Values (as applicable), and Final Small Local and Minority Business Subcontracting Plan at the Pre-Work Conference, the City Engineer may issue a work order.

107.02.02 Contractor may not commence work on the project until a work order is issued. Upon issuance of a work order, the contractor must begin work on the project in accordance with the work order. If the Project Schedule, Lay Schedule (as applicable), List of Subcontractors, Traffic Control Plan, Erosion Control Plan, Schedule of Values (as applicable), and Final Small Local and Minority Business Subcontracting Plan are not approved at the Pre-Work Conference, the work order may be issued and project time will commence but contractor work on site will be suspended until the contractor submits any required revision or re-submission thereof and the revised or resubmitted Project Schedule, Lay Schedule (as applicable), List of Subcontractors, Traffic Control Plan, Erosion Control Plan, Schedule of Values (as applicable), and/or Final Small Local and Minority Business Subcontracting Plan is approved. No additional compensation will be paid, and no additional days will be granted, whether a Completion Date Project or Calendar Day Completion Project or other, for lost time pending approval of the Project Schedule, Lay Schedule (as applicable), List of Subcontractors, Traffic Control Plan, Erosion Control Plan, Schedule of Values (as applicable), or Final Small Local and Minority Business Subcontracting Plan.

107.02.03 For Calendar Day Completion Projects, the counting of calendar days will start on the date work is to commence as stated in the work order and must be completed within the number of calendar days stated on the Notice to Bidders, even should work be suspended pending approval of the Project Schedule, Lay Schedule (as applicable), List of Subcontractors, Traffic Control Plan, Erosion Control Plan, Schedule of Values (as applicable), Final Small Local and Minority Business Subcontracting Plan or any other requirement in the Bidding Documents.

107.02.04 For Completion Date Projects, the project must be completed on or before the Completion Date stated in the Notice to Bidders, even should a work order not be issued or work be suspended pending approval of the Project Schedule, Lay Schedule (as applicable), List of Subcontractors, Traffic Control Plan, Erosion Control Plan, Schedule of Values (as applicable), and Final Small Local and Minority Business Subcontracting Plan, or any other requirement in the Bidding Documents.

107.03– AUTHORITY OF CITY ENGINEER

107.03.01 The contractor must submit a proposed Project Schedule with the executed contract, insurance, and bonds. The contractor's Project Schedule must clearly demonstrate the ability of the contractor to timely complete the project in accordance the Contract Documents utilizing generally accepted industry standards. The contractor's Project Schedule must include reasonably defined and realistically achievable timelines tied to each significant task on the critical path for the orderly and timely completion of all work and the project. The contractor's Project Schedule must demonstrate continuous, significant progress of work and the well-planned coordination of submittals, work, orders, suppliers, vendors, and subcontractors. The City Engineer shall have the right and authority to deny or to require the contractor revise the Project Schedule, should the Project Schedule or any revision thereof not meet these requirements. The contractor will be bound by the timelines and performances in the approved Project Schedule and

any approved revision thereof.

107.03.02 Neither the contract nor Contract Documents will be construed to have been waived, revised, or modified by approval of the Project Schedule. The contract may only be modified or amended by Amendments and Change Orders approved by the Awarding Public Agency.

SECTION 108 – SCOPE OF WORK

108.01 – INTENT OF CONTRACT DOCUMENTS

108.01.01 The Contract Documents describe the work and the project. The contractor must timely perform all work as provided in the Contract Documents and must timely perform such necessary and incidental work as may be required to complete the project in accordance with the Contract Documents. The contractor must furnish all items, labor, services, systems, material, supplies, tools, equipment, processes, permits, licenses, tests, and incidental work necessary for the completion of all work and the project.

108.01.02 On public construction contracts, the contractor must timely and fully perform all work and services and provide all items, labor, services, systems, material, supplies, tools, equipment, processes, permits, licenses, tests, and incidental work necessary for the completion of all work and the project. The contractor must include all costs and expenses for all work and the project in the Bid Tab. The contractor will only be paid such compensation as expressly provided in the Bid Tab and any Amendments and Change Orders approved by the Awarding Public Agency. The contractor will not receive any separate, other, or additional compensation or any time for incidental items, labor, services, systems, material, supplies, tools, equipment, processes, permits, licenses, tests, and incidental work necessary for the completion of all work and the project.

108.02 – CONFORMITY WITH CONTRACT DOCUMENTS

All work must conform to the lines, grades, cross sections, and dimensions shown in the Contract Documents. Any changes, modification or revision of the Contract Documents may only be accomplished by written Amendments, Change Orders or Field Changes as provided, authorized, and approved in these Standard Specifications.

108.03 – ORDER OF CONSTRUCTION

Contractor must perform the work in the order set forth in the approved Project Schedule, or the most recently revised Project Schedule, approved by the City Engineer. However, approval of a revised Project Schedule will not change the Project Completion Days or the Project Completion Date, which may only be changed by Change Order approved by the Awarding Public Agency.

108.04 – PROSECUTION OF WORK

108.04.01 – GENERAL

Contractor must perform the project and the work under the contract within the time limit stated in the Notice to Bidders and must conduct the work in such a manner and with sufficient equipment, tools, materials, supplies, and labor as is necessary to ensure its timely completion. The sequence of all construction operations must at all times be in accordance with the Project Schedule approved by the City Engineer. Should the prosecution of the work for any reason be suspended for more than one day by the contractor, the contractor must immediately notify the City Engineer and whenever possible at least twenty-four (24) hours in advance of suspending and also at least twenty-four (24) hours in advance of resuming operations.

108.04.02 – PROJECT SCHEDULE

108.04.02.01 Contractor must establish such construction scheduling and phasing/sequencing, “Project Schedule,” required to timely perform all work and the

project in accordance with the Contract Documents within the time for completion in the Notice to Bidders. Contractor must develop the Project Schedule for all work and the project to establish a chronological and logical order for the scheduling of construction and related activities also including without limitation any testing, inspection, punch list, and site remediation and clean up. The Project Schedule must graphically illustrate a series of activities including but not limited to project start, subcontracting plan, ordering of materials and equipment, description of project activities, relationships with other tasks, and time for commencing, and required for performance of each critical activity or task, testing, inspections, and punch list through to completion. The maximum duration for any single activity or task may not exceed thirty (30) calendar days.

108.04.02.02 The Project Schedule must establish the critical path for timely completion of all work and the project from the work order through Acceptance of the project. Contractor must provide a preliminary Project Schedule in a re-writable format agreeable to the Awarding Public Agency within seven (7) days of notification of award and a proposed final Project Schedule at least seven (7) days prior to the Pre-Work Conference for review by the Engineer/Architect and City Engineer. The final Project Schedule will be revised and finalized at the Pre-Work Conference. The Project Schedule must be accepted by the City Engineer prior to the contractor commencing work at the project site; however, no time or delay in providing and in the approval of Project Schedule will entitle the contractor to additional time or compensation.

108.04.02.03 The Engineer/Architect and City Engineer will consider acceptance of the Project Schedule once the contractor has incorporated all comments, questions, and revisions and contractor has satisfactorily responded to all requests for information and documentation.

108.04.02.04 Contractor must update and submit a revised and updated Project Schedule with each monthly pay claim or request. The revised and updated Project Schedule must show work completed and schedule recovery of any work not completed in accordance with the previous Project Schedule and Contract Documents so that the project will be completed timely. Claims for payment for work performed will not be processed until the monthly revised and updated Project Schedule is received and approved. Any significant change to the project sequencing must be submitted for acceptance by the Engineer/Architect and approved by the City Engineer in a proposed revised and updated Project Schedule.

108.04.02.05 In the event that the contractor is not able to perform the work on the critical path to the latest submitted and approved Project Schedule, the contractor must develop and submit a Recovery Schedule with the monthly schedule update. The Recovery Schedule shall be considered a revision to the Project Schedule that must be accepted by the Engineer/Architect and approved by the City Engineer. The Recovery Schedule must show completion of the project within the time allowed on the project unless the Awarding Public Agency, in its sole discretion, has granted a written Change Order with an extension of time. In the event that the contractor has failed to perform the work on the critical path to the latest submitted and approved Project Schedule, no claims for payment will be processed without an updated and approved Recovery Schedule.

108.04.03-CONFORMANCE TO PROJECT SCHEDULE AND RECOVERY SCHEDULE. Contractor must conform work and progress to all submitted and accepted Project Schedules and Recovery Schedules. If a new Project Schedule or Recovery Schedule has not been accepted by the Engineer/Architect and approved by the City Engineer, the most recently submitted or approved Project Schedule and Recovery Schedule must be utilized in planning and performing the project activities and tasks.

108.04.04 Neither the Awarding Public Agency nor the City will be responsible for any delays to the project or changes to the Project Schedule in the absence of an updated approved Project Schedule or an approved recovery Project Schedule. Neither the Awarding Public Agency nor the City will be responsible for any delays to the project or work that are not directly caused by and the direct result of the actions of the Awarding Public Agency. In addition, neither the Awarding Public Agency nor the City will be responsible for any delays to the project or work that do not substantially affect the critical path.

108.04.05 No additional time or change in Completion Days or Completion Date will be granted through the Project Schedule or the Recovery Schedule, or any approval thereof. No additional time or change in Completion Days or Completion Date will be granted for the process of approving, updating or revision of the Project Schedule or Recovery Schedule.

108.04.06 Additional time, if any, will only be granted by the approval of a Change Order by the Awarding Public Agency.

108.05 – DAY'S WORK AND WORKING HOURS

Work may only be done on weekdays, except City holidays, during regular and commonly accepted and prescribed working hours unless otherwise provided in the Contract Documents or pre-approved in writing by the City Engineer. No work shall be done nights, Saturdays, Sundays, or City holidays unless otherwise provided in the Contract Documents or pre-approved in a special work order or permit is given by the City Engineer to do so. The City Engineer may direct or restrict work that requires connection to or the suspension of utility service or the operation of or the access or use of street or traffic operation to hours designated by the City Engineer for the purpose of minimizing the impact on those utilities, streets and/or operations. Any such direction or restrict will be considered incidental and no additional time or payment will be granted the contractor for any such direction or restriction.

108.06 – TIME OF COMMENCEMENT AND COMPLETION

Contractor must perform all work and complete the project within the time specified in the Notice to Bidders. Contractor must perform the work at a rate of progress must be such that the project and the whole work will be performed in accordance with the Contract Documents, the Punch List items completed, the work sites and project site remediation and cleaned up, and the project has been accepted by the Awarding Public Agency within that time limit specified in the Notice to Bidders, unless an extension of time be made in a written Change Order approved by formal action of the Awarding Public Agency.

108.07 – EXTENSION OF TIME OF COMPLETION

108.07.01 Contractor assumes all responsibilities for timely performance of the contract and will include any risk of delay in the bid. In addition, delays which may be or may have been addressed by additional cost or expense, though unexpected, will not be deemed a basis for additional time or compensation.

108.07.02 Contractor is not entitled to any additional time or compensation for any delay, except for unavoidable delays directly caused by and the result of the acts of the Awarding Public Agency. Contractor has the duty and obligation to make all reasonable efforts to reduce and minimize the impact of delays caused by Awarding Public Agency or the City.

108.07.03 A request for additional time must be submitted to the City Engineer in writing by the contractor within seven (7) calendar days from and after the time when the alleged cause of delay occurred and must include a detailed statement of the facts and cause of the delay. In addition, failure of the contractor to provide timely written notice of a cause of delay directly caused by the Awarding Public Agency within said seven (7) calendar days shall be a waiver of the contractor’s potential claim for delay, time and any costs and expenses related thereto.

108.07.04 Performance or non-performance of contractor or its subcontractors, materialmen or suppliers will not be deemed a basis for additional time or compensation and no additional time or compensation will be granted.

108.07.05 Contractor must obtain and maintain such insurance or other protection against force majeure events. Contractor is not entitled to any additional time or compensation for force majeure events.

108.08 – FAILURE TO COMPLETE WORK ON TIME

108.08.01 Time is of the Essence.

Both the Awarding Public Agency and the contractor expressly agree that time is of the essence with respect to this project and the performance of the contract. The progress of work and the completion of the project in a timely manner is essential. Contractor is responsible for and must include all such costs and expenses for the work and the project in its bid and the contract price.

108.08.02 For each calendar day that any work or the project shall remain incomplete after the completion time in the Notice to Bidders, actual direct costs, expenses and damages will be due and owing from the contractor to the Awarding Public Agency and any such costs, expense and damages may be deducted from the retainage and/or the monies due or to be due the contractor in the amount of such actual costs, expenses and damages incurred by the Awarding Public Agency and/or the City as reasonably determined by the City Engineer.

108.08.03 In addition, liquidated damages as set forth in these Standard Specifications or as may be set in the Bidding Documents. The liquidated damages will be deducted for such delay, for failure to complete or non-completion of the project, and for untimely completion of the contract within the time established in the Notice to Bidders not as a penalty but as reasonable liquidated damages for indirect and consequential damages, incurred by the Awarding Public Agency and the City, since it would be impracticable and extremely difficult to fix those actual damages.

108.08.04 Liquidated Damages - Unless otherwise stated in the Special Provisions for a specific project, the contractor and the Awarding Public Agency agree as a stipulation and condition of the contract that the contractor must pay $1,000 per calendar day, and each part of a calendar day, after the time for completion in the Notice to Bidders until completion or until substantial completion, if any defined by the contract, (unless an extension of time is made by written Change Order approved by formal action of the Awarding Public Agency), which amount shall be presumed to be the amount of indirect and consequential damages sustained by a breach of such contract for failure to timely complete the project, as from the nature of the contract, it would be impracticable or extremely difficult to fix the actual damage.

108.09 – CONTINUOUS PROGRESSION OF THE WORK

108.09.01 Interruption of Work – Private and Public Projects

Once construction operations commence within the project limits, work must continue without interruption until the project is completed.

108.09.02 Non-Suspension of Work – Private and Public Projects

Contractor may not suspend work without the prior written authority from the City Engineer and must proceed with the work promptly when notified by the City Engineer to resume operations.

108.10 – AMENDMENTS, CHANGE ORDERS AND FIELD CHANGES

The provisions of the contract may be amended or changed only by a written Amendment, or a written Change Order approved by the Awarding Public Agency.

108.10.01 – AMENDMENTS

108.10.01.01 No Amendment of quantities shall be paid until the Amendment has been approved by the Awarding Public Agency.

108.04.01.02 No Amendment shall become effective until the Amendment has first been approved by the Awarding Public Agency.

108.04.01.03 No additional time is or will be granted for Amendments or by Amendments.

108.10.02 – CHANGE ORDERS

108.10.02.01 A Change Order may authorize an addition, deletion, or revision in the work or project and/or an adjustment of the contract price or the contract time.

108.10.02.02 The cumulative amount of Change Orders for a contract may not exceed the limit established by state of Oklahoma law.

108.10.02.03 Contractor must proceed with the work and project as stated in a Change Order as signed by the contractor and recommended by the City Engineer. No Change Order shall be paid until it has first been approved or ratified by the Awarding Public Agency.

108.10.02.04 Any Change Order may not exceed the actual net additional cost incurred by the contractor and its subcontractors, materialmen, and suppliers to perform the work in the Change Order including labor (actual net salary or wages paid), materials, supplies, tools, and equipment to accomplish the change in the scope of work or project. In addition, the Change Order may include a total, not to exceed fifteen percent (15%) of such actual net additional costs for the contractor and all subcontractors to compensate for all other costs and expenses, including but not limited to general conditions, loss opportunity, delay, insurance, bonds, overhead and profits, are to be divided between the contractor and the subcontractors, materialmen, and suppliers.

108.10.02.05 Contractor will not be compensated, under the Change Order, for laborers, subcontractors, employees, supervisor, or administrators while also working on the previously contracted work or project or for any tools or equipment already on site. Laborers, subcontractors, employees, supervisors, and administrators may not be double recovered for simultaneously working on the previously contracted work or project and the Change Order as actual additional cost will not be deemed to incur or will be deemed to be incurred by the contractor. If such personnel or laborers are utilized or could be utilized for previously contracted work and the Change Order work, then no actual additional cost will have accrued or will be due to the contractor. If tools and equipment are utilized or could be utilized for previously contracted work and the Change Order work, then no actual additional cost will be deemed to have accrued and no compensation will be due to the contractor under the Change Order. No actual additional cost for equipment will be deemed to have accrued or will be deemed due to the contractor for use of equipment on site, only for additional equipment subsequently and separately procured for the completion of the Change Order work and then only for the time that all such equipment is used simultaneously for the previously contracted work or project and the Change Order work.

108.10.02.06 The Awarding Public Agency reserves the right to require the contractor to bid or re-bid materials, supplies, tools, equipment, systems, and labor to establish and/or document the cost of the Change Order.

108.10.02.07 No additional time will be granted for a Change Order that does not impact the critical path of the previously contracted work or project, as such critical path is

expressly provided in the last approved Project Schedule. If additional time is granted for the impact of the Change Order on the critical path of the previously contracted work or project, the contractor will only be entitled to such additional time and no additional compensation for the performance of the previously contracted work or project.

108.10.02.08 Should the contractor fail or decline to approve a Change Order in accordance with these Standard Specifications, the Awarding Public Agency may contract with another contractor to perform the Change Order. No additional time or compensation will be granted to the contractor for performance of the previously contracted work or project due, or related to the performance of the Change Order by the City or by another contractor.

108.10.03 – FIELD CHANGES

108.10.03.01 Field Changes are changes to the Contract Documents when the overall contract price and contract time are not changed. Field Changes do not change the function or purpose of the project.

108.10.03.02 Field Changes requested by the contractor must be reviewed by the Engineer/Architect and recommended by the Engineer/Architect to the City Engineer. Field Changes must be agreed to by the contractor and recommended by the Engineer/Architect to the City Engineer. Field Changes shall be binding when approved by the City Engineer.

108.10.03.03 No additional compensation or additional time will be granted the contractor by or for a Field Change.

108.10.03.04 Field Changes will be documented by the contractor on as-built plans.

108.11 – POST CONTRACT AWARD REQUESTS FOR SUBSTITUTIONS

Bidding Documents are incorporated into the Contract Documents. Contractors must provide the project and all items, work, labor, services, tests, permits, licenses, materials, equipment, systems, processes and supplies necessary to timely complete the project in accordance with the Bidding Documents as modified by the Contract Documents.

108.11.01 If the Bidding Documents identify a bid item by naming a manufacturer and/or product, the contractor must provide the bid item as identified, unless a substitution is timely requested by the contractor, recommended by the Engineer/Architect, and approved by the City Engineer before use or incorporation into the work or project.

108.11.02 If the Bidding Documents identify a bid item by naming a manufacturer and/or product “or equal,” the contractor must timely provide the identified bid item or may timely submit an “or equal” submittal to the Engineer/Architect for review. If the “or equals” submittal is recommended by the Engineer/Architect and approved by the City Engineer, then the contractor may provide or use the “or equal” submittal at contractor’s own risk. The contractor may only use or provide the submitted “or equal” after approval by the City Engineer. If the contractor uses or provides the “or equal” before approval by the City Engineer, then the City Engineer may require the contractor to remove the “or equal,” provide the identified bid item, and/or redo the work at contractor’s own cost and expense. The contractor will not receive any additional compensation for removal of the “or equal”, redo of the work, or performing the approved bid item or work. The contractor will not receive any additional time or compensation for the processing, approval, or denial of an “or equal” where a bid item was identified in the Bidding Documents.

108.11.03 If the Bidding Documents identify a bid item or work by establishing a standard of

required character, function, dimension, appearance, useful life, and/or quality, the contractor must timely submit the bid item or work to the Engineer/Architect for review. If the submitted bid item or work is recommended by the Engineer/Architect and approved by the City Engineer, then the contractor may provide or use the submitted bid item or work. The contractor may only use or provide the bid item or work after approval by the City Engineer. If the contractor uses or provides the bid item or work before approval of the submittal by the City Engineer, then the City Engineer may require the contractor to remove the bid item or work and/or redo the work at contractor's own cost and expense. The contractor will not receive any additional compensation for removal of the unapproved submittal, redo of the work, or performing approved bid item or work submittal. The contractor will not receive any additional compensation or time for denial of a submittal that does not conform, meet the requirements, or achieve the function or purpose of the bid item or work. The contractor will include the time for submittals in the Project Schedule and will not receive additional time or compensation for the submittal process.

108.11.04 Substitutions may be considered after award of contract, at the sole discretion of the Awarding Public Agency, unless specifically prohibited otherwise in the Bidding Documents. However, contractor has no right to a substitution and any contractor basing a bid on a substitution, not approved by pre-bid addendum, does so at the contractor's own risk of being required to provide the bid item or work as designated in the Bidding Documents. The contractor must include in its substitution documentation evidencing any cost or time savings to Awarding Public Agency.

108.11.5 Substitution requests must be timely submitted in writing by the contractor, to Engineer/Architect, with documentation supporting the quality and adequacy of the bid item or work. The contractor must submit all additional information requested by the Engineer/Architect for review of the substitution by the Engineer/Architect. The Engineer/Architect will make a recommendation to the City Engineer. Contractor may not use the substitute until approved by the City Engineer.

108.11.06 If the substitution is recommended by the Engineer/Architect and approved by the City Engineer, then the contractor may provide or use the substitution at contractor's own risk. The contractor may only use or provide the submitted substitution after approval by the City Engineer. If the contractor uses or provides the substitution before approval by the City Engineer, then the City Engineer may require the contractor remove the substitution, provide the identified bid item and/or redo the work at contractor's own cost and expense. The contractor will not receive any additional time or compensation for the process, approval, or denial of a substitution where a bid item was identified in the Bidding Documents.

108.11.07 Substitutions will not be binding unless and until approved by the City Engineer. The City Engineer reserves the right to accept or reject any post-contract award substitution requests. The City Engineer may also condition approval of any substitution request on shared cost and/or time savings to be gained or obtained by the substitution. Substitutions which include a change in the contract time or price, if approved, must be included, and must be specifically approved in a Change Order approved by the Awarding Public Agency.

108.11.08 The Awarding Public Agency does not promise and is not obligated to the contractor for the Engineer/Architect to review or the City Engineer to review a submittal or substitution within a particular time but only that the Engineer/Architect and City Engineer will sequentially review the submittal or substitution within a reasonable time after receipt and verification of all requested information and documentation. No additional time or compensation will be granted for submittal or substitution review and/or denial or approval, if any. Contractor must include time for submittals and substitution processes in its Project Schedule.

SECTION 109 – CONTROL OF THE WORK AND MATERIALS

109.01 – ADJUSTMENT OF EXISTING STRUCTURES AND UTILITIES

109.01.01.01- General The contractor must call for location of underground utilities and facilities. Contractor, at its expense, must manually pothole and locate underground utilities and facilities including but not limited to public and private oil or gas pipelines and facilities, water pipelines and facilities, sewer pipelines and facilities, telecommunication lines and facilities, traffic control lines, devices and facilities, storm water lines and facilities and other utility lines and facilities, whether or not identified or shown on the plans or in the Contract Documents. The contractor may use such electrical or mechanical devices or use such other reliable means the contractor may select to locate any underground lines and facilities. The contractor must:

(1) protect,
(2) adjust to grade,
(3) disconnect and replace,
(4) remove or relocate and replace, and/or
(5) provide supports,

during the project, excavation, construction and backfill to protects such utilities and facilities against damage, settlement, freezing and weather-related damage by the elements and must pay all fees to the owner of such utilities and facilities, local, county, City, state of Oklahoma, or federal agencies, which may be required in the performance of the work.

109.01.01.02 The contractor must make satisfactory arrangements with the owners of such utilities and facilities for performing the work. Except where specific item or unit prices are specifically provided in the Contract Documents, the contractor will not be entitled to any additional time or compensation for such work and any cost or expense is incidental and will not be separately due or paid.

109.02 – GEOTECHNICAL INFORMATION

109.02.01 All geotechnical information when shown in the Bidding Documents or included in the Contract Documents, only represent the materials and/or subsurface characteristics only as to the point, depth or location expressly and specifically stated in the geotechnical information included in the Bidding Documents and only to the extent specifically stated in the geotechnical information included in the Contract Documents.

109.02.02 Each bidder and contractor must make its own interpretation of the character and condition of the materials and/or subsurface characteristics, which will be encountered between the points and locations in the geotechnical information. Awarding Public Agency neither represents or warrants the condition of the materials and/or subsurface characteristics between points or locations in the geotechnical information provided nor does the Awarding Public Agency imply, represent, or warrant the condition of the materials and/or subsurface characteristics are similar or humongous with the point or location in the geotechnical information. The bidder and contractor are responsible for including any potential risk and/or potential cost in its bid. Each contractor may, at his own expense, make additional surveys and investigations as may be deemed necessary to determine conditions which will affect performance of the work to determine the method and means for performing the work.

109.03 – AUDIO-VIDEO RECORDING PRE-CONSTRUCTION AND POST-CONSTRUCTION

Contractor must make and provide the Engineer/Architect and City Engineer copies of pre-construction and post-construction audio-video recordings of the project site, work sites, and any access, roads, streets, easements, rights-of-way to be utilized by the contractor, also including by its suppliers,

materialman, and subcontractors. The pre-construction audio-video recordings must be delivered by the contractor to the Engineer/Architect and City Engineer for review and approval prior to accessing or commencing construction on the project site, any work site, or any construction related access road. The post-construction audio-video recording must be delivered by the contractor to the Engineer/Architect and City Engineer for review and approval prior to submitting a claim for release of retainage or final payment. These audio-video recordings will serve as a record of pre-construction and post-construction final conditions. All audio-video recordings must be recorded in a manner that logically follows the entire project and any access, roads, streets, easements, rights-of-way, project sites and work sites to be utilized by contractor in a continuous, logical, and accurate manner. The audio-video recordings will be the property of the Awarding Public Agency.

109.03.01 PRE-CONSTRUCTION AUDIO-VIDEO RECORDING

Before clearing, grading or construction operations begin, the contractor is also required to record above ground topography, trees, vegetation, landscaping, and existing improvements, structures, facilities, and amenities located in and along the project site, work sites, adjacent properties, and structures, and also on and along street and road access to the project site.

109.03.02 POST-CONSTRUCTION AUDIO-VIDEO RECORDING

After construction is completed, the contractor is required to record above ground topography, trees, vegetation, landscaping, and existing structures, facilities and amenities located in and along the project site, work sites, and adjacent properties and structures, and also on and along street and road access to the project site.

109.03.03 AUDIO-VIDEO RECORDING QUALITY

Audio-video recordings must be in color and recorded digitally on format as approved by the City Engineer. The audio-video record must be high quality and framed to provide sufficiently detailed information to settle disputes that may arise as to existence and condition and any damage to then structures, facilities, and amenities.

109.03.04 DEEMED CONTRACTOR RESPONSIBILITY TO RESTORE, REMEDIATE OR REPLACE

If the audio-video recording does not include the structures, facilities, trees, vegetation, landscaping, and amenities located in and along the project site, work sites, and adjacent properties and structures, and also on and along access to the project site or its condition or is not adequate to clearly demonstrate the condition, then contractor shall be responsible for the restoration, remediation and/or replacement of any alleged damage at contractor's cost without additional compensation or time granted by the Awarding Public Agency.

109.03.05 COLOR AUDIO-VIDEO OF PRECONSTRUCTION, FINAL RECORD (RECORDED DIGITALLY)

A) Scope

Prior to commencing work, the contractor must make a continuous color audio-video recording, recorded digitally on approved format, and made of the entire project site and surrounding areas in a manner that logically follows the entire project path in a continuous manner and a minimum of 100 feet from both sides of the construction centerline or from building face to building face. The contractor must make a color audio-video recording, recorded digitally on approved format, made of the entire project at completion. These recordings will serve as a record of pre-construction and post-construction conditions. Contractor must submit one copy to the Project Engineer and one copy to Field Services for these phases of audio-video recording. The contractor

will be responsible for damages and repairs for which pre-construction recording is inadequate to definitively establish pre-construction condition.

B) Professional Electrographers
The contractor must engage the services of a professional electrographer. The color audio-video approved format must be prepared by a responsible independent commercial firm known to be skilled and regularly engaged in the business of pipeline construction color audio-video documentation.

C) Equipment
All equipment, accessories, materials, tools, and labor to perform this service must be furnished by the contractor. The total audio-video system must produce bright, sharp, clear pictures with accurate colors and must be free from distortion, tearing, rolls, or any other form of imperfections. The audio portion of the recording must produce the commentary of the camera operation with proper volume, clarity and be free from distortion and interruptions.

D) Recorded Information-Audio
Each recording must begin with the current date, project name and municipality and be followed by the general location, i.e., viewing side and direction of progress. The audio tract must consist of an original live recording. The recording must contain the narrative commentary of the electrographer, recorded simultaneously with his video of the zone of influence of construction.

E) Recorded Information-Video
All video recordings must begin by displaying digital information to include the date and time of recording. The date information must contain the month, day, and year. Additional information must be displayed periodically. Such information must include, but not be limited to, project name, contract number, direction of travel and the viewing side.

F) Lighting
All video recording must be done during times of good visibility. During precipitation, mist or fog, artificial light must be provided to properly illuminate the objects.

G) Speed of Travel
The rate of speed in the general direction of travel used during video recording, as well as panning and zooming rates, must be sufficiently controlled to maintain a clear view of the objects.

109.03.06 PAYMENT FOR THIS ITEM

If not specified with a separate pay item on the Bid Tab, the cost of audio-video recording will be incidental, will not be paid separately, and will be deemed to be included in other bid items.

109.04-STORM WATER CONSTRUCTION ACTIVITIES PERMIT

Contractor must also comply with the Environmental Protection Agency (EPA), Oklahoma Department of Environmental Quality (ODEQ) regulations, and all construction activities within its corporate boundaries of Oklahoma City must comply with the following regulations:

A) Environmental Protection Agency
B) Code of Federal Regulations (40 CFR, Part 122)
C) Clean Water Act
D) Oklahoma Department of Environmental Quality
E) Oklahoma Pollutant Discharge Elimination System Act (OPDES) 27A O.S. 2-6-201
F) ODEQ General Permit OKR10
G) City of Oklahoma City
H) Oklahoma City Municipal Code

A copy of the City's Best Management Practices Manual can be downloaded at http://www.okc.gov/pw/storm.html or a copy can be picked up at the City of Oklahoma City's City Clerk's Office, 200 N. Walker Avenue, 2nd Floor, Oklahoma City, Oklahoma 73102.

As a part of the project the contractor will be required to submit a completed Notice of Intent (NOI), a Storm Water Pollution Prevention Plan (SWPPP) and an Erosion Control Site Plan for permitting purposes. Contractor must follow the SWPPP, as submitted and approved, at all times during construction of the project. Along with the above stated items the contractor must also provide a check payable to the City in an amount required by the project. This permit must be approved before the contractor will be allowed to obtain the building/construction permit. Permits may be renewed annually upon filing of a renewal application and payment of permit fee, provided that the contractor's activity, and the location where it is carried on are the same as originally permitted. In addition, the application for renewal shall be subject to all the requirements pertaining to original permit. (Oklahoma City Municipal Code 48-33)

Construction activities that result in land disturbance of equal to or greater than one (1) acre, or less than one (1) acre if they are part of a larger common plan of development or sale that totals at least one (1) acre must also obtain a permit from ODEQ (form 605-002a) for Storm Water Discharge from Construction Activities. This means that land disturbing of one (1) acre or more must permit with ODEQ and the City of Oklahoma City, Storm Water Quality.

109.05 – SEDIMENT AND EROSION CONTROL

109.05.01 The contractor must minimize the amount of land disturbed to minimize:

A) costs, damage and the loss of the dirt or sediment from the project site, work site and/or neighboring properties.
B) deposit of dirt or sediment on the project site, work Site or neighboring properties.
C) changes in surface water flow.
D) cause water impoundment or stagnation.
E) blowing or flying dirt, sediment, and debris.
F) sediment, dirt, and debris contaminating storm water conduits, waterways and streams.
G) cost of re-vegetation and remediation of land.

The most effective and direct means of controlling erosion during and after construction is to attain a good vegetative cover over all soil surfaces laid bare or disturbed as soon as possible. Permanent vegetative cover must be established promptly after completion of work in an area and prior to acceptance of any work or portion of work. Contractor must establish and continuously maintain such vegetative cover and erosion control measures, structures and devices as may be necessary to comply with City ordinances and other applicable regulatory requirements. Contractor must utilize such other and additional techniques as will minimize erosion and prevent sediment, dirt, and debris from being carried offsite by runoff. Contractor must create and submit an Erosion Control Plan prior to the Pre-Work Conference. Contractor must timely implement an Erosion Control Plan that meets City standards whether within the City limits or not. All work must continuously comply with the contractor's Erosion Control Plan. Contractor must also comply with any other or additional applicable local, City, state of Oklahoma and federal requirements.

109.05.02 Contractor must designate a full-time employee on the project site and each other work site to be responsible for implementation and continuous maintenance of erosion and sediment control measures. Contractor's designated employee must inspect and document the condition of all erosion control measures, devices, and structures on a daily basis. In the event of forecast for rainfall in excess of one-half inch on the next calendar day, Contractor must inspection and restore all erosion control measures, devices, and structures before suspending work on the preceding day and inspect and restore the erosion control measures, devices and structures on the day of the rainfall

event. In the event of rainfall in excess of one-half inch, an inspection and restoration of all erosion control measures, devices and structures must also be inspected and restored by noon on the calendar day following such rainfall event.

109.06 – EXISTING STRUCTURES NOT SHOWN IN CONTRACT DOCUMENTS

Contract Documents identifies the location of known surface and subsurface structures and facilities. The City assumes no responsibility for failure to show any surface structures on the Contract Documents or to show them in their exact location. No claim for extra work, additional time or additional compensation will be considered for identified surface and subsurface structures and contractor will be deemed to have included all potential costs and time to locate, avoid, move, secure, support or otherwise address such structures in its bid as incidental costs and contingencies. No claim for extra work, additional time, or additional compensation will be considered unless the unidentified facility or structure encountered necessitates substantial changes in the lines, elevation, location, or grades of the project or requires the building of a special structure for the project to function as intended in the Contract Documents. Nothing herein shall relieve the contractor of the responsibility to thoroughly inspect the project site and physically locating surface and subsurface facilities and structures prior to commencing work.

109.07 – CONSTRUCTION STAKES

109.6.07.01 Contractor must, at the contractor's expense, maintain all surveys, stakes, field controls and benchmarks established by the Engineer/Architect and must provide and maintain all additional surveys, construction staking, field controls and benchmarks in accordance with these Standard Specifications for Construction Staking, unless otherwise provided in the Contract Documents.

109.07.02 Contractor must also establish and maintain throughout the project all construction stakes, field controls, and benchmarks as necessary and as may be required to construct the project in accordance with the Contract Documents at the contractor's expense.

109.07.03 Construction staking consists of furnishing, placing, and maintaining construction stakes, field controls, or benchmarks as necessary to establish lines and grades required for completion of the project in accordance with the Contract Documents.

109.07.04 Field controls must be provided by the contractor at the contractor's expense prior to the work commencing. Contractor must preserve all surveys, stakes, field controls and benchmarks and the contractor must have them reset at the contractor's expense when damaged, lost, displaced, or removed at the contractor's expense.

109.07.05 Bridge centerline, horizontal, and vertical control shall be set by the Engineer/Architect.

109.07.06 Contractor must notify the Engineer/Architect and City Engineer immediately whenever plan errors or whenever the contractor believes latent obstructions require deviations from the specified elevations or horizontal locations.

109.08 – MEASUREMENTS

Before ordering any material or equipment or performing any work the contractor must verify and affirm the accuracy of all measurements. Errors, inconsistencies, or omissions discovered must be immediately reported to the Architect/Engineer and City Engineer. No extra, additional, or other charge or compensation will be allowed due to any difference between actual dimensions and the estimates or measurements indicated in the Contract Document, except payment of unit price items will be paid for based on the actual units installed and accepted in accordance with the Contract Documents.

109.09 – SUBMITTALS AND SHOP DRAWINGS

109.09.01 Contractor may not start delivery of any materials or equipment, requiring submittals or shop drawings, until the Engineer/Architect approves and the City Engineer reviews any such required submittals and/or shop drawings. Only materials and equipment conforming to the requirements of the Contract Documents may be used in the work or project.

109.09.02 Contractor must transmit an electronic copy of each submittal and shop drawing to the Project Manager and the Engineer/Architect for review, in a format approved by the City Engineer. Each transmittal must be sequentially numbered and must include the City's project number, contractor's name, bid item number, supplier or manufacturer, and all information required by the Contract Documents. Contractor must also provide a certification or affix its approval stamp to each submittal, shop drawing and product booklet. The certification or approval stamp must certify that "The contractor has determined and verified submittal or shop drawing meets all dimensions, quantities, field dimensions, relations to existing work, coordination with work to be installed at a later date, coordination with information on previously approved submittals, and verification of compliance with the Contract Documents." The accuracy of all information in the submittal or shop drawing is the responsibility of and warranted by the contractor. Contractor submittal and/or shop drawing must be reviewed and approved by the Engineer/Architect prior to use on or incorporation into the project.

109.09.03 In reviewing and approving submittals and shop drawings, the Awarding Public Agency is entitled to rely upon the contractor's representations and warrants that all information is accurate and correct. Contractor shall not be relieved of any responsibility for deviations, errors or omissions of the submittals and shop drawings by the approval thereof by the Engineer/Architect. Upon receipt, the Engineer/Architect shall be allowed up to fourteen (14) calendar days for review. Upon approval by the Engineer/Architect, submittals and shop drawings that meet the requirements of the Contract Documents may be approved by the City Engineer. Submittals and shop drawings that do not meet the requirements of the Contract Documents will be returned to the contractor with an emailed letter directing additional information and/or correction and re-submittal or with an emailed letter rejecting the submittal and requiring submittal of different material or equipment. The date indicated on the Engineer/Architect emailed approval, denial or review letter will be considered the date returned to the contractor. Contractor must keep at least one (1) copy of all approved submittals and shop drawings at the project site.

109.10 – MATERIALS AND EQUIPMENT

109.10.01 – DELIVERY

Approved construction items, materials, supplies, and equipment may be ordered but may not be delivered to the work site or project site in advance of the start of construction as stated in the work order. Contractor will be held responsible for the delivery, storage, security of all construction items, materials, supplies, and equipment. Contractor will be held responsible for the compliance of all materials and equipment in the Contract Documents and for the continued compliance with the Contract Documents through formal acceptance of the project by the Awarding Public Agency.

109.10.02 – SAMPLES

Contractor must provide samples of work materials, supplies, systems, and equipment, when required by the Contract Documents or the Engineer/Architect. All such samples must be approved by the Engineer/Architect in writing before the work is executed or the material, supplies, or equipment is incorporated into the work or project. All work, material, supplies, systems, and equipment must conform in all respects to the approved samples and the Contract Documents. Any work, material, supplies, systems, and equipment that does not conform to the approved samples or the Contract Documents will be rejected and shall be removed and replaced by the contractor at contractor's sole cost and expense and no additional time will be granted therefor.

109.10.03 – TESTS

109.10.03.01 – A Test Schedule will be provided by the City for the work and shall designate which materials, supplies, equipment, processes, and work must be sampled and tested, the tests to be conducted, and the approved testing laboratories. Contractor must include the Test Schedule in its Project Schedule. All samples must be taken, and tests conducted in the presence of an inspector and in accordance with the Contract Documents.

109.10.03.02 – The City Engineer may require such additional samples and tests, as necessary for the verification, affirmation and assurance of performance and compliance in accordance with the Contract Documents, conformance with samples and tests, and proper construction of the project. All tests must be made in accordance with the appropriate Contract Document provisions.

109.10.03.03 – Contractor must provide such facilities as the City Engineer, Engineer/Architect, Project Manager, Testing Laboratory, and/or Inspector may require for inspecting work, collecting, and forwarding samples, and performing tests.

109.10.03.04 – All tests must be performed at a laboratory designated by the City Engineer.

109.10.03.05 – Public Construction Contracts – All costs of tests on materials, supplies and equipment, and tests of work performed, and all tests of performance and construction for compliance with the Contract Documents will be at the expense of the Awarding Public Agency. All costs of tests that fail to meet the Contract Document requirements shall be at the expense of the contractor. Upon written notification from the designated laboratory of failed tests, the Awarding Public Agency is entitled to and will withhold the cost of the test from retainage and/or subsequent payment voucher claims from the contractor until the cost of the test is paid in full by the contractor. No claim for damages, costs, delays, or additional time or compensation may be made to the contractor for any delays associated with the resolution of payment or failed tests. The Awarding Public Agency will not make payment of the final claim until all materials, supplies and equipment have passed its test and until the contractor has paid the Awarding Public Agency for all failed tests. The Awarding Public Agency may bring such actions as may be necessary to collect the costs of failed tests.

109.11 – MATERIALS CERTIFICATIONS

Contractor must furnish required samples of all submittals and substitutions without charge to the Awarding Public Agency. The Engineer/Architect will exam all samples and certifications to determine whether the sample meets contractor representations and the Contract Documents and whether the submittal is approved. When the Contract Documents require testing of prefabricated work, equipment, materials, supplies, or any other products, the Engineer/Architect may waive local testing requirements in lieu of a certification from the manufacturer that the work, equipment, material, supply, or product furnished conforms to the appropriate Contract Document provisions and purpose. All tests must be performed by a laboratory designated by the Awarding Public Agency.

109.11.01 – GENERAL REQUIREMENTS

Contractor is responsible for obtaining all certifications and for arranging for delivery of the work, equipment, materials, supplies, or any other products, to the proper destinations designated by the Engineer/Architect and City Engineer as required by the Contract Documents. A responsible representative of the company that issues the certification must sign the certifications and include the official company title of the signer immediately beneath the signature.

All submittals of certifications must be furnished by the contractor in duplicate and each copy must

show the following information:

A) City's project number,
B) name of contractor,
C) name of the manufacturer,
D) identification markings on shipment,
E) detailed quantity and description of work, equipment, materials, supplies, or any other products, represented by the certification, and
F) reference to the Contract Document section the submittal is presented to satisfy.

109.11.02 – DISTRIBUTION OF CERTIFICATIONS

City Engineer City of Oklahoma City
Certifications for Project No. _____
420 West Main, Suite 700
Oklahoma City OK 73102Name: Project Manager

These certifications will be checked by the Engineer/Architect for conformance with the applicable Standard Specifications and Contract Documents.

109.11.04 – BASIS OF ACCEPTANCE

Whenever a certification, as defined above, is required or requested by the Engineer/Architect or the City Engineer such material, supplies or equipment may be accepted based on certification provided that all applicable requirements were met. However, visual inspection at delivery and installation must show the workmanship and condition of the material or equipment to be satisfactory and the material and equipment must continue to meet certification requirements and must continue to conformance with the applicable Standard Specifications and Contract Documents.

All material, supplies and equipment furnished under certification must 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 or project until the Engineer/Architect or City Engineer has approved the certificates.

Testing must be completed on all public improvement projects per the Testing Schedule as provided by these Standard Specifications and the Engineer/Architect. All testing will be performed by a testing laboratory designated by the City Engineer upon a written order. Any cost accrued by the contractor is incidental and must be included in the unit price bid for other items.

All testing for private development is paid for by the contractor, but still must meet the requirements of the Testing Schedule provided by the City Engineer.

A satisfactory test is defined as being a test that shows that the quality of the materials, equipment or workmanship meets the requirements of these Standard Specifications and the Contract Documents. Where tests reveal that the quality of the materials, equipment, or workmanship does not meet the requirements of these Standard Specifications and the Contract Documents, additional tests may be required as directed by the City Engineer until the number of satisfactory tests called for in the schedule have been made. The reports of these tests results shall constitute the evidence referred to above.

The City Engineer may order tests in addition to the number provided for in the schedule to be made if, in his opinion, such additional tests are necessary. The cost of all tests ordered, in addition to the tests provided for in the schedule, which show that the materials, supplies, equipment, or workmanship conform to the Contract Documents shall be paid for by the Awarding Public Agency. For privately constructed public improvements, the contractor shall pay for all such tests whether the test reveals that the materials or workmanship do or do not conform to the Contract Documents.

All costs of coring, testing of cores, and repair of core holes, shall be borne by the Contractor.

109.12. – STORED MATERIALS AND EQUIPMENT

109.12.01 – Contractor must timely order, store, and secure materials, supplies, and equipment at contractor's cost. The cost to order, store, secure and deliver materials and equipment is incidental.

109.12.02. Stored material must be stored in accordance with manufacturer's recommendations, these Standard Specifications, and the Contract Documents.

109.12.03 – In addition:

109.12.03.01 Contractor must store materials, supplies, and equipment on wooden platforms or other hard, clean surfaces and not on the ground.

109.12.03.02 Contractor must place stored materials, supplies, and equipment under cover.

109.12.03.03 Contractor must be located to facilitate prompt inspection of stored materials, supplies, and equipment.

109.12.03.04 Contractor must protect stored materials, supplies, and equipment from weather, temperature, the elements and acts of God.

109.12.03.05 Contractor must protect and preserve the condition, integrity, quality and gradation of the materials and equipment and their fitness for the work or project. Stored materials, supplies, and equipment must be handled in such a manner as to preserve their condition, integrity, quality, gradation and fitness for the work and project.

109.12.04 - Awarding Public Agency assumes no responsibility for stored materials, supplies or equipment located on the project site or off-site regardless of whether the Awarding Public Agency has paid for those materials, supplies, and equipment. Contractor also assumes full and sole responsibility for any damage to or loss of any stored materials, supplies, and equipment regardless of whether the Awarding Public Agency has paid for those materials, supplies or equipment. No stored material, supplies, or equipment may be located off-site unless pre-approved by the City Engineer. Stored material, supplies, and equipment located off-site must be insured prior to payment for stored materials or equipment, which insurance must be maintained until the materials, supplies and equipment are incorporated into the project and the project has been accepted.

109.13 – AGGREGATE MATERIALS

109.13.01 Contractor must provide for timely delivery of aggregate materials to assure a continuous and adequate supply of the aggregate materials as may be necessary for the timely performance of the work and completion of the project.

109.13.02 Aggregate material stockpiles must be built up in such a manner that all acceptable aggregate will be delivered to and separately stored on the work site or the project site. Aggregate materials from different sources and aggregates of different gradations may not be stockpiled together. Contractor is responsible for establishing and maintaining the individual stockpiles.

109.13.03 Aggregate materials that have become integrated with other materials or material grades and aggregate materials that become mixed with earth or other foreign material are unacceptable and will not be utilized in the work or project, unless and until contractor causes aggregate piles to be segregated and all foreign materials have been removed.

109.14 – INSPECTION

109.14.01 Contractor must provide proper and safe access for all inspections required by these Standard Specifications, the Contract Documents, and any other inspections required by City, local, federal, or state of Oklahoma laws or regulations. The City Engineer, Inspector, Project Manager, and the Engineer/Architect must at all times have access to the project. Contractor must provide proper and safe access for inspections. Awarding Public Agency may maintain inspectors on the work site and on the project site for the purpose of inspecting materials, supplies, workmanship, and equipment, for the purpose of inspecting the conditions of work and stored materials and equipment, and for inspecting contractor performance and compliance with the Contract Document, Project Schedule, LBU, and Test Schedules.

109.14.01.01. Contractor must notify the City Engineer twenty-four (24) hours prior to pouring concrete and at any other times required in the Contract Documents.

109.14.01.02. Contractor must notify the City Engineer twenty-four (24) hours prior to performing work relating to exposing, supporting, adjusting, connecting, or relocating waterlines and appurtenances, sewer mains and appurtenances, and other underground utilities and facilities.

109.14.01.03. The phone number for Field Services is 405-297-3571. The Field Services office is open between 7:30 a.m. and 4:30 p.m., Monday through Friday.

109.14.02 Contractor is responsible for timely arranging for and having conducted all inspections required by the City of Oklahoma City's Building, Plumbing, Electrical, Mechanical, Fire, and Zoning Codes and to comply with all the provisions of said Codes. Contractor is responsible for compliance with said Codes and for documenting Code compliance and inspections.

109.14.03 Contractor is responsible for timely arranging for and having conducted all inspections required by the Standard Specifications, Standard Details, and/or the Contract Documents, and any other inspections required by City, local, federal, or state of Oklahoma laws or regulations.

109.14.04 Contractor may not cover any materials, supplies, equipment, or portion of the finished work until the material, supplies, equipment, and work have been inspected.

109.14.05 Any material, supplies, equipment, work covered up and any materials, supplies, or equipment used without inspection by the Inspector may, at the sole discretion of the City and the Awarding Public Agency, be ordered uncovered, removed, replaced and/or re-covered by the contractor at the contractor's sole cost and expense, without reimbursement or any additional grant of time.

109.14.06 Contractor must at any time, as may be directed by the Engineer/Architect or the City Engineer or Inspector, remove and uncover any uninspected or unapproved material, supplies, equipment, and work.

109.14.07 Should the uncovered material, supplies, equipment, or work prove acceptable, the cost of removing uncovering and restoring covered material, equipment and work will be at the contractor’s sole costs and expense, without reimbursement or grant of additional time by the City or the Awarding Public Agency.

109.14.08 Should the material, supplies, equipment, or work prove unacceptable, the cost of removing uncovering and the cost of replacing and restoring covered materials, supplies, equipment, or work will be at the contractor’s sole cost and expense, without reimbursement or grant of additional time by the City or the Awarding Public Agency.

109.15 – REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK

109.15.01 - All materials, supplies, equipment, and work that is or has become defective prior to the acceptance of the project or has been rejected or condemned during the performance of work

or construction of the project must be removed and/or replaced at the contractor's cost and expense and without reimbursement or additional time. Causes for removal of materials, supplies, equipment and/or work include but are not limited to:

A) work completed without lines, elevation, location, or grades; and/or
B) work performed beyond the lines, elevation, location, or grade or not in conformity with the lines, elevation, location or grades shown in the Contract Documents; and/or
C) work performed or materials, supplies, or equipment incorporated in the project was without proper inspection or submittal approval; and/or
D) any extra or unauthorized work done without written approval of the City Engineer.

109.15.02 - The City Engineer, upon giving written notice to the contractor, has the authority to cause defective work, supplies, equipment, and materials to be:

A) remedied or removed and replaced at contractor's cost and expense and without additional time, or
B) cause unauthorized work to be removed and to deduct the cost thereof from any compensation due or to become due the contractor.

109.15.03 - However, if the Awarding Public Agency deems it inexpedient to correct defective or unauthorized work, the Awarding Public Agency, at its sole discretion, may take an equitable deduction from retainage and/or any compensation due or to become due the contractor.

109.16 – PUNCH LIST

109.16.01 - Once the contractor believes all work has been completed in accordance with the Contract Documents, contractor must notify the City Engineer, Engineer/Architect, Project Manager, Inspector and Field Services Division.

109.16.02 - Contractor must schedule a punch list walk-through of the project with Field Services. If after the punch list walk-through, if the Project Manager, Inspector, Field Services, and Engineer/Architect agree the project appears to be complete, a Punch List Inspection will be scheduled. Punch List Inspection will not be scheduled if any item or work on the critical path is yet to be fully completed.

109.16.03 - All items of work recorded on the punch list must be corrected, repaired, or replaced within the time for completion of the project and prior to Final Inspection and the Acceptance of the project by formal action of the Awarding Public Agency.

109.16.03 - After Punch List Inspection has been performed and a list of incomplete or defective work has been identified, itemized, and included on the punch list, if the project meets all applicable code requirements and, notwithstanding the punch list items, the project is ready for occupancy and/or full use as intended by the Contract Documents, then upon a request of the contractor, approval of the surety, and the recommendation of the City Engineer, the Awarding Public Agency may determine by formal action that the project is substantially complete by issuing a certificate of substantial completion with the punch list attached, and such substantial completion will be pending completion of the punch list, Final Inspection, and Acceptance. Provided the Awarding Public Agency may retain one hundred and fifty (150%) percent of the estimated costs to correct any incomplete or defective work as identified, itemized, and attached to the certificate of substantial completion. Contractor will not receive any additional time or compensation due to use or occupancy or use of the project pending completion of the punch list, Final Inspection and Acceptance.

109.17 – Substantial Completion

A Project is considered substantially complete when the following items have been performed:

1. The Project, and/or designated phases of construction, as identified in the Contract Documents, is functionally complete and can be fully utilized for the intended purpose as specifically provided in the Contract without impact on the completion of the project or the Project Schedule; and
2. A Punch List inspection has been performed and a list of incomplete or defective Work has been identified, itemized, and included on the punch list; and
3. (**For building/facility projects only)** A Certificate of Occupancy has been issued by the City of Oklahoma City Development Services; and
4. A Substantial Completion Certificate signed and issued by the City Engineer; and
5. Awarding Public Agency determines the project, or phase of the project, is determined substantially complete by formal action of its governing board.

At no time shall a Certificate of Occupancy be independently construed as determining Substantial Completion of a project, or a phase of the project; or be deemed a decision of the Awarding Public Agency that the project, or phase, is useable; or be deemed Acceptance of the project, or a phase of the project.

When a project is declared substantially complete, the contractor must complete the punch list within thirty (30) calendar days. At the end of the thirty (30) calendar days the Awarding Public Agency reserves the right to complete the punch list and deduct the cost of completing the punch list from the final claim. Liquidated damages will be assessed for each calendar day, and any portion of a calendar day, beyond the Completion Date or Completion Days in the Notice to Bidders that the punch list is not complete.

109.18 – FINAL INSPECTION

109.18.01 – Contractor must advise the Engineer/Architect, City Engineer, Project Manager, Inspector and Field Services when all the Punch List items have been completed and/or the work corrected and ready for Final Inspection

109.18.02 - If the work is not acceptable to the City Engineer at the time of such Final Inspection, the contractor will be informed as to the particular defects to be remedied and the punch list items to be completed before Acceptance can be made; however no additional compensation and no additional time will be granted the contractor.

109.18.03 - The Awarding Public Agency reserves the right to complete, replace or correct any punch list item that was not performed by the contractor within the contract time and to deduct the cost and expense thereof from retainage and/or any compensation due or to become due the contractor. If the Awarding Public Agency, in its sole discretion, deems it inexpedient to correct defective or unauthorized work, the Awarding Public Agency may take an equitable deduction from any compensation due or to become due the contractor.

109.19 – FINAL CLEAN UP

Upon completion of the construction of project and prior to Acceptance by the Awarding Public Agency, the contractor must remediate and clean the work site and the project site and remove traffic control devices, equipment, surplus materials, discarded materials, temporary structures, stumps or portions of trees, and debris of any kind within the contract time. Contractor must leave the work site and project site in a neat and orderly condition acceptable to the Awarding Public Agency. Waste materials removed from the work site or project site must be disposed of at locations satisfactory to the City Engineer and in compliance with federal, state of Oklahoma, local and City requirements.

109.20 – COMPLETION- A project is considered complete when:

109.19.01 All the work on the punch list is verified as complete by the Final Inspection, and

109.19.02 Contractor has provided “as-built” drawings, and

109.19.03 Contractor has provided payment verification and lien releases from all subcontractors and suppliers, and

109.19.04 Contractor has submitted a final pay claim with all necessary and appropriate supporting documents, and

109.19.05 Contractor has provided any required manufacturer’s warranties and operating manuals, and

109.19.06 Contractor has provided the Final Small, Local and Minority Subcontracting Report, and

109.19.07 The project is ready for Acceptance by formal action of the Awarding Public Agency.

109.21 – WARRANTY AND CORRECTION OF WORK AFTER FINAL PAYMENT

Neither the substantial completion nor completion nor Acceptance nor payment nor any other provision in the contract, bonds or any other Contract Documents relieves the contractor of responsibility for faulty or defective workmanship or missing or defective materials, supplies, structures, or equipment, which shall appear or may be discovered within a period of two (2) year from the date of Acceptance or the duration of Maintenance Bond, whichever is longer. The Awarding Public Agency or the City Engineer shall give the contractor notice of observed defects with reasonable time after discovery. Contractor must immediately remedy any defects and remedy or pay for any damage to other work or property resulting therefrom.

SECTION 110 – LEGAL RELATION AND RESPONSIBILITY TO THE PUBLIC

110.01 – LAWS TO BE OBSERVED

Contractor must at all times observe and comply with all federal and state of Oklahoma and local laws and regulations and all City of Oklahoma City ordinances, codes, and regulations (regardless of City limits or City jurisdiction lines) which in any manner affect the conduct of the work or affect the project. Contractor must observe and comply with all orders and decrees, which exist at the present or which may be enacted or issued later, of agencies, bodies or tribunals having jurisdiction or authority over the work or project. No plea of misunderstanding or ignorance thereof will be considered an excuse for non-compliance or for additional compensation or time.

110.02 – PERMITS AND LICENSES

110.02.01 Contractor must secure, at its own cost, all permits, licenses, and fees required by all federal and state of Oklahoma and local laws and regulations and all City of Oklahoma City ordinances, codes, and regulations (regardless of City limits or City jurisdiction lines). Required permits, licenses and fees include, but are not limited to, building, electrical, plumbing, and other related permits, other fees, charges, taxes, licenses, and inspections necessary for proper execution and completion of the work and project. Contractor is also required to give all notices necessary and incidental for the lawful prosecution of the work or construction and provision of project.

110.02.02 Contractor must also secure, at its own cost, all permits, certificates of inspection, and occupancy permits that may be required by authorities having jurisdiction over the work or project.

110.02.03 No claims for delay or additional time or compensation may be made for or related to the procurement and/or satisfaction of permit, licensing requirements, inspections, or

certifications.

110.03 – PATENTED DEVICES, MATERIALS AND PROCESSES

If contractor is required or desires to use any design, device, material, equipment, software, or process covered by letters, patent, or copyright, then the contractor must provide to Awarding Public Agency such right to use by suitable legal license or agreement with the patentee or owner. Contractor must provide to the Awarding Public Agency a copy of any such agreement prior to installation of the device or material or use of the design or process. The license or agreement must be to the benefit of the Awarding Public Agency and the contractor. The costs and expenses of all royalties, licenses and agreement or arising from patents, trademarks and rights in any way involved in the work or project are incidental and will not be separately paid or reimbursed by the City or the Awarding Public Agency

110.04 – SANITARY PROVISIONS

110.04.01 Contractor must establish and enforce policies and procedures regarding cleanliness and disposal of wastewater, garbage, and other waste. Contractor will prevent the inception and spread of contagious or infectious diseases about the work site, project site, or any public or private property.

110.04.02 Contractor must, at contractor's cost and expense, construct, provide, maintain, and ensure the use of necessary sanitary conveniences (secluded from public observation) for the use of laborers on the work site and on the project site.

110.05 – PUBLIC CONVENIENCE AND SAFETY

110.05.01 Contractor must establish and implement safety measures, policies and standards conforming to those required or recommended by governmental authorities including, but not limited to, the requirements of the United States Occupational Safety and Health Act, Oklahoma City-County Health Department, and the Oklahoma Department of Environmental Quality.

110.05.02 Contractor must take such special precautions for the safety of the work, the project, and the traveling public as may be necessary, including, but not limited to, sheeting, bracing and thoroughly supporting the sides of any excavation and supporting and protecting any adjacent structures.

110.05.03 Contractor may not cause any obstruction to the traveling public. Contractor must, at the contractor's own cost and expense, make provisions for reasonable accommodation and, if necessary, the diversion of traffic and the traveling public. The Awarding Public Agency reserves the right to remedy, at the contractor's cost and expense, any neglect on the part of the contractor regarding the public travel, convenience, and safety upon twenty-four (24) hours written notice and contractor's failure to timely respond.

110.05.04 In cases of emergency, the Awarding Public Agency has the right to remedy any neglect on the part of the contractor that creates or permits any potential immediate harm to the public safety without notice, at the contractor's cost and expense.

110.05.05 – SAFETY AND OSHA RULES AND REGULATIONS

Contractor must establish and implement safety measures, policies and standards conforming to these Standard Specifications and those required or recommended by governmental and quasi-governmental authorities including, but not limited to, the requirements of the United States Occupational Safety and Health Act.

110.06 – STREETS, ALLEYS, OR RIGHTS-OF-WAY

	Telephone #
Field Services	297-3571

Traffic Engineer	297-2531
Emergency Operations Center	297-2255

110.06.01-TEMPORARY CLOSURE OF STREETS

Streets or lanes of streets in the construction zone may be temporarily closed only upon the prior approval of the City Engineer. Should a lane or street closing be approved, the contractor is responsible for notifying the Engineer/Architect and Project Manager at least twenty-four (24) hours in advance of the closing. Notification to the Project Manager by email at workzones@okc.gov. In addition, the contractor must also give notice to Field Services and the Emergency Operations Center.

110.06.02 – DETOURS

All detour routes during construction must be submitted by the contractor with the Project Schedule and must be approved by the City Engineer. Contractor, at contractor's cost and expense (unless a specific bid item provides otherwise for compensation), must provide and continuous maintain all detour routes, signs, and devices, which shall conform to the requirements of the "Manual on Uniform Traffic Control Devices."

110.06.03 – OCCUPYING STREETS, ALLEYS, RIGHT OF WAY OR CITY PROPERTY

During work the contractor may be allowed to occupy such portions of streets, alleys, rights-of-way, or City property if provided for in the Contract Documents or as authorized by the City Engineer. Streets, alleys, rights-of-way and/or City property must be free and unobstructed at all times, unless otherwise specifically approved in writing by the City Engineer, including, but not limited to, excavated and waste materials, stored materials, equipment, etc. Other contractors of the City or the Awarding Public Agency may, as required by their contracts, enter the project, work site and/or project site as provided in the Contract Documents. Contractor must provide the other City or Awarding Public Agency contractors all reasonable access and assistance for the performance of the adjoining and/or contemporaneous work. Any additional project or work access and area desired by the contractor must be acquired at the contractor's cost and expense. Any cost or delay resulting from the procurement of access or additional project, or work site will not be reimbursed by the Awarding Public Agency and will not entitle the contractor to additional time or compensation.

110.06.04 – BARRICADES AND WARNING SIGNS

Where work is carried on in, or adjacent to, any street, alley or public place, the contractor must, at his own cost and expense, furnish, erect, and maintain such barricades, fences, lights, warning signs and danger signals. In addition, enough barricades must be erected to keep pedestrians and vehicles from entering on or into any work zone(s), work sites or project sites. From sunset to sunrise, contractor must furnish and maintain at least one operating light on each barricade. All devices shall be in conformance with the "Manual on Uniform Traffic Control Devices." Contractor shall provide a **twenty-four (24) hour a day phone number** to the City of Oklahoma City's Emergency Operations Center, Project Manager, and Field Services Division to be used for notification to the contractor of the need to repair or replace signs, barricades or other warning or control devices. Failure to comply with these requirements may result in the issuance of a stop work order by the City Engineer to remain in effect until the deficiencies are corrected. The issuance of a stop work order shall not act to defer or suspend the counting of days or alter the Completion Date or Completion Days specified for project completion and the contractor shall not be entitled to any additional or different compensation or time thereby.

110.06.05 - The Awarding Public Agency reserves the right to remedy any neglect on the part of the contractor regarding the public convenience and safety, upon twenty-four (24) hours written notice. In cases of emergency, the Awarding Public Agency shall have the right to remedy any neglect immediately without notice at the contractor's cost and expense.

110.07 – RAILWAY CROSSINGS

110.07.01 When the project encroaches upon any railway right-of-way, the Awarding Public Agency will secure for contractor all the necessary contracts and/or easements and/or authority to enter upon such right-of-way for the prosecution and completion of the project; provided however, the contractor will be required to obtain and provide such insurance as required by the railroad to cover the contractor, its subcontractors, the City and the Awarding Public Agency for the acts and omissions of the contractor and its subcontractors. If the project site is occupied by railway tracks, the work must be carried on in such manner as not to interfere with the railway operation. Where railway tracks are to be crossed, the contractor must construct or contract for the railroad to construct the necessary bridges, trestles, cribs, or other structures for the safe operation of trains or cars across any excavation during the time or construction of the work. The cost of the construction of such bridges, trestles, cribs, or other structures must be paid to the railroad company by contractor. This cost shall include the necessary cost of any supervision, flagmen, permit, insurance, or other incidental expenses that may be required by the railroad company while the work is in progress on the right-of-way of the railroad company. The contractor submitting a bid shall take all insurance and railroad coordination costs into consideration and include in its bid. Contractor must include such costs and expenses in bid items. No other or additional payments and no time will be granted contractor.

110.07.02 Contractor must coordinate and cooperate with the City Engineer, Awarding Public Agency, and railroad in all ways possible to timely complete the project in case of delay due to the railroad coordination, only an extension of time for the actual railroad caused coordination delays may be considered on a one day for one day basis; however, no additional compensation will be due or paid the contractor.

110.07.03 Contractor must obtain any insurance, and procure flagmen and training required by the railroad as a condition of work on or near railroad tracks or rights-of-ways. These costs are incidental and will not be separately paid or reimbursed by the Awarding Public Agency unless specifically provided otherwise by a bid item in the Contract Documents.

110.08 - ACCESS

Contractor must separately and timely obtain any additional access, construct access roads, and change of grade required for access to perform the work or to construct the project. The cost of access, unless expressly included in a discrete separate bid item, is an incidental cost and no additional payment or time will be granted by the City or Awarding Public Agency.

110.09 - TEMPORARY SURFACING

110.09.01 When temporary surfacing is required to maintain access to property or required by the Contract Documents, the contractor must timely and continuously provide and complete temporary paving as soon as practical before adjacent work is commenced. Unless expressly included as a discrete separate bid item, the temporary surfacing is an incidental cost, and no additional payment or time will be granted by the City or Awarding Public Agency.

109.09.02 Contractor must repair any damage and repair any degradation of access, roads, streets, easements, and rights-of-ways throughout the performance of the project to a standard that the access, roads, streets, driveways, easements, and rights-of-ways were prior to the commencement of work, or such higher standard as set forth in the Contract Documents. If there is a dispute as to the pre-work condition of the access, roads, streets, driveway, easements and rights-of-ways, then the pre-work video will control but if the pre-work video is not sufficient to reasonably determine the pre-work condition, then the contractor will repair and maintain the access, roads, streets, driveway, easements and rights-of-ways to the standard the City Engineer determines to be reasonable.

110.10 – USE OF EXPLOSIVES

110.10.01 Should the contractor desire to use explosives for any purpose in the prosecution of the work all affected or concerned City departments and all utility companies must be notified and given a reasonable opportunity to review the type of explosive to be used and proposed use. These notifications shall include the date, time, location, type, and quantity of any explosives to be used.

110.10.02 In addition, prior to any use of explosives, the contractor must notify the proper representative of all utility companies having service connections within the area to be affected. These notifications must include the date, time, location, type, and quantity of any explosives to be used.

110.10.03 Contractor or subcontractor utilizing the explosives must have all required licenses, certifications and permits and provide a copy to the Engineer/Architect, Project Manager, and City Fire Marshall before permission will be granted by the City Fire Marshal or the City Engineer.

110.10.04 Prior to any blasting, the contractor must receive prior written permission of the City Fire Marshall and the City Engineer. Written permission will not be issued until the contractor obtains a release from all utility companies.

110.10.05 The City Fire Marshall and the City Engineer may require additional detailed information on all progress toward the use of explosives and may require additional safety precautions.

110.10.06 All precautions must be taken by contractor as required by the local, City and the state of Oklahoma, and federal laws and regulations relative to use of explosives.

110.10.07 Necessary provisions must be made for the protection of the project and all public and private property. All use of explosives must be conducted in a manner to protect persons or property.

110.10.08 Contractor may only keep enough explosives necessary for the immediate day's work on hand.

110.10.09 Storage of explosive devices must be offsite and done strictly in compliance with applicable laws, industry standards and/or as directed by the City Engineer.

110.11 – PROTECTION AND RESTORATION OF PROPERTY

110.11.01 Contractor may not enter upon private property for any purposes without first obtaining permission from the property owner.

110.11.02 Contractor is responsible for the preservation of public or private property. Contractor must use every precaution necessary to prevent damage to all vegetation, trees, fences, culverts, bridges, pavements, driveways, sidewalks, mailboxes, etc., and to all water, sewer, gas or electric lines or appurtenances thereof and to all other public or private property along or adjacent to the work site and project site.

110.11.03 Contractor must notify the proper representatives of any public utility, any company, or any individual not less than twenty-four (24) hours in advance of any work which might damage or interfere with the operation of their property, along or adjacent to the work site or project site.

110.11.04 Contractor is responsible for all damage or injury to property of any character resulting from any act, omission, neglect or misconduct in the manner or method of executing the

work or providing the project.

110.11.05 Contractor is also responsible for the negligent execution and non-execution of the work and for any defective work or materials. Contractor's responsibility will not be released until the project is completed and accepted less and except the contractor's obligations under warranties and the Maintenance Bond shall continue. When and where any direct or indirect damage or injury is done to public or private property on account of any act, omission, neglect or misconduct in the execution or non-execution of the work, the contractor must restore the property to a condition similar or equal to that existing before such damage or injury was done at the contractor's cost and expense. Contractor must repair, rebuild, or otherwise fix the property as may be directed, or contractor must make good such damage or injury in an acceptable manner to the owner.

110.11.06 In case of the failure on the part of contractor to restore such property or make good such damage or injury, the City Engineer may, upon forty-eight (48) hours written notice proceed to restore such property at contractor's cost and expense. The Awarding Public Agency may without notice immediately restore such property when a nuisance or hazardous condition results. The cost for the Awarding Public Agency's restoration will be deducted from retainage and/or any monies due or to become due the contractor under the contract and/or by such legal action as the Awarding Public Agency or the City may bring.

110.12 – PROTECTION AND PRESERVATION OF LAND MONUMENTS AND PROPERTY LINE MARKS

Contractor must carefully protect from disturbance or damage all land monuments, benchmarks, and iron pins and other markers that establish property lines, easement lines, right-of-way lines or street lines. Where such monuments, pins, benchmarks, or other markers must, of necessity, be disturbed or removed in the performance of the contract. Contractor must first give ample prior notice to the Engineer/Architect and City Engineer so replacement of such monuments or markers may be witnessed or referenced by the City Engineer. Should contractor disturb, remove or damage any established land monument or markers without first giving the Engineer/Architect and City Engineer ample prior notice, the City Engineer may direct the contractor to re-survey and re-establish that monument, pins, benchmarks or other markers at contractor's cost and expense or may, in its sole discretion, re-survey and re-establish monument, pins, benchmarks or other markers and deduct the cost of re-surveying and re-establishing such monuments, pins, benchmark or other marks from any monies due or to become due the contractor.

110.13- SECURITY AND WATCHMEN

Contractor must also provide such security and watchmen and must take such other precautionary measures as may be necessary for the protection of persons and property and for the protection of the project and any work, equipment, supplies, and materials until Acceptance of the project. Contractor is solely responsible for any vandalism, theft, damage, or loss that may occur on any work site or the project site and for any vandalism, theft, damage or loss of stored materials, supplies and equipment or any loss or damages to the work or project until Acceptance of the project. No compensation or additional time will be granted the contractor for any vandalism, theft, damage, or loss. The provision of watchmen and any necessary security is an incidental cost for which no payment shall be made by the Awarding Public Agency or the City.

110.14 – PUBLIC UTILITIES AND PUBLIC PROPERTY TO BE CHANGED

110.14.01 Contractor may not inhibit free access of the utility owner to operate and maintain all utilities.

110.14.02 Contractor may not inhibit the access by the utility owner to or through the project site or any work site for emergency services.

110.14.03 Before commencing work on any work site or the project site and periodically thereafter, as necessary, the contractor must call OKIE and have the utilities located by the owners of those underground utilities. Contractor must create and maintain a record of calls to OKIE and the response by the owners of the underground utilities. Contractor may not excavate until the time required by the Oklahoma Underground Facilities Damage Prevention Act has expired and all underground utility and facility owners listed in the by OKIE and all underground utility and facility owners listed in the Bidding Documents have marked their underground facilities. Should an underground utility or facility owner not mark the location of its underground utilities and facilities within the time provided by the Oklahoma Underground Facilities Damage Prevention Act, then the contractor must ask the Engineer/Architect for approval to proceed. The Engineer/Architect will make a recommendation to the City Engineer and upon approval of the City Engineer, the contractor may proceed. Approval by the City Engineer is for administrative purposes only and neither makes the contractor an agent of the City or the Awarding Public Agency nor shall be deemed an assumption of liability or responsibility of the City or the Awarding Public Agency for the acts or omissions of the contractor. Approval to proceed by the City Engineer will not relieve the contractor of any responsibility for any damage thereby and will not relieve the contractor of any responsibility or liability under the Oklahoma Underground Facilities Damage Prevention Act or by law. These procedures and this work and cost is deemed incidental, and no additional payment or time will be granted to the contractor for any resultant process, work, or delay.

110.14.04 Traffic signal devices and appurtenances are not located through the OKIE one-call system, so in addition to calling OKIE, the contractor must call the City Traffic Division and request the marking of underground facilities. Contractor must create and maintain a record of calls to the City Traffic Division and the response by the City. Contractor may not excavate until the traffic signal devices and appurtenances have been marked. This work and the cost is deemed incidental and no additional payment or time will be granted to the contractor for any resultant delay.

110.14.05 Should the contractor encounter any utilities or facilities, whether or not marked by the underground utility or facilities owner or the City, the contractor must physically locate and mark all existing utilities and facilities within the project site and within any work site. This work and cost is deemed incidental and no additional payment or time will be granted to the contractor.

110.14.06 Contractor is responsibility for protection of all utilities and facilities on the project site and all work sites, whether or not shown in the Bidding Documents, from damage by the contractor and its subcontractors, suppliers, and materialmen during construction. The contractor must, at contractor's cost and expense, repair or replace any such damaged utility or facility to a condition equal to or better than their pre-work condition, unless otherwise directed by the City Engineer. This work and cost is deemed incidental and no additional payment or time will be granted to the contractor.

110.14.07 Contractor must support all underground utilities and facilities that may be affected by the work. Contractor must relocate any underground utilities and facilities that prevent the performance of the work or the completion of the project. Unless specifically separately called out in the Bidding Documents as a bid item with a bid price, the supporting and/or relocation of underground utilities and facilities is incidental work and costs, and no additional payment or time will be granted for such work.

110.14.08 Contractor is required to coordinate all work with that of the utility companies, the Awarding Public Agency, and the City so that the work on the project can proceed in an orderly

and timely manner.

110.14.09 Contractor must coordinate the project and the work to be performed with that of other contractors in and around the project site and all work sites. The provision of coordination is an incidental cost for which no payment will be made, and no time will be granted by the Awarding Public Agency or the City.

110.15 – TEMPORARY SEWER AND DRAIN CONNECTIONS

110.15.01 When existing storm sewers are or have to be taken up or removed by contractor, then the contractor, at the contractor's own cost and expense, must provide and maintain temporary conduits, outlets and connections, and adequate pumping facilities for all private or public storm water drains, inlets and facilities, to maintain adequate continuous storm water conveyance and to protect the project, the project site, the work site and all private and public property.

110.15.02 When existing sanitary sewers are or have to be taken up or removed by contractor, then the contractor, at the contractor's own cost and expense, must provide and maintain temporary conduits, outlets and connections, and adequate pumping facilities for all private or public inlets and facilities, and for all private and public sanitary sewer service lines, mains and facilities to maintain adequate continuous sanitary sewage conveyance and to protect the project, the project site, the work site and all private and public property.

110.15.03 Contractor must prepare and submit a pumping plan to the Engineer/Architect for the assembly, operation, and maintenance of adequate facilities to collect, contain, pump, convey and dispose of storm water and sanitary sewage until completion of the project. Contractor may not disconnect any existing storm water or sanitary sewer service or system until a plan has been received by the Engineer/Architect, recommended for approval by the Engineer/Architect to the City Engineer and approved by the City Engineer. Approval of a pumping plan will not relieve the contractor of any responsibility for maintaining storm water or sanitary sewer service or system or any damage therefrom.

110.15.04 Contractor must take care of all sewage and storm water drainage that will be received from and conveyed by these facilities. Contractor must construct such pipe or other structures necessary and be prepared at all times to dispose of drainage and sewage received from these temporary connections until such time as the permanent connections are built and in service. The existing sewers and storm water facilities and connections must be kept in service and maintained, save where specified in the approved plans or ordered to be abandoned by the City Engineer. All water, wastewater, storm water and sewage must be disposed of in a satisfactory manner so that no nuisance is created and that existing structures, facilities, and the work under construction will be adequately protected.

110.15.05 Unless specifically separately called out in the Bidding Documents as a bid item with a bid price, this work and cost is incidental, and no additional payment or time will be granted for such work.

110.16 – ARRANGEMENT AND CHARGE FOR UTILITIES FURNISHED BY THE CITY

110.16.01 If the contractor desires to use City water, the contractor must establish an account and timely pay the utility bills for such service and must make complete and satisfactory arrangements with the City Utilities Department for so doing. Contractor must bear the cost and must separately pay for all water usage and water and wastewater discharge.

110.16.02 If the contractor is not the water account holder, the contractor must establish and maintain an account and obtain and use a City hydrant meter, in accordance with City policies, to

obtain water service for the work or project.

110.16.03 Contractor must timely pay all utility bills for all utility services to all service providers. The cost and expenses for utility services is incidental and no additional payment will be made for such costs or expenses.

110.16.04 If the contractor damages or loses the meter, the contractor will pay for replacement or all repairs to the meter and will pay for water service as estimated by the Utilities Director for the period which the contractor had or was responsible for the meter.

110.16.05 Contractor may not use the City solid waste or bulk waste services and must separately arrange for private trash containers and trash removal and disposal. The cost for solid waste and bulk waste services is incidental and no additional payment will be made for such costs or expenses.

110.16.06 Contractor's use of treated water is subject to any ordinance or order related to water conservation or water use suspension. No additional compensation will be paid, and no additional days will be granted contractor for limitation or suspension of use of treated water related to such ordinances or orders.

110.16.07 Contractor's use of raw water or ground water requires a separate written permission from the City and the Oklahoma Water Resources Board. In addition, contractor is responsible for obtaining any required permits and permissions for the use of raw water or ground.

110.17 – USE OF FIRE HYDRANTS

110.17.01 Contractor may not open, turn off, interfere with, attach pipe, or hose to, or connect anything with any fire hydrant, stop valve, or stop cock or to connect to or tap any water main belonging to the Awarding Public Agency or the City unless duly authorized to do so by the Awarding Public Agency and Utilities Department.

110.17.02 Contractor must obtain from the City of Oklahoma City a water flush meter for access to City fire hydrants. Contractor is responsible for the water flush meter, and any and all related deposits, set-up charges, and the water usage. All water usage expenses are considered incidental costs and will not be paid separately.

110.17.03 Contractor may not obstruct or use a fire hydrant when notified by the Project Manager or the Oklahoma City Fire Department that there is a fire or water main break in the area. No additional compensation will be paid, and no additional days will be granted contractor for temporary suspension of use of a fire hydrant related to a fire or water main break in the area.

110.18 – CONTRACTOR'S RESPONSIBILITY FOR THE WORK

Until Acceptance by formal action of the Awarding Public Agency, the project is under the charge and care of the contractor. Contractor must take every necessary precaution to prevent injury or damage to the work or project, and any part thereof, by the action of subcontractors, third parties, the elements, or any other cause whatsoever, whether arising from the execution or non-execution of the work, less and except by actions of the Awarding Public Agency. Contractor must at his own expense rebuild, repair, restore, and make good all injuries or damage to any portion of the work or project occasioned by any of the forgoing causes before Acceptance of the project by formal action of the Awarding Public Agency.

110.19 –RESPONSIBILITY AND LIABILITY

In exercising or carrying out any of the provisions the Standard Specifications or in exercising or carrying out any power or authority granted by the Contract Documents, the City Engineer and City Engineer's authorized representatives shall not be personally or professionally liable, either as agents or officials of the City. It being understood and agreed that in such matters the City Engineer and City Engineer's

authorized representatives act only as the agent and representative of the Awarding Public Agency and the City. The Engineer/Architect is an independent contractor and shall not be deemed to an agent or representative of the City Engineer, the City, or the Awarding Public Agency.

110.20 – WAIVER OF LEGAL RIGHTS

110.20.01 Any inspection, order, measurement, certificate, submittal approval, substitution approval, or invoice approval by the City Engineer or City Engineer's authorized representatives shall not be deemed to waive or release any obligation of the contractor under applicable law or under the Contract Documents or any insurance or bonds.

110.20.02 Any payment for any work or use or occupancy of any work or any portion of the project by the Awarding Public Agency, shall not be deemed to waive or release any obligation of the contractor under applicable law or under the Contract Documents or any insurance or bonds.

110.20.03 Failure to discover or notify the contractor of any breach of contract shall not be held to be a waiver of such breach or any other or subsequent breach.

110.20.04 Acceptance of the project by formal action by the Awarding Public Agency will be deemed completion of the contract and acceptance of the project, less and except for any terms or requirements in the Contract Documents, any warranties, the insurance, and bonds, which will continue beyond acceptance of the project. In addition, any right of the Awarding Public Agency provided in equity or at law shall not terminate with Acceptance of the project.

110.20.05 The Awarding Public Agency reserves the right to correct any error that may be discovered in any estimate or payment that may have been made and reserves the right to adjust the same to meet the terms of the Contract Documents. The Awarding Public Agency reserves the right to claim and recover by process of equity or law such sums as may be sufficient to correct any error(s) or make good any deficiency in the work or project resulting from such error or deficiency, misrepresentation, dishonesty, or collusion discovered in the work or related to the project after the final payment has been made.

110.21 – INDEMNIFICATION

110.21.01 Contractor must indemnify the Awarding Public Agency, the City, and its participating Trusts against liability for damage arising out of death or bodily injury to persons or damage to property; provided, that indemnification shall not exceed an amount that is proportionate to the degree or percentage of negligence or fault for which the contractor and any person or entity for which the contractor is legally responsible are adjudicated liable.

110.21.02 Contractor will not be required to indemnify, defend or hold harmless the Awarding Public Agency, the City or participating Trusts against liability for damage arising out of death or bodily injury to persons or damage to property which arises out of the negligence or fault of the Awarding Public Agency, the City or participating Trusts or their agents, representatives, subcontractors, suppliers or any other entity for whom the contractor is not otherwise legally responsible.

110.21.03 Contractor shall promptly advise the Awarding Public Agency, the City, and its participating Trusts, in writing, of any action, administrative or legal proceeding or investigation as to which this indemnification may apply.

110.21.04 This indemnification requirement will survive the expiration of the contract and Acceptance of the project.

110.21.05 This indemnity and hold harmless obligation is separate and distinct from the

insurance requirements of these Standard Specifications or the Contract Documents.

110.21.06 This indemnity and hold harmless obligation does not limit or define the insurance requirements of these Standard Specifications or the Contract Documents.

110.21.07 The minimum insurance requirements set forth in the Contract Documents and the Standard Specification do not define or limit the indemnity obligations of the contractor.

110.22 – CONTRACTOR'S INSURANCE

110.22.01 Contractor must obtain and maintain insurance coverage as provided below. The required insurance must be maintained in full force and effect until completion and Acceptance by formal action of the Awarding Public Agency of the project and during any work subsequently performed on the project during the Maintenance Bond period. Contractor must provide, pay for, and maintain insurance, written with an insurance company, for the coverage and amounts of coverage not less than those set forth below. All insurance must be from responsible insurance companies eligible to do business in the state of Oklahoma. Contractor is solely responsible for obtaining and maintaining such other or additional insurance and for the sufficiency of its own insurance program to cover the liabilities of the contractor.

110.22.02 All liability policies (except worker's compensation insurance) must name the Awarding Public Agency, the City of Oklahoma City, and any Trust participating in the project, and all other parties to the contract, as additional insureds without reservation or restriction. All liability policies must provide that with respect to claims involving any insured, each such interest shall be deemed separate from any and all other interest and coverage shall apply as though each such interest was separately insured. All policies must be in the form of an "occurrence" insurance coverage or policy. If any insurance is written in a "claims-made" form, the contractor must also provide tail coverage that extends a minimum of two years from the Acceptance of the project by the Awarding Public Agency.

110.22.03 No policy may have a deductible or self-insured retentions in excess of $25,000.

110.22.04 Any deductibles or self-insured retentions in excess of $25,000, or any scheme other than a fully insured coverage of general liability, automobile liability and/or employer's liability must be requested by the contractor and formally approved in advance by the Awarding Public Agency. However, the Awarding Public Agency is not required to approve any deductibles or self-insured retentions in excess of $25,000. At the option of the Awarding Public Agency, approval of deductibles or self-insured retention in excess of $25,000 may be conditioned upon: (1) the contractor obtaining such additional insurance coverage or requiring the insurer to reduce or eliminate such deductibles or self-insured retentions with respect to the Awarding Public Agency; or (2) the contractor procuring an irrevocable letter of credit naming the Awarding Public Agency as a loss payee or bond guaranteeing payment of the losses and related investigations, claim administration and defense expenses not otherwise covered by the contractor's insurance because of deductibles or self-insurance retentions; or (3) the contractor providing owner's protection liability coverage with the Awarding Public Agency and all other parties to the contract and participating Trust in the project or program, each as the named insured, for the commercial general liability requirement, in a combined single-limit bodily injury and property damage amount of One Million Dollars ($1,000,000.00) without a deductible or self-insured retentions in excess of $25,000. The certificate of insurance evidencing the insurance required herein and naming the Awarding Public Agency, the City and any participating trust as additional insured must include the following statement: "The named additional insureds is required by contract."

110.22.05 The insurance coverage and limits required must be evidenced by properly executed certificates of insurance on the form furnished by the Awarding Public Agency or on forms approved by the Oklahoma Insurance Commissioner. The contractor must furnish to the

Project Manager current copies of Certificate of Insurance required below with its signed contract and bonds. The certificates must include the project number and project description. The certificates must also be signed by the authorized representative of the insurance company(s) and must be accompanied by proof that the person signing is an authorized representative thereof. In addition, certified, true, and exact copies of all insurance policies and endorsements providing the required insurance coverage must be provided to the Awarding Public Agency on a timely basis if requested by the City Engineer or Project Manager. The required insurance coverage and policies shall be performable in Oklahoma City, Oklahoma, and shall be construed in accordance with the laws of Oklahoma.

110.22.06 In the event of a reduction or impairment in any aggregate insurance coverage or limits below the coverage required, the contractor must take immediate steps to have the full amount of the required insurance coverage reinstated. If at any time the Awarding Public Agency requests a written statement from the insurance company(s) as to any reduction or impairment to the aggregate coverage or limits, the contractor hereby agrees to promptly authorize and have delivered to the Awarding Public Agency such statement and/or certificate of insurance. Contractor must remove any impairment and cover any reduction to insurance coverage as soon as known to it. Contractor authorizes the Awarding Public Agency to confirm with the contractor's insurance agents, brokers, surety, and/or insurance carriers all information necessary to confirm or evidence the Contractor's compliance with bonding and insurance requirements. Contractor's insurance coverage shall be primary to any insurance or self-insurance program carried by the Awarding Public Agency, by the City and by any participating Trust.

110.22.07 There may be no termination, cancellation, non-renewal or modification of such insurance coverage or policy without at least thirty (30) calendar days prior written notice to the Awarding Public Agency, in conformance with the provisions of the contract. Any notification of cancellation, termination, non-renewal, or modification must be submitted to the Project Manager and must include the project number and project title in the reference line. Contractor must provide a covenant from the insurance agent that the insurance agent will provide the Awarding Public Agency, the City, and any participating Trust with such thirty (30) calendar days advanced written notice as described above. No work order, occupancy of the project site, or payment for any work will be provided unless and until the required insurance policy and coverage have been obtained and certificates of insurance are provided, and insurance coverage is in effect. The contract must provide a copy of an insurance certificate demonstrating current coverage as required by these Standard Specifications with each claim for payment on the project.

110.22.08 The minimum amounts of such insurance policy and continuing coverage must be at least as follows:

110.22.08.01 Worker's Compensation and Employer's Liability Insurance. Contractor must provide and maintain, during the term of the contract, Worker's Compensation Insurance as prescribed by the laws of the state of Oklahoma and Employer's Liability Insurance for all its employees employed at the project site, and in case any work is subcontracted, the contractor must require each subcontractor to similarly provide Worker's Compensation and Employer's Liability Insurance for all the subcontractor's employees, unless such employees are covered by the protection afforded by the contractor. In the event any class of employees engaged in work performed under the contract or at the project site is not protected under such insurance heretofore mentioned, the contractor must provide and must cause each subcontractor to provide adequate, Worker's Compensation and Employer's Liability insurance for the protection of the employees not otherwise protected.

110.22.08.02 Commercial General Liability Insurance. Contractor must provide and maintain commercial general liability insurance coverage not less than the greater of the

following amounts the maximum cumulative liability under the Governmental Tort Claims Act (51 O.S. § 151 *et seq*.), and any amendment or addition thereto, of the City, the Awarding Public Agency, any public trust participating in the project, and all parties to this Contract. The current required minimum commercial general liability coverage for each entity under the Governmental Tort Claims Act (GTCA) is $175,000 per person for bodily injury or death, $25,000 for property damage and $1,000,000 for any number of claims arising out of a single accident or occurrence.

110.22.08.03 Automobile Liability Insurance. Contractor must provide and maintain comprehensive automobile liability insurance coverage as to the ownership, maintenance, and use of all owned, non-owned, leased or hired vehicles not less than the greater of the following amounts: the maximum cumulative liability under the Governmental Tort Claims Act (51 O.S. § 151 *et seq*.), and any amendment or addition thereto, of the City, the Awarding Public Agency, any public trust participating in the project, and all parties to this contract. The current required minimum commercial general liability coverage for each entity under the GTCA is $175,000 per person for bodily injury or death, $25,000 for property damage and $1,000,000 for any number of claims arising out of a single accident or occurrence.

110.22.09 The requirements of the insurance provisions listed above shall survive the completion, expiration, cancellation, or termination of this contract. All policies, unless specified otherwise, shall remain in full force and effect during this contract, during the construction of the project, and for a period of two (2) years after the Acceptance of this project by the formal action of the Awarding Public Agency.

110.22.10 The lapse of any of the insurance policy or coverage required by the contract is a breach of the contract. The Awarding Public Agency may at its option suspend the contract and/or any work under the contract until there is full compliance with this paragraph or may cancel or terminate the contract and seek damages for the breach of the contract. The remedies in this paragraph shall not be deemed to waive or release any remedy available to the Awarding Public Agency. The Awarding Public Agency expressly reserves the right to pursue and enforce any other cause or remedy in equity or at law. Contractor will not be entitled to any compensation or additional time for any suspension or termination pursuant to this provision.

110.22.11 Nothing in this insurance provision defines or limits the responsibilities and duties of the contractor under any other provision of the Contract Documents or these Standard Specifications, including but not limited to any indemnification provision. Nothing in this insurance provision shall define or limit the rights of the Awarding Public Agency, the City, and any party to the contract, or any Trust participating in the project under any other provision of the contract, including but not limited to any indemnification provision in the contract, Contract Documents, or Standard Specifications.

110.22.12 Contractor and its insurer will not be required to insure, defend or hold harmless the Awarding Public Agency, the City or participating Trusts under the required insurance against liability for damage arising out of death or bodily injury to persons or damage to property which arises out of the negligence or fault of the Awarding Public Agency, the City or participating trusts or their agents, representatives, subcontractors, suppliers or any other entity for whom the contractor is not otherwise legally responsible.

110.22.13 The certificate of insurance evidencing the insurance required herein and naming the Awarding Public Agency, the City and any participating trust as additional insured must include the following statement: “The named additional insureds is required by contract,” or other certification acceptable to the insurance provider and the City or Awarding Public Agency.

110.23 – EXTENDED COVERAGE AND BUILDER'S RISK INSURANCE

110.23.01 Extended Coverage – Contractor must procure and must maintain during the life of the contract and until the Acceptance of the project by the Awarding Public Agency and/or the City, Builder's Risk Insurance (extended coverage including fire coverage on building construction and/or renovation) on a one hundred percent (100%) completed value basis on the insurable portion of the project including any existing improvements at the project site and any work sites, which were made or are to be made a part of the project. The insurance coverage must also include all stored materials, supplies, and equipment. The Awarding Public Agency, the City, and the contractor (as their interests may appear) must be named as the insureds. The certificate of insurance evidencing the insurance required herein and naming the Awarding Public Agency, the City and any participating Trust as additional insured must include the following statement: "The named additional insureds is required by contract," or other certification acceptable to the insurance provider and the City or Awarding Public Agency.

110.23.02 Scope of Extended Coverage Insurance - The insurance required above must provide adequate protection for the project and any existing materials, supplies and improvements at the project site and any work sites from the acts and omissions of the contractor and the contractor's subcontractors, respectively, against damage claims which may arise under the contract or in conjunction with the project, whether such acts or omissions were by the contractor or by anyone directly or indirectly employed by the contractor in the performance of the contract or the construction of the project, also, against any of the special hazards which may be encountered during the performance of the contract or construction of the project.

110.23.03 Builder's Risk Insurance - On all building projects, the contractor must provide Builder's Risk Insurance (all risk coverage for building or facility construction and renovation projects). Contractor must procure and must maintain, during the term of the contract and construction of the project, builder's risk insurance (broad form coverage, including theft, fire, and the elements coverage on building construction or renovation) in the amount of one hundred percent (100%) of the construction cost plus the cost of any deductible for any insurance of the building by the City and the Awarding Public Agency. Such insurance must remain in effect until 11:59 p.m. on the date of Acceptance of the entire fully completed project by the latter of the formal acceptance of the Awarding Public Agency or the formal acceptance by the City, whether or not the project is substantially completed or whether or not the building or some part thereof is occupied in any manner prior to Acceptance. Contractor must be named as insured and the City and the Awarding Public Agency, all parties to this contract, and any public trust participating in the project (as their interests may appear) must be named as additional insureds. The certificate of insurance evidencing the insurance required herein and naming the Awarding Public Agency, the City and any participating Trust as additional insured must include the following statement: "The named additional insureds is required by contract," or other certification acceptable to the insurance provider and the City or Awarding Public Agency. The coverage must provide protection for the contractor, the City and the Awarding Public Agency, all parties to this contract, and any public trust participating in the project, respectively, against property damage and damage claims which may arise from activities, omissions, or operations by the contractor or its subcontractors under the contract and also against any of the special hazards which may be encountered by the contractor or its subcontractors in the performance of the contract. Neither the contractor nor any of its subcontractors, employees, or agents may commit any act, operation, or omission that would vitiate, invalidate, or impair the insurance coverage hereunder. The insurance coverage must also include all stored materials, supplies, and equipment when stored off site.

110.23.04 Nothing in this insurance provision defines or limits the responsibilities and duties of the contractor under any other provision of the contract, Contract Documents, or these Standard Specifications, including but not limited to any indemnification provision. Nothing in this insurance provision shall define or limit the rights of the Awarding Public Agency or any party to

the contract or any Trust participating in the project under any other provision of the contract, including but not limited to any indemnification provision.

110.23.05 Contractor and its insurer will not be required to insure, defend or hold harmless the Awarding Public Agency, the City or participating Trusts under the required insurance against liability for damage arising out of death or bodily injury to persons or damage to property which arises out of the negligence or fault of the Awarding Public Agency, the City or participating Trusts or their agents, representatives, subcontractors, suppliers or any other entity for whom the contractor is not otherwise legally responsible.

110.24 – LIENS

110.24.01 Neither the final payment nor any part of the retained percentage shall become due until the contractor delivers to the Awarding Public Agency and the City a complete release of all liens from its contractors, subcontractors, materialmen, and suppliers arising out of this contract or out of construction or provision of the project.

110.24.02 Contractor may, if any subcontractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the Awarding Public Agency, to indemnify the Awarding Public Agency, the City, and any participating Trust against any lien. If any lien remains unsatisfied after all payments are made to the contractor, the contractor must refund to the Awarding Public Agency all monies that the Awarding Public Agency or the City or a participating Trust may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.

SECTION 111 – PROSECUTION AND PROGRESS

111.01 – SUBLETTING OF WORK

111.01.01 The Awarding Public Agency has no contractual relationship with or responsibility for or to any subcontractor on the contract or project. Subcontractors are the agents of the contractor, and the acts and omissions of the subcontractor are the acts or omissions of the contractor.

111.01.02 Contractor will not employ any subcontractor on the contract or project not authorized to perform such work under federal, state of Oklahoma or City law, regulation, or ordinance. Subcontractors must be prequalified with the City Prequalification Review Board to perform any work for which a prequalification class exists at the time of their performance of the work. Subcontractors must be licensed with the state of Oklahoma, the City, and any other regulatory public entity to perform any work for which a licensing requirement exists at the time of performance of the work.

111.01.03 Contractor must always be represented at the project site and any work site, by a qualified and knowledgeable superintendent or other qualified and knowledgeable designated representative any time work is performed by the contractor or its subcontractor.

111.01.04 If contractor sublets any part of the work, the contractor will not, under any circumstances, be relieved of the contractual responsibility and obligations or any obligation under these Standard Specification, the Contract Documents, or under any federal, state of Oklahoma or City law, regulation, or ordinance.

111.01.05 All communication of the Awarding Public Agency and the City Engineer will only be through the contractor.

111.01.06 Subcontractors will be considered only in their capacity as agents, employees, or workmen of the contractor. Subcontractors are subject to the same requirements as to character

and competency as the contractor.

111.02 – ASSIGNMENT OF CONTRACT

Contractor may not assign, transfer, convey or otherwise dispose of the contract or right, title or interest in or to the same or any part thereof without the previous written consent of the Awarding Public Agency and the City and concurred in by the contractor's surety. If the contractor does, without such previous written consent assign, transfer, convey, or otherwise dispose of the contract or the contractor's right, title or interest therein or any part thereof to any person or persons, partnership, company, film, or corporation, or by bankruptcy, voluntary or involuntary, or by assignment under the insolvency laws of any state, attempt to assign, transfer, convey, or otherwise dispose the contract or make default in or abandon said contract, then the contractor may, at the option of the Awarding Public Agency, be declared to have breached the contract and the contractor will be subject to damages, losses and expenses of the Awarding Public Agency, the City and any participating Trust, unless the contractor's surety successfully and timely completes said contract and any monies due or to become due under said contract shall be retained by the Awarding Public Agency until all damages, costs and expenses incurred by the Awarding Public Agency, the City and any participating Trust, are determined and paid.

111.03 – LIMITATION OF OPERATIONS

Contractor must conduct work so as to create a minimum amount of inconvenience to the public and to any operations, structures and activities of the Awarding Public Agency and the City. At any time, when in the judgment of the City Engineer, the contractor has obstructed or closed or is carrying on operations on a greater portion of project site, the street, or public way than is necessary for the proper execution of the work, the City Engineer may require the contractor to finish the section on which work is in progress before work is started on any additional section.

111.04 – CHARACTER OF WORKMEN AND EQUIPMENT

111.04.01 Contractor must employ such superintendents, foremen and workmen as are skilled, experienced, careful, competent and qualified, and knowledgeable in the work to be performed and in the type of project to be constructed or improved. Contractor must address and resolve any issues or events in, about or on the work, work site, or project site, by an employee or subcontractor who creates a dangerous situation, or whose conduct is a danger to himself/herself, a City employee or the general public, or who has shown to be incompetent or negligent in the proper performance of work or duties. Failure of the contractor to address and resolve such issues or events may, in the discretion of the City Engineer, cause a suspension of work at that site. Such suspension of work will remain in effect until the contractor demonstrates to the satisfaction of the City Engineer that the issue or event has been adequately addressed or resolved. Contractor will not be granted any additional time or compensation for any such suspension.

111.04.02 All contractor's and subcontractor's employees must have sufficient skill, competence, training, and experience to properly perform the work assigned them. All contractor's and subcontractor's employees engaged on special work or skilled work or in any trade must have all required licenses, certifications, and sufficient training and experience in such work to perform it legally, properly, and satisfactorily and to operate the equipment involved. All contractor's and subcontractor's employees must make do and proper effort to execute the work in the manner prescribed in the Contract Documents. Failure of the contractor to address and resolved such issues or qualifications may, in the discretion of the City Engineer, cause a suspension of work at that site. Such suspension of work will remain in effect until the contractor demonstrates to the satisfaction of the City Engineer that the issue or event has been adequately addressed or resolved. Contractor will not be granted any additional time or compensation for any such suspension.

111.04.03 Contractor must timely furnish such equipment, tools, machinery, supplies, and

materials as may be necessary for the prosecution of the work in an acceptable manner and at a satisfactory rate of progress. All equipment, tools and machinery used for handling supplies and/or materials and executing any part of the work must be in a condition established by the manufacturer to perform the work and must be maintained by the contractor in a satisfactory working condition in accordance with manufacturer standards. Contractor must use and maintain equipment, tools, machinery, supplies, and materials on any portion of the work site or project site such that no injury any person or any damage to any the work, project or adjacent property will result from its use.

111.05 – STOP WORK ORDER; AND ANNULMENT OF CONTRACT; TERMINATION

111.05.01 Stop Work/Suspension

The work or project and any portion of the work or project (private or public) may be suspended, immediately, by written order of the City Engineer. The City Engineer may issue a stop work order at any time for good cause. The issuance of a stop work order will not act to change the time of completion for the project. A copy of such notice may be served upon the contractor or upon the contractor's superintendent. Good cause includes, among other reasons, the following:

A) Deliberate failure on the part of the contractor to observe any requirements of these Standard Specifications or the Contract Documents or deliberate failure to comply with any orders given by the City Engineer, as provided for in these Standard Specifications.
B) Failure of the contractor to promptly repair or replace any defects in materials or workmanship or any defects of any other nature, the correction of which has been directed in writing by the City Engineer
C) Substantial evidence of collusion for the purpose of illegally procuring a contract or perpetrating fraud or misrepresentation on the City in the construction of the project or the performance of the work under contract.
D) No license, permit, certification or prequalification to perform the work.

When work is suspended for any one of the causes itemized above, or for any other cause or causes, the contractor must discontinue the work or such part thereof as the City Engineer may designate until the stop work order is released or work is authorized to resume in writing by the City Engineer. No compensation or time will be granted by reason of a suspension pursuant to this provision.

111.05.02 Annulment

A). After the award of a contract, but prior to its execution, the Awarding Public Agency, upon discovery of an administrative error in the award process that would void an otherwise valid award, may suspend the time of execution of the contract. The Awarding Public Agency may rescind the award and readvertise for bids or may direct correction of the error and award the contract to the lowest responsible bidder, whichever shall be in the best interests of the Awarding Public Agency.

B). The Awarding Public Agency shall, at the next regularly scheduled public business meeting of the governing body of the Awarding Public Agency, upon the record, present to the governing body that an error has been made in the award process and shall state the nature of the error. The governing body of the Awarding Public Agency, upon presentation of the facts of the error, may rescind the award and readvertise for bids, or may direct correction of the error and award the contract to the lowest responsible bidder, whichever shall be in the best interests of the Awarding Public Agency.

111.05.03 Termination on which no work performed.

Any contract which has been bid under the provisions of the Public Competitive Bidding Act, and on which no work has been performed and no formal claim or litigation has been pending within the last twenty-four (24) months shall be terminated by the public agency which awarded the contract. After termination, the Awarding Public Agency shall determine the amount of any final payment due to the contractor, which amount shall be the actual direct cost of purchasing the bonds and the insurance for this specific project, and the Awarding Public Agency shall make such payment to the contractor.

111.05.03 Termination for failure to timely perform or complete work.

111.05.03.01 The City Engineer may terminate a contract for cause at any time the contractor is not timely performing work or progressing the project in accordance with the timelines and/or milestones in the approved Project Schedule by providing written notice to the contractor. Upon notice of termination, the contractor must secure the site and project and terminate work in accordance with the termination notice. Contractor will only be due and owed compensation for work properly and timely completed in accordance with the Contract Documents up to the date of notice of termination. Contractor will not be entitled to any compensation for termination, securing the site and project, bidding costs, costs of bonds, cost of insurance, lost or anticipated revenues, lost or anticipated profits, overhead, demobilization, or contractual obligations with others including but not limited to materialmen, suppliers, equipment suppliers and renters, subcontractors, and banks or other financing entities or for any other claims, costs or anticipated revenues or compensation. Contractor must include in its contracts with others, the contractor's right to terminate subcontracts and the right to return materials, supplies, equipment, and other items. Provided, however, nothing herein waives, inhibits, or subordinates the right of the Awarding Public Agency to bring any action for damages and breach of contract.

111.05.03.02 The City Engineer may negotiate termination of any construction contract without cause of a contract at any time upon written notice to the contractor. Upon approval or ratification of a termination agreement by the Awarding Public Agency, the construction contract will be deemed terminate and, within thirty (30) days of approval or ratification of such termination agreement by the Awarding Public Agency, the Awarding Public Agency will tender any payment due under the termination agreement. Provided, nothing in this subsection shall entitle a contractor to compensation or consideration for termination of a construction contract containing a provision for termination at will or without cause in excess of the terms of such construction contract.

111.06 – COMPLETION OF CONTRACT

Save as provided in any bond or bonds or any warranty or provided in these Standard Specifications, the contract will be considered fulfilled, when all work has been performed, the project has been completed, the project is ready for use as intended in the Contract Documents, the Final Inspection has been made by the City Engineer, Acceptance has been made by formal action of the Awarding Public Agency, and the final payment has been made by the Awarding Public Agency.

SECTION 112 – MEASUREMENT AND PAYMENT

All pay applications must be fully and properly executed by the contractor, in a form or format provided by the Awarding Public Agency and must contain all necessary supporting documents. Partial payments shall be made based on the work timely completed and in accordance with the Contract Documents and the submission of the required pay requests and supporting documents subject to deductions or withholding as provided in the Contract Documents and subject to retainage as allowed by law. Applications for payment must be made upon the forms provided by the Awarding Public Agency, or copies thereof, and such forms must be properly completed, signed by the contractor and notarized. Applications for payments must have attached thereto the contractor's invoice and all other detail supporting the pay claim, updated Project Schedule, and certificate of insurance. In addition, each pay application must include redline "as-built" plans for the work completed. Additionally, the contractor will include with each pay application an updated and completed Time of Completion Report in the form or format provided by the Awarding Public Agency. After receipt of fully and properly submitted pay claims the Engineer/Architect must have a reasonable time for review and verification before execution by the Engineer/Architect signs and recommends payment to the City Engineer. The City Engineer must have a reasonable time to review and verify the pay claim before approval and forwarding on for payment.

112.01 – MEASUREMENT OF QUANTITIES

For unit price contracts and unit price bid items, the quantities of unit price items must be documented in detail by the contractor, inspected by the Awarding Public Agency, and verified and reconciled by the Engineer/Architect. Any quantity that was covered, consumed, or destroyed before inspection and verification by the Engineer/Architect or the Inspector will not be included in the quantity for payment and no payment will be due and owing under the contract. If it is determined that an error in the measurement of quantities was made before the Acceptance by formal action of the Awarding Public Agency, then a correction or reconciliation will be made and the compensation or reimbursed due must be paid or deducted from payments due, as appropriate to correct the error. If it is determined after Acceptance that an error in the measurement of quantities was made due to mutual mistake or due to misrepresentation, then a correction or reconciliation will be made and the compensation by the Awarding Public Agency or reimbursement by the contractor must be paid or will be deducted from payments due, if any, as appropriate to correct the error.

112.02 – SCHEDULE OF VALUES (FOR LUMP SUM CONTRACTS ONLY)

For lump sum contracts, the contractor must submit Schedule of Values of various parts of the work at least seven (7) calendar days before the Pre-Work Conference for review by the Engineer/Architect and acceptance by the City Engineer. Schedule of Values include a complete breakdown of labor and materials required for the work and project showing estimated quantities and prices, delivery times and performance timelines, and such other values as the Engineer/Architect may have called out in the Bidding Documents. The cumulative value of the Schedule of Values must not exceed to the contract price. In review of the Schedule Values, the City Engineer may furnish the contractor a list of the certain additional items on which additional prices and quantities are desired for inclusion in the Schedule of Values. The Schedule of Values, when accepted by the City Engineer, shall be used as a basis for proportional monthly payments to the contractor but not in excess of the work completed in accordance with the Contract Documents as relates to the value of the total work to be performed under the project in accordance with the accepted Schedule of Values. In applying for payments, the contractor's statement must be broken down in conformity with this Schedule of Values.

112.03 – SCOPE OF PAYMENT

The compensation as herein provided is full payment for all sums due and owing the contractor. Less and except any reimbursement or withholding due and owing from the contractor hereunder which the Awarding Public Agency is hereby authorized to deduct from payment due the contractor.

Any payment prior to Acceptance of the project by the Awarding Public Agency will in no way:

A) constitute an acknowledgment of acceptable work or substantial completion or completion or the Acceptance of the work or project, or any portion thereof; or

B) prejudice or affect the obligation of the contractor to repair, correct, renew, or replace at the contractor’s expense any defects in the materials or workmanship or any imperfections in the construction or in the strength or quality of the materials used in or about the construction of the project under the contract nor any damages due to or attributed to such defects, whether such defects, imperfections or damages have been or should have been discovered on or before the Final Inspection and Acceptance of the project.

The City Engineer will be the sole judge of such defects, imperfections or damage and the contractor will be liable to the Awarding Public Agency for failure to correct the same as provided herein.

112.04 – PARTIAL PAYMENTS

112.04.01 It is understood that the partial payments from month to month will be approximate only and all monthly estimates and payments will be subject to correction in the quantity rendered following discovery of an error in any previous quantity and such estimate shall not, in any respect, be taken as an admission of the Awarding Public Agency of the amount of an item or amount of

work done or of its quality or sufficiency nor as an acceptance of the item or work or the release of the contractor or any of the contractor's responsibility under the contract.

112.04.02 Partial payments will be made based on the work performed in accordance with the Contract Documents. Unless otherwise provided in the Contract Documents where Unit Prices are bid, partial payments and final claims will be based on actual quantities used in accordance with the Contract Documents.

112.05 – RETAINAGE

Partial payments are subject to retainage as provided by law. Release of retainage is subject to the determination of the Awarding Public Agency that the work or project is complete in accordance with the Contract Documents and approval by the surety. Provided further, however, release of retainage will be subject to withholdings for punch list items as provided by the contract and applicable law and subject to payments withheld by the Awarding Public Agency as provided in the contract for costs and expenses due from contractor to Awarding Public Agency for any damages and/or any liquidated damages. In the event the project is not completed in accordance with the Contract Documents, the retainage may be used by the Awarding Public Agency to fund or reimburse for completion of the project.

112.06 – ACCEPTANCE AND FINAL PAYMENT

112.06.01 When the project is completed in accordance with the Contract Documents and recommended by the City Engineer for Acceptance, upon receipt of a complete payment application the Engineer/Architect shall review the Final Payment for the contract. The final payment will be based on the final measurements of the work completed. All prior estimates, upon which payments had been made, are subject to corrections or revisions in the Final Payment.

112.06.02 When the project is finally and fully accepted by formal action of the Awarding Public Agency and the Maintenance Bond is placed into effect, the final payment for the accepted work, less any actual or liquidated damages or other sums that have been deducted or retained under the provisions of the contract, will be paid to the contractor as soon as practical after the Acceptance Neither the City nor the Awarding Public Agency shall be deemed to have accepted partial completion or substantial completion of a project without the formal action of their governing bodies. Any partial completion or substantial completion which creates a right to use or occupy the project or any portion thereof prior to Acceptance must be defined on the approved plans and effectuated by formal action of the governing body of the City and Awarding Public Agency.

112.06.03 With the request for Final Payment and release of retainage, the contractor must furnish to the Awarding Public Agency satisfactory evidence that all sums of money due any subcontractor, materialmen, supplier, labor materials apparatus, fixtures or machinery furnished for the purpose of the project and all liens have been paid and that the person or persons to whom the same may respectively be due have consented to such final payment.

112.06.04 The acceptance by the contractor of the Final Payment shall release the Awarding Public Agency of all claims and liability of the Awarding Public Agency under the contract, and in equity and at law.

112.06.05- Acceptance.

After Final Inspection but prior to submitting the final request for payment and requesting release of retainage from the Awarding Public Agency, the contractor must be complete and submitted to the Project Manager:

A) A loose leaf of all warranties and all manufacturer's recommended operation and

maintenance manuals; and

B) A directory containing the firm name of each subcontractor and material supplier on the project, subcontractor's and material supplier's address, telephone number, and representative to contact for repair and/or maintenance; and
C) A copy of the Engineer/Architect's color and finish schedule with any subsequent revisions duly noted. Information must include project manufacturer's name, style name and product number, for all paints, flooring and other finish products used on the project; and
D) Contractor must deliver to the Awarding Public Agency through the Engineer/Architect three copies of a neatly bound Operations and Maintenance manual organized in a manner corresponding to the division within the Standard Specification and containing the following information: guarantees, warranties and/or operating instructions for materials, equipment, or installations; and
E) Final claim with all supporting documents; and
F) Post construction video; and
G) Copies of all tests and test results; and
H) Copies of all permits and passed inspections; and
I) Certificate of Occupancy; and
J) As-builts drawings and redline plans with GPS locations of all utility apparatuses, and subsurface features and structures; and
K) Small, Local, and Minority Subcontracting Plan Final Report; and
L) Lien releases and acknowledge of full payment from all subcontractors, materialmen, and suppliers; and
M) Verification or Notice of Completion of Erosion Control Plan; and
N) Verification of completion of the Punch List.

INDEX SECTION 100

TABLE OF CONTENTS
CHAPTER 200

SECTION 200 – EXCAVATION

200.01 DESCRIPTION

This section covers work consisting of excavation, disposal or compaction of all material not being removed under other items which are encountered within the limits of the work necessary for the construction of the project in accordance with these specifications and in conformity with the lines, grades and cross sections shown on the plans or established by the City Engineer. All excavation will be classified as "unclassified excavation", "excess excavation" or "unsuitable material excavation" as hereafter described.

200.02 MATERIALS

A) UNCLASSIFIED EXCAVATION shall consist of all the work as described herein which is necessary for the preparation and construction of the project, embankments, subgrade, shoulders, parking, curb trenches, drainage ditches, channels, cross street and alley approaches, sidewalks, driveways, private entrances, etc. Unclassified excavation shall include the completion of all necessary backfilling, tamping, compacting, and refilling.

B) EXCESS EXCAVATION shall consist of all excavation not designated for embankment or stockpiling on the project and is to be removed from the limits of the project.

C) UNSUITABLE MATERIAL EXCAVATION consists of the removal and disposal of soft, spongy material below the finished grade, either saturated or unsaturated which will not be suitable for foundation material regardless of moisture content, extending downward to firm earth.

200.03 EQUIPMENT

Excavating and grading equipment shall be approved types and designs. Equipment used for disposing of excavated materials outside of the limits of the work shall be such as will avoid scattering or wasting material along the line of haul.

200.04 CONSTRUCTION METHODS

200.04.01– GENERAL

All grass or weeds or other vegetation shall be cut and properly disposed of in a satisfactory manner before the ground is broken for grading and excavation in accordance with Section 204. All existing structures, such as manholes and sewer inlets, which are to remain in place shall be adjusted or rebuilt and care shall be taken not to damage existing structures during grading or construction operations.

After the site of the work has been properly cleared and cleaned, excavation and grading of the roadway shall proceed in conformity with the plans and the specifications.

Rock, boulders, or existing structures which are abandoned, shall be removed to a depth of not less than twelve inches (12”) below the subgrade elevation. Soft, spongy, or other unsuitable material shall be removed to such a depth as may be necessary to permit the preparation of an acceptable subgrade. The determination of unsuitable material shall be

made by the City Engineer. All excavation below subgrade elevation and all excavation material used in embankments shall be backfilled with approved materials, placed in layers not exceeding eight inches (8”) in thickness (loose measure). These layers shall be rolled or tamped, or both, to a density of ninety- five percent (95%) Standard Proctor at ±2% of optimum moisture content. (Per ASTM D698-00a)

For excavated material used to construct embankments, begin placement of material at the low point and place layers in horizontal lifts not greater than eight inches (8”) in thickness up to the final subgrade elevation. Do not construct fills on frozen material or place frozen material in fills. Do not place fill material containing rocks or remnants of pavement greater than three inches (3”) diameter. Construct embankments in accordance with Section 201.

The Unsuitable Material Excavation item will be used if unstable soil is encountered which cannot be stabilized by conventional dewatering operations. The unsuitable material shall be excavated to a depth not to exceed 2-1/2 feet or until stable soil is reached. The area excavated will then be filled with soil or aggregate materials as approved by the City Engineer. The Contractor shall not begin backfilling operations until cross section of the excavation has been determined and approved by the City Engineer.

Care shall be taken not to disturb the ground below the required finish subgrade elevation except for necessary structures, and where provision is made for uniformly scarifying or loosening the ground below subgrade. Excavation outside the curb lines, or beyond the slab edges shall not be made wider than necessary for the setting of the forms or string lines. The finish grade, slopes, and edges of the excavation on all parking, cross street, or private driveway approaches, etc., shall be backfilled where necessary, using approved material thoroughly compacted in layers and dressed off uniformly in a neat and workmanlike manner. Slab edges shall be backfilled for a width of not less than two feet (2’) measured at the level of the top of slab. Ample provision will be always made for completely and readily draining the subgrade and all excavations.

The Contractor shall immediately clean up all material wasted or scattered. The Contractor shall restore all streets, alleys, rights-of-way or other lands, either public or private, damaged or occupied by the Contractor in the performance of the contract, to as good of condition as they were prior to the beginning of the work.

200.04.02 STRUCTURES REMOVED AND SURPLUS EXCAVATED MATERIALS

All structures removed and surplus surfacing materials or excavated materials become the property of the contractor and will be properly disposed of in a manner approved by the City Engineer, unless otherwise specified in the plans or contract. In selecting locations for the disposal of surplus excavated materials the requirements for filling abutting or adjacent property shall be given priority in the order named.

200.05 TESTING – VACANT

200.06 METHOD OF MEASUREMENT

Unless otherwise specified in the plans or contract, the quantity of *Unclassified Excavation* or *Excess Excavation* for which payment will be made shall be the quantity shown on the plans, provided the project is constructed essentially to the lines and grades shown on the plans.

When the plans have been altered, the quantities involved shall be measured from the original plan cross sections. Additional original cross sections may be interpolated or determined by other approved methods at points where necessary to determine the quantities more accurately. When quantity is not specified by the plans, all accepted excavation and borrow shall be measured in its original position by cross sectioning the area excavated. Volume will be computed from one of the following methods:

- Average End Area from Cross-sections. This method calculates the average of the cross-sectional end areas multiplied by the distance between them.
- Original Surface vs. Final Surface (Digital Terrain Model). This method creates three-dimensional surfaces from the original and final surveys' data, triangulating the data points, and calculating the volume between them.
- Three Dimensional Measurements. This method uses acceptable measuring practices to calculate volumes for isolated and unusual locations.

The Contractor and City Engineer will agree each day on the depth, width and linear feet of *Unsuitable Material Excavation*. *Unsuitable Material Excavation* will be the material removed. Replacement material will be measured and paid by the item used to replace the unsuitable material.

200.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) UNCLASSIFIED EXCAVATION	Cubic Yard
(B) UNSUITABLE MATERIAL EXCAVATION	Cubic Yard
(C) EXCESS EXCAVATION	Cubic Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 201 – EMBANKMENT

201.01 DESCRIPTION

This section will cover construction of roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or outside the right-of-way; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits and other depressions within the roadway area, in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the City Engineer. Only approved materials shall be used in the construction of embankments and backfills.

201.02 MATERIALS — VACANT

201.03 EQUIPMENT — VACANT

201.04 CONSTRUCTION METHODS

All grass, weeds, trees, stumps, and existing structures shall be removed in a satisfactory manner from the entire area to be occupied by the embankment. All embankments shall be formed of good sound earth, gravel, or other acceptable materials, and shall be built to sufficient heights and width that after full shrinkage, will conform to the lines, grades and cross sections shown on the plans, or called for in these specifications. Rocks may be placed in embankment provided they are not placed in piles and provided no rock larger than three inches (3”) is placed nearer the finish grade than twelve inches (12”). No sticks, weeds, trash, or other vegetable matter, nor any other unsuitable materials shall be placed in embankments. Embankments shall not be constructed on or of frozen material.

Soft, spongy, or other unsuitable material shall be removed to such a depth as may be necessary to permit the preparation of an acceptable subgrade. The determination of unsuitable material shall be made by the City Engineer. All excavation below subgrade elevation and all embankments shall be placed with approved materials in layers not exceeding eight inches (8”) in thickness (loose measure). Begin placement of material at the low point and place layers in horizontal lifts up to the final subgrade elevation. These layers shall be rolled or tamped, or both, to a density of ninety-five percent (95%) Standard Proctor at ±2% of optimum moisture content. (Per ASTM D698-00a)

All excess or unsuitable excavated material, including rock and boulders larger than three inches (3”) in the largest dimension, that cannot be used in embankments shall become the property of the Contractor and disposed of by him to the satisfaction of the City Engineer.

Embankments constructed of material of which a large portion is rock of such a nature that, in the opinion of the City Engineer, construction in eight-inch (8”) 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 twenty-four inches (24”). 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 of roller or with a vibratory roller as approved by the City Engineer. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. The top twelve inches (12”) of embankment shall be constructed with approved materials, smoothed, and placed in layers not exceeding eight inches (8”) in loose thickness and compacted as specified for embankments.

The surface layer of the entire embankment shall 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 Proctor Density. (Per ASTM D698-00a)

Material in embankments shall be placed in layers not exceeding eight inches (8”) in depth measured when loose and extending the entire width and length of the embankment. Each succeeding layer shall be uniformly spread over the surface, then thoroughly compacted. Areas inaccessible to the roller shall be thoroughly hand tamped until the degree of compaction is equivalent to that of the rolled area. Hand tampers shall have a tamping surface not exceeding twenty-five square inches (25 in2), shall weigh not less than one pound per square inch (1 psi), and shall be of a design approved by the City Engineer.

If the embankment can be deposited on only one side of abutments, wing walls, piers 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.

201.05 TESTING — VACANT

201.06 METHOD OF MEASUREMENT

The quantity of *Embankment* for which payment will be made shall be the quantity shown on the plans, provided the project is constructed to the lines and grades shown on the plans.

When the plans have been altered, the quantities involved shall be measured from the original plan cross sections. Additional original cross sections may be interpolated or determined by other approved methods at points where necessary to determine the quantities more accurately. When quantity is not specified by the plans, all accepted embankment shall be measured in its original position by cross sectioning the area. Volume will be computed from one of the following methods:

- Average End Area from Cross-sections. This method calculates the average of the cross-sectional end areas multiplied by the distance between them.
- Original Surface vs. Final Surface (Digital Terrain Model). This method creates three-dimensional surfaces from the original and final surveys' data, triangulating the data points, and calculating the volume between them.
- Three Dimensional Measurements. This method uses acceptable measuring practices to calculate volumes for isolated and unusual locations.

201.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) EMBANKMENT	Cubic Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 202 – BORROW

202.01 DESCRIPTION

This section covers borrow which consists of required excavation, removal, and proper utilization of materials obtained from designated or approved sources. Compaction of embankments constructed from borrow, as provided herein, shall conform to the requirements of Section 201.

202.02 MATERIALS

Where shown on the plans, selected materials will be utilized in the formation of embankment or to improve the roadbed. Borrow material shall be suitable for the embankment purpose desired, as determined by the City Engineer.

202.03 EQUIPMENT — VACANT

202.04 CONSTRUCTION METHODS

All suitable materials removed from the excavation shall be used, in so far as practicable, in the formation of embankments as required by the governing item for "Embankments" or shall otherwise be utilized as indicated on the plans or as directed, and the completed work shall conform to the established alignment, grades, and cross section. During construction, the borrow sources shall be kept drained, in so far as practicable, and the work shall be prosecuted in a neat and workmanlike manner.

Construct embankments using borrow material in accordance with Section 201.

Payment will not be allowed for excavation for any material which is used for purposes other than those designated, except as provided in the governing specifications under Section 108.04.

Site of the borrow operations shall be left in a suitable and sightly condition, such as to provide proper drainage where practical. Where indicated on the plans, the sides and/or ends of borrow pits shall be sloped to the dimensions indicated on the plans.

202.05 TESTING — VACANT

202.06 METHOD OF MEASUREMENT

The quantity of *Borrow* for which payment will be made will be measured in a compacted condition in its final position and the volume computed from one of the following methods:

- Average End Area from Cross-sections. This method calculates the average of the cross-sectional end areas multiplied by the distance between them.
- Original Surface vs. Final Surface (Digital Terrain Model). This method creates three-dimensional surfaces from the original and final surveys' data, triangulating the data points, and calculating the volume between them.
- Three Dimensional Measurements. This method uses acceptable measuring practices to calculate volumes for isolated and unusual locations.

202.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) BORROW	Cubic Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 204 – CLEARING AND GRUBBING

204.01 DESCRIPTION

This work consists of clearing, grubbing, removing, and disposing of vegetation and debris. This

work includes protecting vegetation specified to remain. This work excludes items specified for removal in accordance with other sections of the Specifications.

204.02 MATERIALS — Vacant

204.03 EQUIPMENT — Vacant

204.04 CONSTRUCTION METHODS

Do not disturb or remove hazardous waste material, archeological or historic material, or human remains or graves without the prior approval of the City Engineer. Immediately notify the City Engineer upon encountering evidence of these items.

Prior to clearing and grubbing operations, install appropriate sediment and erosion control devices. Do not scar, break, or otherwise damage during clearing and grubbing operations directed by the City Engineer, or indicated, to remain. If the Contractor damages these items, the City will assess the value of the damage and any fines or costs to the City against the Contractor. Phase construction in order to limit the amount of ground disturbed at one time. Phase construction in order to limit the amount of ground disturbed at one time.

A. Clearing

Only remove trees as indicated when outside the limits of construction. Within the limits of construction, remove trees except those the City Engineer directs to remain. (The City Engineer's direction regarding the removal of trees within the limits of construction will comply with the “Clear Zone” requirements.) Remove all branches that overhang the roadway. Use experienced workers for tree trimming and pruning.

Remove, bury, burn, or dispose of trees, logs, stumps, brush, and other debris, as approved by the City Engineer when clearing site. When burning material, obey all laws and ordinances. DEQ rule 252:100-13 requires air curtain incinerators to be used in all counties in the Oklahoma City “Metropolitan Statistical Areas” (MSAs). Supervise the fire to avoid endangering the surrounding vegetation, adjacent property, or features specified to remain in the right-of-way.

Obtain the City Engineer’s approval before removing from the right-of-way perishable vegetation and debris that cannot be burned. Dispose of the debris off the Project and outside the view from the Project. Make arrangements with and obtain written permission from the owner of the property intended for disposal of the debris. Provide copies of the property owner agreements to the City Engineer before beginning work outside of the Rights-of-Way.

B. Grubbing

Grub and dispose of stumps and roots within the right-of-way (including channels), except as specified in Subsection 201.04.C, "Preserving Areas Outside of Construction." In channel areas, leave stumps and nonperishable solid objects that extend less than 6 inches above the original ground line or water level.

C. Preserving Areas Outside of Construction

Preserve areas outside the limits of construction (except areas needed for constructing fences or storing topsoil). Do not clear and grub outside the limits of construction except if indicated. If an area within the median lies outside the limits of construction, equipment may cross the median only at points approved by the City Engineer.

The Contractor may use areas outside the limits of construction to store reserved topsoil from areas within the right-of-way. If clearing operations damage areas within the right-of-way, except for topsoil storage, restore the area and obtain the City Engineer's approval at no additional cost to the City.

D. Selective Clearing

This work includes the following activities:

- Trimming selected trees and shrubs (except those directed or shown to remain);
- Removing and disposing of logs, root balls, brush, refuse dumps, and other undesirable debris; and
- Cutting, removing, and disposing of undergrowth, stumps, and standing trees.

Perform selective clearing at locations indicated and as approved by the City Engineer. Dispose of vegetation and debris in accordance with Subsection 201.04.A, "Clearing," and Subsection 201.04.B, "Grubbing." When selecting trees for removal, leave remaining trees from 20 ft to 30 ft apart.

Sever stumps, trees, and shrubs flush with, or below, the original ground line. Remove the stumps of uprooted trees and fill the holes with material approved by the City Engineer.

E. Eastern Red Cedar Removal

The Eastern Red Cedar is an invasive native species of evergreen tree that can tolerate a wide variety of soils, and habitats. It grows ordinarily from 16 to 66 ft tall, with a short trunk 12 to 39 in in diameter. The bark is reddish-brown, fibrous, and peels off in narrow strips.

The seed cones are 0.12 to 0.28 in long, berry-like, dark purple-blue with a white wax cover giving an overall sky-blue color. For more information on Eastern Red Cedars visit: http://oklahomainvasivespecies.okstate.edu./eastern_redcedar.html

Remove all Eastern Red Cedars within the project right-of-way up to, and including the right-of-way line for the project site. For cedars within the project right-of-way, remove the tree so that the stump is flush with the finished slope elevation. For cedars growing on the right-of-way fence line, do not remove the trees without the approval of the City Engineer, and unless the removal can be performed without damaging the right-of-way fence. Repair fence damaged by the removal of the cedars at no additional cost to the City.

Dispose of the cedars in accordance with Subsection 201.04.A, “Clearing,” and in a manner approved by the City Engineer.

204.05 METHOD OF MEASUREMENT — Vacant

204.06 TESTING — Vacant

204.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CLEARING AND GRUBBING	Lump Sum
(B) SELECTIVE CLEARING	Lump Sum

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

Include the cost of disposing of debris outside the right-of-way in the contract unit price for Clearing and Grubbing or Selective Clearing.

If a pay item for Clearing and Grubbing or Selective Clearing does not exist, include the cost of the work in the appropriate earthwork or fencing pay item in accordance with the Plans.

Include the cost of Eastern Red Cedar removal in the cost bid for Clearing and Grubbing. If no pay item exists within the contract for clearing and grubbing, include the cost of removal in other items of work.

SECTION 205-SALVAGING TOPSOIL

205.01 DESCRIPTION

This work consists of salvaging natural topsoil from areas of excavation and embankment, stockpiling, and replacing material on the completed areas for revegetation as indicated or as directed by the City Engineer.

205.02 MATERIALS

Topsoil. Soil consisting of vegetative matter and grass roots, or exhibiting other characteristics common to surface soils. In all cases, the top inch of the soil surface shall be a part of the salvaged material.

205.03 EQUIPMENT — Vacant

205.04 CONSTRUCTION METHODS

Clear brush, rock, shale, or other deleterious material from topsoil salvage areas indicated. Mow weeds and grasses more than 1 ft tall and incorporate into the topsoil. Excavate the topsoil and stockpile at areas approved by the City Engineer. Stockpiles shall be at least 50 feet from a stream or river depicted as blue on the USGS 7.5 Minute Quadrangle Map. Topsoil depths and quantities indicated are approximate; remove all topsoil from salvage areas.

Replace contaminated or lost topsoil with an equivalent, City Engineer approved material, at no additional cost to the City.

A. Type A Salvaged Topsoil
    - Type A salvaged topsoil consists of the following:
    - Removing existing, untreated topsoil;
    - Storing the topsoil in a stockpile; and
    - Placing the topsoil on prepared slopes as indicated or directed by the City Engineer.

Finish the roadway excavation and embankment areas as indicated or as directed by the City Engineer. Before placing the salvaged topsoil, apply fertilizer of the type and at the rate indicated.

Spread the salvaged topsoil to a depth of 5 in, unless otherwise directed by the City Engineer.

205.05 TESTING — Vacant

205.06 METHOD OF MEASUREMENT

The City Engineer will measure *Type A Salvaged Topsoil* in a stockpile. The City Engineer will not subtract measured quantities of *Type A Salvaged Topsoil* from excavation, embankment or borrow quantities. If the Plans show *Type A Salvaged Topsoil* as a lump sum pay item, the volume of salvaged topsoil will not be measured.

Include *Type A Salvaged Topsoil* 50 percent complete when the material has been removed from its original location and stockpiled; and 100 percent complete when the material has been placed in its final location.

205.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) TYPE A SALVAGED TOPSOIL	Lump Sum or Cubic Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

Additional handling of Type A Salvaged Topsoil will not be measured for payment and no additional compensation will be considered.

SECTION 211 – DEWATERING

211.01 DESCRIPTION

This section covers dewatering of trenches, pits, and all other excavation areas. The Contractor shall provide and maintain ample equipment with which to remove all water from every source that enters excavations for structures and pipelines. Dewatering operations shall ensure dry excavations and preservation of the elevations of excavation bottoms shown in the plans. Surface drainage shall not be allowed to enter excavated areas.

Where areas to be excavated are located under water surfaces or near banks of flowing streams or other bodies of water, the Contractor may adopt and carry out any method of dewatering he may deem feasible for the performance of excavation work and for protection of the work thereafter, if method and equipment to be used results in completed work which complies with the specifications and is acceptable to the City Engineer. In such cases, the excavation areas shall be effectively protected from water damage during the excavation period and until all contemplated construction work therein has been completed.

Prior to beginning excavation for pipes and structures, which are to be constructed at or below the ground water table, groundwater levels shall be lowered and maintained at a level at least two feet (2') below the bottom of trench or such structures until construction and backfilling operations have been completed.

The Contractor shall be responsible for damage to structures caused by hydrostatic displacement during construction operations.

211.02 MATERIALS — Vacant

211.03 EQUIPMENT — Vacant

211.04 CONSTRUCTION METHODS

211.04.01 SUBMITTALS

When requested by the City Engineer, the Contractor shall submit the following, but not limited to, for review and approval:

- Proposed dewatering method.
- Well and pump layout, and depth of penetration.
- Points of discharge.

211.04.02 – METHODS

A) Bailing, Sump, or Trench Pumping - For trench or structural excavations, and for small quantities of water, a sump or trench pump may be used to pump excess water from the low end of the excavations. When, as determined by the City Engineer, soil conditions are such that dewatering may readily be accomplished by ordinary bailing and use of trench pumps, well systems shall not be used.

B) Well Systems - When required, the Contractor may utilize the following methods of dewatering:

- Deep Pumped Wells Method - In locations where the water table is deep, pumped filtered wells may be used for lowering the water level or for controlling artesian pressures in aquifers beneath excavations.
- Well Points Method - Well points are small-diameter wells with one or more slotted or screened sections of pipe attached to riser pipes that are connected through swing joints to header pipes. Where a single row of well points is not enough to lower the water level adequately, then two (2) or more rows of well points shall be used as directed by the City Engineer.
- Vacuum Method - Soils that are too fine-grained for gravity drainage may be dewatered by application of a vacuum to filters surrounding well points.
- Electroosmosis Method - Dewatering of soils by electro osmosis may be achieved by installing a line of metal well points serving as negative electrodes to attract water and allow it to be removed by suction and a line of rods serving as cathodes.

211.05 TESTING — Vacant

211.06 METHOD OF MEASUREMENT

A. Dewatering trenches using a well system shall be measured as the length of trench dewatered plus twenty feet (20') from each end well, or forty feet (40') for one well.

B. Dewatering of excavations using a well system shall be measured as the length of the perimeter of the structure such as clarifiers or basins.

C. Dewatering for pits and/or shafts excavated for construction operations such as those needed for trenchless construction methods shall be measured per length of pit along the line.

D. All dewatering performed using bailing and trench or sump pumping shall be considered incidental work and NOT be paid for directly but shall be included in the cost of other items.

211.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) DEWATERING	Linear Foot

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 212 – TRENCH EXCAVATION AND BACKFILL

212.01 DESCRIPTION

This section covers trench excavation for pipelines and consists of excavation necessary for construction of all underground work and all appurtenant facilities, including site preparation, placement of embedment material, backfilling, and compaction of pipe trenches and around structures and disposal of waste materials, all of which shall conform to the applicable provisions of these specifications.

Trench excavation shall be made in open-cut and true to the lines and grades shown on the plans or established by the City Engineer.

212.02 MATERIALS — Vacant

212.03 EQUIPMENT — Vacant

212.04 CONSTRUCTION METHODS

212.04.01– EXCAVATION IN ADVANCE OF CONSTRUCTION

The length of trench excavated approximately to grade shall not exceed one hundred-fifty feet (150') and no trench excavation whatsoever shall be made farther than three hundred feet (300') in advance of completed backfill.

212.04.02– TRENCH WIDTHS

A) General - Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, joining, and embedment. Stipulated minimum trench widths are not minimum average widths but are minimum widths that shall be required. Stipulated maximum trench widths shall not be exceeded. Trench width shall be the width of the trench excavation measured from bank to bank at the top of the pipe. For rigid pipes, when the

maximum trench width is exceeded, the Contractor shall be required to provide a higher strength pipe or higher bedding classification, singly or in combination as directed by the City Engineer, at the Contractor's expense. Any additional foundation material and/or embedment material required due to over-excavation, beyond the maximum trench width shall be at the Contractor's expense. Minimum and maximum permissible trench widths shall be as shown in table below.

Table 212:1
Minimum and Maximum Trench Widths

Pipe Nominal Size (Inches)	Minimum Trench Width (Feet)	Maximum Trench Width (Feet)
≤12*	3.00	5.00
18	3.25	5.00
21	3.75	5.25
24	4.00	6.00
30	4.50	6.75
36	5.25	9.00
42	6.25	9.50
48	7.00	10.00
54	8.00	10.50
60	9.00	11.00
64	9.75	11.50
66	9.75	11.50
72	10.50	12.00
78	10.50	12.50
84	11.00	13.00
90	11.50	13.50

*Pipe underdrain only

B) Trenches Requiring Sheeting and Shoring - Where trenches are excavated in soil of such nature as to require sheeting and shoring to assure proper installation, and safety of the workmen and any adjacent structures or other objects, the Contractor shall provide the necessary sheeting and shoring. Where possible, shields designed to be portable and moved along as work progresses may be used. The contract pay widths shown in the above shall apply to all trenches with or without sheeting or shoring.

C) Trenches With Stepped Sides - Where the work is in open areas, if the right-of-way is of sufficient width and soil conditions are suitable, the Contractor may at his option, upon approval of the City Engineer, excavate trenches with sloping or stepped sides provided that no additional compensation for excavation and backfilling will be allowed for work performed outside the maximum trench widths designated in the above Table.

D) Trenches at Tunnels - Where the water line is in a tunnel, the trench excavation shall be measured to the faces of the tunnel.

E) Excavation for Valve Boxes and Other Waterline Structures - When structural excavation is listed as a separate pay item, excavation for valve boxes and other waterline structures shall be computed in cubic yards using dimensions of the net prescribed area outside trench width excavation where the length of trench is measured through or partially through structures. When structural excavation is not listed as a pay item, cost shall be included in the cost of other items.

F) Exterior forms with or without sheeting and shoring are used, the excavation shall be computed for a width five feet (5') greater than the exterior dimension of the structure.

G) Excavation for Trenchless Construction Methods - Excavation shall be considered a part of the trenchless work per linear foot and shall not be paid for separately.

Any sheeting, shoring, bracing, or sheet piling left in place, in conformity with the plans and specifications or as directed by the City Engineer, shall be paid for separately.

212.04.03 PERFORMANCE REQUIREMENTS

A) General Excavation - Excavation shall be made in open-cut from the surface of the ground and shall be made no larger than necessary to permit proper construction of the work in accordance with the plans and specifications. The entire foundation area in the bottom of all excavations shall be firm, stable and of uniform density as nearly as practical, and unless necessary, materials shall not be disturbed below grade. Where trenches are excavated in soft, unsuitable materials, or rock, trench bottom may be stabilized in accordance with Section 200.04.01, when directed by the City Engineer. Where depth of trenching and other excavations is greater than twenty feet (20’), and when not provided for in the plans, an engineer shall be retained by the Contractor to design bank protection as per OSHA rules and regulations. The bank protection design, signed and sealed by a Professional Engineer registered in the State of Oklahoma, shall be submitted to the City Engineer for approval.

B) Sheeting, Shoring, Bracing and Sheet Piling - The sides of all excavations shall be sufficiently sheeted, shored and braced to prevent slides, cave-ins, settlement, or movement of the banks. In wet, saturated, or flowing ground where it is necessary to install tight sheeting or cofferdams, wood or steel sheet piling of approved design and type shall be used. All sheeting, shoring, and bracing shall have sufficient strength and rigidity to withstand the pressures exerted and maintain the walls of the excavation properly in place and protect all persons or property from injury or damage. When excavations are made adjacent to existing buildings or other structures, or in paved streets or alleys, particular care shall be taken to adequately sheet, shore, and brace the sides of the excavation to prevent any undermining of or settlement beneath the structures or the pavement. Underpinning of adjacent structures, when necessary, shall be done in an approved manner. The foundation material that is undermined shall be replaced and compacted in accordance with the requirements of this section. Sheeting, shoring, and bracing shall not be left in place unless otherwise shown on the plans or authorized by the City Engineer. The removal of sheeting, shoring, and bracing shall be done in such a manner as not to endanger or damage either the new structure or any existing structure or property, either private or public, and to avoid

cave-ins or sliding of the banks. If for any reason the Contractor, with the approval of the City Engineer, leaves in place any sheeting, shoring, or bracing, no payment will be allowed for such material left in place unless it is classified as a contract pay item. All holes or voids left by the removal of sheeting, shoring, or bracing shall be satisfactorily filled and compacted in accordance with the requirements of this section.

C) Pumping, Dewatering and Draining - The Contractor shall remove immediately any surface or seepage water or water from sewers, drains, creeks, or other sources which may accumulate during the excavation and construction work by doing the necessary pumping, dewatering, or draining by ditch or other means. The Contractor shall always have available sufficient equipment in proper working order for doing the work herein required. All water removed from excavations shall be disposed of in an approved manner so as not to create unsanitary conditions nor to cause injury to persons or damage to the work in progress or to other property, either public or private, nor to interfere unduly with the use of streets, alleys, or of private drives and entrances.

D) Disposal of Excavated Materials - Excavated materials, so far as needed and of a suitable character, shall be piled adjacent to the work to be used for backfilling as required. Excavated materials unsuitable for backfilling or more than that required for backfilling shall be disposed of in an approved manner at locations designated or approved by the City Engineer. Desirable topsoil, sod, etc., shall be carefully piled separately from other excavated materials so that it can be replaced to its original position when required. Excavated materials shall be always handled in such a manner as to cause a minimum of inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the line of the work.

212.04.04 BACKFILLING

A) Description - Backfill is that portion of the total trench backfill down to but not including the pipe embedment material. The backfill shall be only material approved by the City Engineer consisting of loose earth, free of clods, stones, organic matter, debris, or other objectionable materials. Backfill of trenches beneath the limits of the pavement shall be done using aggregate material in accordance with City Standard Details the full depth of the trench up to the top of the subgrade elevation.

All backfilling shall be done in such a manner as not to disturb or injure the pipe or structures over or against which it is being placed. Any pipe or structure injured, damaged, or moved from its proper line or grade during backfilling operations shall be opened and repaired and then re-backfilled as herein specified.

The placing of backfill material shall not begin until approval for so doing has been given by the City Engineer, but backfilling about structures or portions of structures shall be done immediately when so ordered by the City Engineer. The top surface or slopes of all backfill shall be neatly graded off where select topsoil, sod or other material is removed and piled separately; such material shall be carefully replaced in a manner satisfactory to the City Engineer. The top twelve inches (12”) of backfill material shall be of as good quality as the original topsoil that was removed.

B) Compaction Requirements - All backfill shall be placed and compacted in eight-inch (8”) lifts for hand-tamped equipment and for self-propelled or power-driven

equipment to the following minimum percent of Standard Proctor Density or Relative Density as determined by ASTM D-698, "Tests for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures".

Cohesive backfill material shall reach the indicated compaction levels at plus or minus (±) three percent (3%) of optimum moisture content. The lift thickness shall be reduced, if necessary, to meet the compaction requirements specified herein.

Table 212:2
Minimum Compaction Requirements

General Location	Percent Compaction (%)
	Standard Proctor Test (ASTM D-698)
Under Traffic Area or Improved Existing Surfaces	95
Urban and Residential Areas	90
Undeveloped and Other Areas	85

C) Compaction Methods - Compaction methods may vary depending on the material or as approved by the City Engineer.

1. Cohesive Materials - Compaction of cohesive materials may be obtained by use of impact type equipment. In confined areas, pneumatic tampers and engine driven rammers may also be used. In relatively narrow trenches, self-propelled rammers may be used. In wide trenches, sheepsfoot rollers may be used.

2. Cohesionless Materials - Cohesionless materials are granular materials classified as non- plastic. In general, vibratory equipment may be used for proper compaction. In confined areas, vibratory plates may be used. For wider trenches, vibratory rollers may be used.

3. Flooding (Jetting) - When approved by the City Engineer, backfill materials may also be compacted or settled by flooding where adequate quantities of water are available from the City's water system, privately owned ponds, creeks, or other sources located within three hundred feet (300') of the trench. Water shall be used to produce a semi-fluid mass, but an excessive amount shall not be used which may cause flowing of the mass along and out of the trench at stream crossings or other places of abrupt changes in ground profile. The Contractor shall make necessary arrangements with the City for purchase of water from the City mains, and with owners for water procured from privately owned sources.

   No additional compensation shall be allowed the Contractor for settling the backfill by flooding. The cost of such work shall be absorbed in the unit bid price for trench excavation and backfill or other pay units the Contractor may elect.

D) Testing of Backfill - All backfill shall be tested by an approved laboratory for compliance of the compaction requirements given in these specifications.

E) Surface Restoration - Upon completion of backfill, the Contractor shall replace all surface materials and shall restore paving, curbing, sidewalks, gutters, shrubbery, fences, sod, and other surfaces disturbed to a condition equal to that before the work began, furnishing all labor, tools, equipment, materials, and incidentals

thereto as provided elsewhere in these specifications.

212.05 TESTING — Vacant

212.06 METHOD OF MEASUREMENT

General - Bid prices for *Trench Excavation and Backfill* and *Structural Excavation* shall be full compensation for all labor, materials, tools, equipment, and incidentals necessary to complete the work in accordance with the plans and these specifications.

Trench Excavation and Backfill (LF) - The Contractor shall be paid for *Trench Excavation and Backfill* on a linear foot basis for depths from zero feet (0') to ten feet (10'), zero feet (0') to fifteen feet (15') , zero feet (0') to twenty feet (20'), zero feet (0') to twenty-five feet (25') , and zero feet (0') to thirty feet (30') . The price established shall be full compensation for *Trench Excavation and Backfill*, and shall include all necessary sheeting, shoring, bracing and incidental dewatering, pumping, draining, and disposition of any surplus excavated material not needed unless otherwise provided.

Trench Excavation and Backfill (CY) - When classified as a pay item, *Trench Excavation and Backfill* shall be paid for on a cubic yard basis. The price established shall be full compensation for all necessary dewatering, sheeting, shoring, excavation and backfilling and disposal of surplus material. When not classified as a pay item, it shall be included in the cost of other items in accordance with the plans..

Trench, Lineal Measurement - For the purpose of determining pay quantities, trenches shall be measured through valve boxes and similar structures, based on the applicable width of trench for size of waterline under consideration unless otherwise designated. Should size of waterline change at a valve or other structure, the appropriate width of trench for each size shall apply, with the consideration for the purpose of ascertaining pay quantity, that the change of size takes place at the centerline of the valve or structure.

Structural Excavation - When classified as a pay item, *Structural Excavation* shall be paid for on a cubic yard basis. The price established shall be full compensation for all necessary dewatering, sheeting, shoring, excavation and backfilling and disposal of surplus material. When not classified as a pay item, it shall be included in the cost of other items.

212.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) TRENCH EXCAVATION & BACKFILL – 0' TO 10'	Linear Foot
(B) TRENCH EXCAVATION & BACKFILL – 0' TO 15'	Linear Foot
(C) TRENCH EXCAVATION & BACKFILL – 0' TO 20'	Linear Foot
(D) TRENCH EXCAVATION & BACKFILL – 0' TO 25'	Linear Foot
(E) TRENCH EXCAVATION & BACKFILL – 0' TO 30'	Linear Foot
(F) TRENCH EXCAVATION & BACKFILL	Cubic Yard
(G) TRENCH LINEAL MEASUREMENT	Linear Foot
(H) STRUCTURAL EXCAVATION	Cubic Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications. In the absence of this Pay Item in a contract, the cost shall be considered incidental, and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 213 – CRUSHED ROCK FOUNDATION

213.01 DESCRIPTION

This section covers proper treatment of unsuitable and soft foundation materials. A crushed stone mat shall be provided for waterline support where directed by the City Engineer. Stone shall be hand or mechanically tamped to obtain a firm support.

213.02 MATERIALS

Gravel containing rounded aggregates shall not be acceptable for this work. The aggregates for crushed rock pipe foundation shall be a uniformly graded crusher run material meeting the following gradation requirements:

Table 213:1
Crushed Rock Foundation Gradation Requirements

Nominal Sieve Sizes	Percentage Passing
2 inches	100%
½ inch	< 30%

213.03 EQUIPMENT — Vacant

213.04 CONSTRUCTION METHODS

The crushed stone mat shall be six (6") to twelve inches (12”) thick and shall be hand or mechanically tamped to obtain a firm support.

213.05 TESTING — Vacant

213.06 METHOD OF MEASUREMENT

Measurement for *Crushed Rock Foundation* shall be per cubic yard or ton. The price established shall be full compensation for furnishing and placing of all materials, labor, tools, equipment, and any incidentals necessary to complete this item of work.

213.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CRUSHED ROCK FOUNDATION	Cubic Yard
(B) CRUSHED ROCK FOUNDATION	Ton

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 215 – EMBEDMENT MATERIAL

215.01 DESCRIPTION

This section covers furnishing and placement of material for embedment of both rigid and flexible pipes. The embedment is that material to be placed from a minimum of six inches (6”) below bottom of the pipe to the spring line (half pipe diameter) or to a minimum of twelve inches (12”) above top of pipe for rigid and flexible pipes, respectively. The remaining material to be placed over the embedment is considered backfill. Refer to Section 505.04.01 of these Specifications for Ductile Iron Pipe Embedment Material requirements used in waterline construction.

215.02 MATERIALS

General - Embedment material shall meet the requirements Aggregate Base Type A in accordance with the applicable City Standard Details, unless otherwise specified in the plans or contract.

215.03 EQUIPMENT — Vacant

215.04 CONSTRUCTION METHODS

Compaction Requirements - All embedment material shall be placed and compacted in six-inch (6”) lifts to the following minimum percent of Standard Proctor Density or Relative Density as determined by ASTM D-698, "Tests for Moisture-Density Relations of Soil-Aggregate Mixtures.”

Table 215:1
Embedment Material Compaction Requirement

Compaction Test	Compaction Requirement
Minimum Standard Proctor Density	95%

Compaction Methods - All embedment materials shall be compacted in accordance with the methods described in Section 212.04.04.

215.05 TESTING

All embedment material shall be tested by an approved laboratory for compliance of compaction requirements given in Section 212. Following acceptance of compaction, the Contractor may proceed with placing remaining backfill.

215.06 METHOD OF MEASUREMENT

The unit price for *Embedment Material* shall be based on the volume or tonnage of material used. Contractor shall submit material delivery tickets and shall be verified by the City Engineer. The price established shall be full compensation for furnishing and placing of all materials, labor, tools,

equipment, and incidentals necessary to complete this item of work.

215.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CRUSHED ROCK FOUNDATION	Cubic Yard
(B) CRUSHED ROCK FOUNDATION	Ton

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

In the absence of these Pay Items in a contract, the cost shall be considered incidental, and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 220 – SUBGRADE

220.01 DESCRIPTION

This work consists of preparing the existing materials for the immediate construction of subbase, base, pavement, or surface.

220.02 MATERIALS — VACANT

220.03 EQUIPMENT

The vehicle used for proof rolling must have a minimum axle load of 17,000 lbs and pneumatic-tires. Obtain approval of the proposed equipment prior to use. Certified weight of the vehicle must be submitted upon request.

220.04 CONSTRUCTION METHODS

The Contractor shall proof roll the completed subgrade prior to the start of paving operations and prior to the density tests. The entire subgrade surface shall be proof rolled at a walking speed so that the construction inspector can mark the areas requiring remedial measures.

A) Subgrade Method A for Traffic-Bound Surface Course

   Shape and crown the width of the existing roadbed with a blade grader to the grade shown on the Plans. Complete the cross section to at least a 2 percent crown or as directed by the City Engineer.

   Remove unstable soil and exposed rocks larger than 3 inches and replace with acceptable material. Finish each subgrade layer to a smooth, uniform surface and maintain this condition until placement of the succeeding layer.

B) Subgrade Method B for All Other Subbases, Bases, Pavement, or Surface

Scarify or process the subgrade to create uniform moisture to a depth of 8 inches

Shape the subgrade with material as directed by the City Engineer in rock cuts that cannot be scarified or otherwise processed.

Pulverize the loosened soil and compact the top 8 inches uniformly to a maximum density of at least 95 percent in accordance with Subsection 201.04, “Construction Methods.”

Provide subgrade material with moisture content within 2 percentage points of optimum, in accordance with AASHTO T 99 unless approved by the City Engineer. Use mechanical tampers to compact sections of the subgrade inaccessible to rolling equipment.

Finish the subgrade in accordance with the plans. Test the subgrade to ensure it meets the Contract and correct deficiencies before placing the succeeding course.

Excavate unstable material below the top 12 inches of the subgrade and backfill with acceptable material to the subgrade elevation in accordance with Subsection 202.04, “Construction Methods,” and as approved by the City Engineer.

Correct or remove and aerate unstable material due to excess moisture in the top 12 inches of the subgrade at no additional cost to the City.

C) Proof Rolling

Roll the full width of the grading section as directed by the City Engineer. Operate the roller at walking speed and in the presence of the construction inspector. Ensure the rolling equipment can turn without damaging the area being tested.

220.05 TESTING — VACANT

220.06 METHOD OF MEASUREMENT

Subgrade Method A and *Subgrade Method B* will be measured by the square yards of processed subgrade completed-in-place. *Proof Rolling* will be measured by the square yards of subgrade tested and authorized by the City Engineer.

220.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) SUBGRADE METHOD A	Square Yard
(B) SUBGRADE METHOD B	Square Yard
(C) PROOF ROLLING	Square Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

The City will pay for this pay item once for work performed on the subgrade as defined in Subsection 101.02, “Definitions,” regardless of the work necessary to stabilize the subgrade as all subbases or base courses are placed on the subgrade.

If excavation (beyond machine drifting) is necessary to complete the subgrade to the elevations

shown on the Plans, the City will pay for this work as the appropriate earthwork pay items in accordance with Section 202, “Earthwork.” The City will pay for additional material needed to finish the subgrade to the elevations shown on the Plans as the appropriate earthwork pay items in accordance with Section 202, “Earthwork.”

In the absence of these Pay Items in a contract, the cost shall be considered incidental, and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 222 – SUBGRADE STABILIZATION

222.01 DESCRIPTION

This work shall consist of furnishing, placing, and compacting one or more courses of a mixture of soil, a stabilization additive 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 City Engineer for the purpose of increasing the shear strength of subgrade soil. Stabilization additives for the purposes of this specification will be defined as cementitious additive (Portland Cement, fly ash or cement kiln dust) or lime.

222.02 MATERIALS

Materials shall meet the requirements specified in Section 900 - Materials.

Hydrated Lime	906.01
Quick Lime	906.02
Fly Ash	902.01
Portland Cement	901.02
Cement Kiln Dust	902.03
Water	901.04

Any cementitious additives shall be stored in a suitable, weather-tight building or compartment which will (1) protect it from dampness and (2) permit easy access for proper inspection and identification of each shipment. Do not mix cementitious additives from different sources in storage. Cementitious additives shall not be used if for any reason it has become partially set or if it contains hard lumps or cakes.

The lime shall be stored in a suitable, weather-tight building or compartment, which will (1) protect it from dampness and (2) permit easy access for proper inspection and identification of each shipment. Lime shall not be used if for any reason it has become partially set or if it contains hard lumps or cakes. Do not mix limes from different sources in storage, even though they have been tested.

222.03 EQUIPMENT

Provide a pulver mixer with a spray bar in the mixing chamber capable of producing a soil-additive mixture with a moisture content within the specified range. Use the following compaction equipment necessary to achieve uniform density across the subgrade as the type of material and conditions require:

- Non-vibratory steel-wheeled roller,

- Vibratory roller,
- Pneumatic tired roller,
- Tamping type compactor, or
- Any combination of the above equipment or equipment approved by the City Engineer

222.04 CONSTRUCTION METHODS

A) General. The primary requirement of these Specifications is to secure a completed course of stabilized material containing a uniform mixture of soil, stabilization additive, and water:
   - 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 this work, to use the prescribed amount of stabilization additive, to maintain the work, and to rework the courses as necessary to meet the above requirements.

B) Weather Limitations. Stabilization additives shall not be applied unless the air temperature is at least 40º F and rising. The air temperature shall be taken 4 feet above the ground in the shade and away from artificial heat. Stabilization additives shall not be applied when any portion of the ground is frozen. The Contractor shall be responsible for the protection and quality of the stabilization additive and stabilized subgrade under any weather conditions.

C) Preparation of Existing Roadbed. Prior to beginning any subgrade stabilization, 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 City Engineer. The subgrade shall be rolled in a manner approved by the City Engineer, and any soft areas revealed by this rolling shall be corrected.

D) Scarifying and Loosening. Scarifying and loosening may be required prior to the application of stabilization additive to achieve the desired results as determined by the City Engineer. The Contractor shall take precautions to avoid forming furrows of loosened material below the depth specified for the bottom of the stabilized subgrade. Except by special permission from the City Engineer, the length of roadway scarified and loosened at any time shall not exceed the length in which the mixing with stabilization additive can be completed in two calendar days. In subgrade extents designated on the Plans or by the City Engineer as having excessive rock—the dimensions or quantities of which 25 percent or more are greater than 2 ½ inches (63 mm) in size, making compliance with these Specifications impractical—the City Engineer may waive certain portions of the work as described below. The City Engineer may require exploratory scarifying by the Contractor before designation of extents for which full compliance of these Specifications is waived.

E) Application.

   General. The type and proportion of stabilization additive indicated on the plans is approximate. The type and the final rate of application of stabilization additive ultimately used shall be based on tests of the subgrade soil. The tests of the subgrade soils shall be performed by the City. However, with the approval of the City Engineer the Contractor has the option of having the tests performed by a laboratory approved by the City in

accordance with the City policy for soil stabilization at no additional cost to the City. The stabilization additive shall be applied at the rate prescribed by the City Engineer based on tests of the subgrade soil.

The Contractor may propose the use of a cementitious additive that was not specified on the Plans as a substitute, by submitting a proposal to the City Engineer for review and approval. The proposal must include test results performed by a laboratory approved by the City in accordance with the City policy for soil stabilization, the recommended application rates from those test results for the planned and proposed additives, and the cost comparison of the planned and proposed additives. Approval of the City Engineer must be obtained prior to any substitution for the planned additive. Chemical additive options for various soil types must be incorporated at the application percentages specified in ODOT Test Method OHD L-50.

The Contractor shall provide equipment necessary for proper control of the application rate of stabilization additive. Where tests indicate a significant change in the subgrade soil, the City will establish a new application rate as deemed necessary for the section of road affected prior to the Contractor placing and spreading the stabilization additive.

1. Application of Cementitious Additive. Dry methods of application shall be used for placement of the cementitious additive onto the subgrade. Equipment for spreading shall be approved types which demonstrate the ability to distribute cementitious additive uniformly.

   Cementitious additive by the slurry method is allowed (See Section 223). Cementitious additive shall not be placed on wet subgrade or otherwise allowed to become wet during application prior to mixing. Dry cementitious additive shall not be applied when wind conditions are such that blowing cementitious additive becomes objectionable to traffic or adjacent property owners. Cementitious additive shall be placed only on that area of roadway where mixing, compaction, and finishing can be completed in the same day. During the interval of time between application and completion of the first mixing operations, cementitious additive that has been exposed to weather conditions resulting in wetting or excessive loss by blowing will not be accepted for payment, and cementitious additive unacceptable as the result of wetting shall be removed from the project.

   Specific extents of the subgrade may require modification with lime as a pretreatment to lower the plasticity index of the subgrade soils to below 20 prior to the application of a cementitious additive. The lime pretreatment shall be performed to the depth and at the rate prescribed by the City Engineer based on tests of the subgrade soil. Application of lime for pretreatment shall be in accordance with the application of lime as described in Subsection 222.04.

2. Application of Lime. Lime shall not be applied when wind conditions are such that blowing lime becomes objectionable to traffic and adjacent property owners. Equipment for spreading shall be approved types which demonstrate the ability to distribute lime uniformly. When lime is applied to the soil ahead of the mixing equipment, 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 six hours or more may not be accepted for payment; in addition, payment will not be made for lime loss due to excessive washing or blowing.

   i. Dry Method.

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 uniformly in controlled amounts.

2. Hydrated Lime. Bagged hydrated lime may be used for dry-method application only under unusual circumstances, i.e., when it would be impossible or impracticable to use other methods and only upon written approval of the City Engineer and provided that all applicable Federal, State, and local laws are met. The bagged lime shall bear the manufacturer's certified weight.

ii. Slurry Method. Lime shall be mixed with water into a slurry by either of the following methods.

1. Central Plant. Mixing shall be accomplished through integral paddles, recirculating pumps, or other devices that will meet mixing requirements. 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. 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 truck shall be equipped with a pump, regardless of the type of mixing method used. The slurry will be applied through the spray bars under pressure to assure a uniform flow and distribution.

The slurry produced by either method shall consist of a minimum mixture of approximately 1 ton of lime to each 500 gallons of water and shall not contain more than 40 percent lime. Use of compressed air for mixing will not be permitted.

F) Mixing.

General. Mixing of the stabilization additive with the subgrade soil shall follow application and spreading as a continuous construction operation. Work areas for mixing shall not exceed the amount that can complete the mixing operation during the same day that the additive is applied, unless otherwise authorized by the City Engineer.

1. Single Mixing for Cementitious Additive Stabilization: The Single Mixing procedure shall be as hereinafter described for soils classified as Groups A-1 and A-3 in AASHTO M145 soil classification. The Double Mixing procedure described in Subsection 222.04(f)(2) may be allowed at the Contractor's option for these soil classifications.

i. Mixing. Unless authorized by the City Engineer, the pulver mixer shall be equipped with a spray bar in the mixing chamber that can inject enough water to produce a soil- cementitious additive mixture with a moisture content within the specified range in a single pass of the mixer. The quantity of water necessary for the mixing will vary with the nature of materials, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture content for maximum

density of the compacted soil-cementitious additive mixture. All clods shall be reduced in size by mixing until the soil cementitious additive mixture meets the following size requirements when tested dry by laboratory sieves:

Table 222:1 Soil-Additive Mixture Gradation	
Sieve Size	Percentage Passing
1 ½ inch	100%
¾ inch	50 minimum

Cementitious additive shall be added, and the section shall be repulverized at the correct moisture content to any portion of the work area that the cementitious additive has hydrated prior to compaction at the contractor's expense, unless waived by the City Engineer.

ii. Additional Mixing. The specified degree of pulverization and the specified range of the moisture content of the mixture shall be achieved in the initial mixing of the cementitious additive or a second pass with a pulver mixer will be required. The pulver mixer shall be equipped to add additional water, if required. Cementitious additive shall be added, and the section shall be repulverized at the correct moisture content to any portion of the work area that the cementitious additive has hydrated prior to compaction at the contractor's expense, unless waived by the City Engineer.

2. Double Mixing for Cementitious Additive Stabilization: The double mixing procedure shall be as hereinafter described for soils classified as Groups A-2, A-4, A-5, and A-6 in AASHTO M145 soil classification. The Single Mixing procedure described in Subsection 222.04(e)(2) may be allowed only after approval by the City Engineer for these soil classifications if the mixing can be properly performed by using special equipment or construction methods proposed by the Contractor.

   i. First Mixing. The moisture content of the subgrade soil shall not exceed 80 percent of the optimum moisture as determined by AASHTO T-99 at the time of first mixing. The soil and cementitious additive shall be mixed until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2 ½ inches (63 mm) diameter size. The addition of water will not be permitted during the first mixing. First mixing operations shall begin no later than 4 hours after the application of cementitious additive. When deemed necessary by the City Engineer, any portion of the area shall be rescarified and additional cementitious additive added to ensure adequate soil stabilization. The cementitious additive and soil shall be thoroughly mixed prior to the beginning of final mixing operations.

   ii. Final Mixing. After the soil and cementitious additive have been satisfactorily mixed, water shall be added during the final mixing operations to initiate the soil cementitious additive reaction. Water shall be sprinkled or sprayed as a mist onto the subgrade in a manner that produces a uniform coverage. The method of mixing shall be an approved procedure utilizing traveling mixing equipment that demonstrates uniform dispersion of cementitious additive and water throughout the soil. Sufficient water shall be added in the final mixing process to ensure chemical reaction between

cementitious additive and soil. The quantity of water necessary for the final mixing operations will vary with the nature of the materials, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture content of the compacted soil-cementitious additive mixture. All clods shall be reduced until the soil-cementitious additive mixture meets the following size requirements when tested dry by laboratory sieves:

Table 222:2 Soil-Additive Mixture Gradation	
Sieve Size	Percentage Passing
1 ½ inch	100%
¾ inch	50 minimum

iii. Double Mixing for Lime Stabilization: The mixing procedure shall be as hereinafter described.

1. First Mixing. The Contractor shall mix the soil, lime, and water until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2 ½ inches (63 mm) diameter size. The quantity of water necessary for the first mixing operation will vary with the nature of the material, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture content of the compacted stabilized soil. Sufficient water shall be added in the first mixing process to insure proper chemical reaction between the lime and soil. When proper mixing has been accomplished, the mixture shall be allowed to cure. Curing time when hydrated lime is used shall be 72 hours at ambient temperatures above 40º F. Curing time when quick lime is used shall be 48 hours at ambient temperatures above 40º F. Curing time when byproduct lime is used shall be 60 hours at ambient temperatures above 40º F.

   During the curing period, the material shall be maintained in a moist condition. The surface of the stabilized area shall be sealed by light rolling to the extent that the surface will repel water and contain the moisture. When deemed necessary by the City Engineer, the Contractor shall re-scarify any portion of the area under stabilization for additional sprinkling to insure proper moisture for the curing.

   Final Mixing. After the required curing time, the material shall be mixed uniformly by approved methods. All clods shall be reduced until the soil-lime mixture meets the following requirements when tested dry by laboratory sieves:

Table 222:3 Soil-Additive Mixture Gradation	
Nominal Sieve Sizes	Percentage Passing
1 ½ inch	100%
No. 4	60 minimum

2. 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. Sufficient water shall be added within 6 hours after spreading to permit hydration of the quick lime. CAUTION: Uncovered quick lime may be hazardous when in the presence of moisture.

iv. Mixing for Lime Pretreatment: Mixing of lime for pretreatment shall be in accordance with the first mixing for lime described in Subsection 222.04(f).

v. Mixing for Depths of 8 inches or greater compacted thickness. No course stabilized shall exceed 8 inches in depth. If the depth of material to be stabilized in cut sections is more than 8 inches (200mm), that portion above the lower 8 inches shall be removed so that the bottom course can be stabilized in place. The upper portions of the cut section also shall be stabilized in courses not more than 8 inches in depth. During normal fill construction, stabilization shall be accomplished by adding and mixing the amount of stabilization additive as required on the plans to each 8-inch lift, completing the depth of fill to the typical section shown on the plans. The initial mixing shall be considered the only mixing necessary for all except the top course. Variations to the mixing depths that may be properly performed by special equipment or methods may be used only after approved by the City Engineer.

vi. Mixing for Excessive Rock Areas. In areas designated by the City Engineer as excessive rock areas, it is the intent that the completed course of stabilized material shall comply with the Standard Specifications as to uniformity of stabilization additive, 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 City Engineer.

G) Compaction. The soil-stabilization additive mixture shall be compacted immediately after mixing and before any appreciable loss of mixing moisture occurs. Mixing and compaction operations shall be performed so that the mixture will be compacted within plus or minus 2 percentage points of optimum moisture content. Changes or adjustments in the specified moisture requirements to meet field conditions may be authorized by the City Engineer. The soil-cementitious additive mixture shall be compacted immediately after mixing, so that the compaction operation is a continuation of the mixing operation. The urgency for achieving the compaction is to ensure the optimum hydration and performance of the cementitious additive. Once the required compaction has been achieved, it is critical to protect the subgrade from premature construction activities and loads until the sufficient curing has been achieved. The soil-lime mixture shall be compacted during the same day as the final mixing unless approval is obtained from the City Engineer to continue compaction on the following day. The target density shall be determined in the field by moisture-density tests on representative samples of the soil-stabilization additive mixture obtained from the roadway when compaction is started. The test method for the target density will be as specified in Subsection 201.04, modified to provide one compacted specimen of the soil-stabilization additive mixture as obtained from the roadway; and separate portions of the sample will be used for additional specimens with the moisture reduced or increased.

Compaction shall be continued until the entire depth of the mixture is uniformly compacted to not less than 95 percent of target density. Field density will be determined in accordance with Subsection of 201.04. The rate of operation and the number of rollers shall be sufficient to uniformly compact the section of roadway being processed as specified above for the cementitious additive and within two hours of the final mixing for the lime additive.

Depths of two or more lifts or courses shall be compacted as specified in the mixing procedure. The material shall be sprinkled or dried as necessary to provide the moisture for proper compaction. Compaction shall be continued until the entire depth of mixture is compacted to not less than 95 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 immediately corrected by scarifying the areas affected, adding, or removing material as required, and reshaping and recompacting by sprinkling and rolling.

In addition to complying with the requirements specified for density, the full depth of the material shown on the Plans shall be uniformly compacted to the extent necessary for it to remain firm and stable under construction equipment. After each section is completed, density tests as necessary, will be made by the City Engineer for acceptance. 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.

In areas designated by the City 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-stabilization additive mixture may not be uniform, and some variation is to be expected in both the target density and optimum moisture, depending on the stabilization additive content of a given sample. In the event the in-place density tests are not practical because of rock in the soil-stabilization additive mixture, the City Engineer may waive the density and moisture content requirements and approve compacting by visual observation in lieu of such tests.

Should the stabilized subgrade material, due to any reason or cause, lose the required stability, density, finish or planned line and grades before the next course is placed or the work is accepted, it shall be replaced and refinished at the expense of the Contractor.

H) Finishing and Curing. After the final layer of the stabilized subgrade has been compacted, it shall be brought within reasonable compliance to the lines, grades, and typical sections before any appreciable loss of mixing moisture occurs. The completed section shall then be finished with a suitable roller sufficiently light to prevent hair cracking. The stabilized subgrade shall be maintained at a moisture content satisfactory for proper curing for at least three (3) days by sprinkling until a seal or succeeding course is placed, whichever occurs first. If the average daily temperature falls below 60º F during the three (3) day curing period, a fourth day of curing will be required.

   Do not place construction loads or operating equipment until the treated subgrade has cured and can withstand the loads without damaging the subgrade. If the subgrade deforms under the construction loads and cannot return back to its original condition, or if it deflects more than 1 in, allow the subgrade additional curing time before operating equipment on the subgrade.

I) Tolerance. The finished surface tolerance shall be in conformity with the Plans.

222.05 TESTING — VACANT

222.06 METHOD OF MEASUREMENT

Fly Ash will be measured by the ton. *Cement Kiln Dust* will be measured by the ton. *Dry Portland Cement* will be measured by the ton. *Cementitious Stabilized Subgrade* will be measured by the square yards of subgrade stabilization completed in place. *Lime* will be measured by the ton. *Lime Stabilized Subgrade* will be measured by the square yard of subgrade stabilization completed in place. *Lime Pretreatment* will be measured by the square yard of subgrade pretreatment completed in place. Water and rolling will not be measured for payment.

222.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) FLY ASH	Ton
(B) LIME	Ton
(C) CEMENT KILN DUST	Ton
(D) DRY PORTLAND CEMENT	Ton
(E) CEMENTITIOUS STABILIZED SUBGRADE	Square Yard
(F) LIME STABILIZED SUBGRADE	Square Yard
(G) LIME PRETREATMENT	Square Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

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.

SECTION 223 -- CEMENT SUBGRADE STABILIZATION

223.01 DESCRIPTION

Design a cement treated material (CTM) mixture consisting of a homogeneously blended mix of cementitious materials and water for modification and stabilization of subgrade soils, sub-bases, and bases. Construct one or more courses of the CTM as shown in the plans.

223.02 MATERIALS

Provide materials that comply with the applicable requirements listed below:

Portland Cement	901.02
Water	901.04
Admixtures *	

*The admixtures retard the cure time about 6-8 hours depending on the ambient air temperature and improves the mixing of the soil, cement, and water to meet the gradation requirements. Other additives may be used to improve the subgrade as approved by the City Engineer.

The Contractor shall submit the mix design for the cement slurry to the City Engineer for approval prior to construction of the CTM. The mix design submittal shall include all necessary certifications for supplementary cementitious materials and additives to be used. The City Engineer may sample and test project material at any time before and during placement.

A) Cement. “Blended Hydraulic Cement”, of ASTM C-150. In a weatherproof container, properly store the cement to prevent moisture damage. Do not use cement that has become caked due to moisture absorption. Do not use cement containing lumps, foreign material of any nature or in any condition that may be deleterious to the mixing operations.

223.02.01- PROCESS CONTROL

A) General. During construction, the City Engineer may conduct tests to verify compliance of the approved mix design. Any load that fails a test for consistency of viscosity shall be re-tested at least one additional time within 30 minutes after the initial failed test. A second failure will result in rejection of the entire load.

B) Consistency. A 500-cc portion of the slurry will be removed from the middle of the load. The slurry suspension will be allowed to sit with no vibration or agitation at ambient temperature for 30 minutes. Little or no separation of liquid or solid should occur.

C) Viscosity. The Marsh Funnel Viscosity of the slurry shall be a minimum of 60 seconds when measured according to ASTM D6910.

223.02.02- SLURRY MIX

A) General. Submit all slurry mix designs to the City Engineer for review and approval. Do not place any slurry on the project until the City Engineer approves the mix design. Once the City Engineer approves the slurry mix design, do not make changes without the City Engineer’s approval.

B) Cementitious Material. The slurry mix shall contain a minimum of 55% cementitious material by mass.

C) Stabilizing Agent. The slurry mixture shall contain a stabilizing agent capable of maintaining a homogeneous mixture of the cementitious materials in the water for at least four (4) hours after it has been batched.

223.03 EQUIPMENT

Provide a mixing plant, tools, and equipment necessary for proper mixing and delivery of the slurry.

A) Storage Facility. Store all components, except water, in weatherproof containers.

B) Slurry Plant. Provide a pneumatic/hydraulic mixing plant with monitoring devices to regulate flow rates and line pressures. Regulate slurry proportions by calibrated scales. Include all storage silos, weather protected sheds, scales, pumps, mixers, valves, gauges and regulating devices required to continuously measure and mix cementitious slurry at the batch plant. The plant should provide safe and easy access for the City Engineer to obtain samples.

C) Delivery Equipment. Deliver slurry to the project site in a non-baffle tank vehicle that does not re-circulate or agitate the slurry material by any means other than the motion of the vehicle in normal movement. Application of the slurry will be through a vehicle that both injects the slurry into the substrate soil or place the slurry on top of the ground. Meters should measure the precise amount of product per square yard that is recommended.

D) Tickets. Generate tickets through the function of the calibrated plant scales. Tickets shall document the amount of cementitious product in a dry ton mass.

223.04 CONSTRUCTION METHODS

Construct each layer uniformly, free of loose or segregated areas and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines and grades shown in the Contract Documents.

A) Preparation. Before treating the existing base, pulverize, mill, or remove existing pavement in accordance with the Contract Documents. Shape existing material to conform to the typical sections shown on the plans. Proof roll subgrade as required in Section 220 and correct soft spots as directed.

B) Pulverization. After shaping, pulverize or scarify existing material so that 100% passes a 2 ½" sieve. If the material cannot be uniformly processed to the required depth in a single pass, windrow and excavate the material to expose a secondary grade to achieve plan depth.

C) Application of Cementitious Slurry. Uniformly place cementitious material in or on the pulverized pavement or soil that is near optimum moisture for compaction. The substrate soil should be ripped, scarified, or ground to expose the maximum amount of surface area to be coated by the slurry. The slurry shall be mixed throughout the substrate material with a mixer of sufficient size and power in a timely manner.

D) Application Rate. The City Engineer will work with the Contractor to determine the application rate of the cementitious slurry to produce a CTM that meets the requirement shown in the Contract Document.

Thorough mixing and compaction of CTM must be completed within two hours after placing the slurry into the substrate soil/pulverized material. The slurry may begin to dry or form a white curst when exposed to high temperatures or wind. This will require a light application of water spraying or misting of sufficient means to return the slurry to its original gray color. Apply only the proper amount of water to achieve the desired compaction.

E) Compaction. Compact the CTM in one lift using density control unless otherwise shown in the Contract Document. Depending on the method pf placement, follow one of these processes.

1. Full Depth Reclamation (FDR) or Soil Stabilization. Complete compaction two hours after thoroughly mixing of cementitious material into the substrate. Sprinkle or aerate the treated material to adjust the moisture content during compaction so that it is within 2.0 percentage points of optimum as determined by ASTM D558. Determine the moisture content of the mixture at the beginning and during compaction using a nuclear gauge per ASTM 6938. Adjust operations as required.
2. Soil Modification. Complete compaction three hours after thoroughly mixing of cementitious material into the substrate. Sprinkle or aerate the treated material to adjust the moisture content during compaction so that it is within 2.0 percentage points of optimum as determined by ASTM D558.

Determine the moisture content of the mixture at the beginning and during compaction using a nuclear gauge per ASTM 6938. Adjust operations as required.

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half the width of the roller unit. Offset alternative trips of the roller. Operate rollers at a speed between 2 mph and 6 mph, as directed. Remove areas that lose required stability, compaction, or finish. Replace with cementitious mixture at the Contractors expense.

Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding, or removing treated material as required reshaping and re-compacting.

F) Finishing. Immediately after completing compaction, roll the surface with a pneumatic tire roller or smooth drum roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the surface into conformity with the typical sections, line and grades shown in the Contract Documents.

G) Curing. The CTM shall be maintained at a moisture content satisfactory for proper curing for at least three (3) days by sprinkling until a seal or succeeding course is placed, whichever occurs first. Avoid placing construction loads or operating equipment on the treated material that may cause damage. Construction equipment may be used for sprinkling unless it damages the treated subgrade. If the average daily temperature falls below 60º F during the three (3) day curing period, a fourth day of curing will be required.

When a section is microcracked, cure section for an additional two (2) days after microcracking. Maintain the moisture content during curing at no lower than 2 percentage points below optimum. Continue until placing another course.

223.04.01-- WEATHER LIMITATIONS

Do not construct the CTM on any wet or frozen surface or when weather conditions otherwise prevent the proper handling and finishing of the mixture.

Unless authorized by the City Engineer, discontinue mixing and placement operations when the descending ambient air temperature reaches 40°F. Do not begin placement operations until an ascending ambient air temperature reaches 35°F and is expected to exceed 40°F.

During periods of hot weather or windy conditions, special precautions shall be taken to minimize moisture loss due to evaporation. Precautions may include decreasing the allowable time between placement, mixing and final compaction and keeping the surface of the newly constructed CTM damp with a light spray during compaction and finishing operations.

Do not construct the CTM when rain is imminent. Cease all operations if rain occurs during construction of the CTM.

223.04.02-- MICROCRACKING

Maintain the moisture content of the finished CTM for a period of 24 to 48 hours. During this time, but not sooner than 24 hours, roll the finished course with a vibratory roller to induce microcracking. The vibratory roller must have a static weight equal to or more than 12 tons and the vibratory drum must be a minimum of 20 inches wide. The roller must travel at a speed of 2 mph vibrating at maximum amplitude and make two to four passes with 100% coverage exclusive of the outside one foot of the surface crown, unless

otherwise directed by the City Engineer. Additional passes may be required to achieve the desired crack pattern as directed. Notify the City Engineer 24 hours before the microcracking begins.

223.05 TESTING — VACANT

223.06 METHOD OF MEASUREMENT

Portland Cement will be measured by the dry ton of material required. *Cement Slurry Stabilized Subgrade* will be measured by the square yards of subgrade stabilization completed in place.

223.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) PORTLAND CEMENT	Dry Ton
(B) CEMENT SLURRY STABILIZED SUBGRADE	Square Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

Microcracking is considered an incidental item of work and will not be paid for directly and its cost will be included in other related bid items. Proof rolling will be paid for using the *Proof Rolling* pay item in accordance with Section 220. Any yielding subgrade repair that is determined by the City Engineer to be beyond the responsibility of the Contractor will be measured for payment using applicable bid items such as *Unclassified Excavation* or *Aggregate Base (Type A).*

SECTION 224 -- CEMENT TREATED BASE

224.01 DESCRIPTION

This work consists of constructing a cement treated base (CTB) using a soil, aggregate, and cement mixture.

224.02 MATERIALS

Provide material in accordance with the following subsections:

Portland Cement	701.02
Water	701.04
Fly Ash	702.01
Curing Agents	701.07.C
Aggregates	703.02
Geotextiles for Bond Breakers	712.1

Provide aggregates that conform to the requirements of Subsection 703.02, except ensure that the aggregate has an Aggregate Durability Index of at least 30, tested in accordance with AASHTO T 210.

224.03 EQUIPMENT

Use stationary plants and equipment that combines placement and initial compaction.

224.04 CONSTRUCTION METHODS

A) Mix Design and Proportioning

Design CTB mixtures in accordance with ODOT Test Method OHD L-53. Ensure Portland cement is at least 75% of the total cementitious materials in the mix. Submit a CTB mix design to the City Engineer at least seven (7) days prior to the beginning of paving.

At a minimum, include the following information with each CTB mix design:

- Project identification
- Name and address of the Contractor and producer
- A unique mix design name
- Aggregate sources
- Gradations for each aggregate source. Sieve sizes shall include the 1 ½ in, 1 in, ½ in, No. 4, No. 40, and the No. 200
- Hydraulic cement type and source
- Types of cement replacement, if used, and sources
- Types of admixtures and sources, if used
- Material proportions
- Combined gradation charts
- Unit weight
- Compressive strength at 7 days

B) Mixing

Handle and measure materials, batching, and mixing in accordance with Subsection 414.04.C, “Mixing Concrete,” except only use a central mix plant which has been approved by the City Engineer.

C) Placement

Moisten the surface of the compacted subgrade before spreading the CTB, unless the subgrade has been primed. Finish and compact the CTB to produce a smooth, dense surface that is free of surface compaction planes, cracks, ridges, or loose material.

Compact the CTB within two (2) hours of adding water to the aggregate and cement. Follow the recommendations of the mix design. Compact the CTB to at least 95% of the maximum density and test in accordance with ODOT Test Method OHD L-54. Place the CTB in a single layer. After strike off and consolidation, finish the CTB to meet the required elevation and cross section, and to create a smooth surface. Use equipment that automatically controls both grade and line to trim the surface of the CTB.

Keep the CTB surface moist during finishing operations, and until the application of the curing agent. Apply a curing agent on the finished CTB surface at the rate of at least 1 gal per 150 ft2.

Use butt or sawed longitudinal construction joints; those between the driving lanes shall

match the longitudinal joint of overlying pavement. Place other longitudinal joints within 3 ft of the longitudinal joint of the overlying pavement and construct transverse construction joints as butt joints. Before placing the separator fabric, sweep the CTB surface. Place and secure the separator fabric onto the surface of the CTB in such a manner that the fabric remains free of wrinkles and cracks. Secure the separator fabric with asphalt binder, mechanical fasteners, or other method approved by the City Engineer. Overlap the fabric 8 in both longitudinally and transversely.

Limit construction traffic on the CTB to that necessary to apply the separator fabric and overlying pavement. Do not use the CTB layer as a haul road. Allow only concrete delivery trucks necessary to deposit fresh concrete directly in front of the paver. Place overlying pavement on the base after compressive strengths reach at least 600 psi in accordance with ODOT Test Method OHD L-54. Repair damage to the CTB at no additional cost to the City.

D) Weather Limitations

Do not mix CTB if the aggregate or subgrade is frozen. Mix and place CTB when the ambient air temperature is at least 40 °F and rising. Protect CTB from freezing for seven (7) days after placement.

E) Tolerances

Finish the CTB in accordance with Subsection 301.04.A, “Tolerances.”

F) Acceptance

The City Engineer will base pay adjustments for strength on a lot by lot basis. A lot will normally be defined as 10,000 yd² (four sublots of 2,500 yd² each).

The Contractor will be responsible for making test cylinders and determining compressive strength of the CTB in accordance with ODOT Test Method OHD L-54. At least one cylinder will be made for testing from a random location in each sublot in accordance with OHD L-54. Strength of plant mix CTB shall be between 600 psi and 2,000 psi.

The City Engineer is responsible for performing compaction tests during placement of the CTB using a nuclear density gauge in accordance with OHD L-54. At least one (1) test will be performed from a random location in each sublot in accordance with OHD L-54.

The City Engineer will reject any load of mixture that is visually unacceptable for reasons of being too wet, excessively segregated, or otherwise obviously deficient.

Replace rejected CTB at no additional cost to the City. When replacing rejected CTB, remove a width of at least one lane and a length of at least 15 ft. If the removal is within 15 ft of any transverse joint, remove to the joint.

224.05 TESTING - VACANT

224.06 METHOD OF MEASUREMENT

The City Engineer will measure the surface area of the completed *Cement Treated Base* placed at the thickness shown on the Plans.

224.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CEMENT TREATED BASE	Square Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

Include the cost of curing agent, separator fabric, and method of fastening in the contract unit price for Cement Treated Base.

The City will use Table 224:1 to calculate the strength pay factor for CTB extents with strengths less than or greater than the specified requirements:

Table 224:1
Acceptance Pay Factors

Strength	Pay Factor
< 600 psi	Remove & Replace
600 psi - 2,000 psi	1.00
2,000 psi - 4,000 psi	1.00 - ((Actual Strength - 2,000) ÷ 2,000)2
> 4,000 psi	Remove & Replace

Multiply the contract price by the Strength Pay Factor for the represented CTB extent. Check any outlying concrete cylinder breaks in accordance with ASTM E 178 Table 1, “Upper 10% Significance Level.”

SECTION 225 – AGGREGATE BASE

225.01 DESCRIPTION

This work shall consist of furnishing and placing one or more courses of aggregates and additives, if specified, on a prepared subgrade or subbase 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 City 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.

225.02 MATERIALS

Materials shall conform to the requirements specified in the following Section of Section 903 - Materials, for the type of gradation specified.

Aggregate Base	903.01

The gradation will be Type A unless otherwise specified on the Plans or in the Special Provisions. 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 City 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.

225.03 EQUIPMENT — VACANT

225.04 CONSTRUCTION METHODS

A) Preparation of Subgrade - Prior to placing any new base material or subbase and base course material on the roadbed, the subgrade shall be completed according to the requirements of Section 220, Subgrade, of these Specifications or the method specified on the Plans or in the Special Provisions.

If there is an existing aggregate course in place, it shall be prepared in accordance with the requirements of the method of Section 226, Processing Existing Base and Surface, of these Specifications as indicated on the Plans and in the Special Provisions.

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.

   i. 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.

   ii. Water shall be added during the mixing operation in the amount necessary to provide the proper moisture content for satisfactory compaction.

   iii. 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.

   iv. Should the Contractor elect to proportion the materials by volumetric methods and perform the mixing in a continuous type of 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.

   v. If a continuous type of 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.

   vi. The weight of charge in a batch mixer or the rate of feet to a continuous type of mixer shall not exceed that which will permit complete mixing of the material.

   vii. Mixing of materials shall be continued until a uniform mixture is obtained.

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.

i. The total quantities for blending at one operation shall not be more than the amount that can be readily handled and thoroughly and uniformly mixed and blended to these requirements.

ii. 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 subgrade 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.

1. 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.

2. Longitudinal and transverse joints shall be staggered a minimum of 12 inches in each succeeding course.

3. 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.

4. After the blended and flattened windrow of aggregate base material mixed on the roadbed has been tested and approved by the City 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 modified proctor 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 aggregates firmly keyed. Water shall be uniformly applied over the base materials during compaction in the amount necessary for proper consolidation.

E) Tolerances - Tolerances for surface, width and thickness shall be in conformity with Plans and Specifications.

225.05 TESTING — VACANT

225.06 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. 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.

225.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) AGGREGATE BASE	Cubic Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 226 – PROCESSING EXISTING BASE AND SURFACE

226.01 DESCRIPTION

This work shall consist of the removal, processing, reuse 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.

226.02 MATERIALS — VACANT

226.03 EQUIPMENT — VACANT

226.04 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 subgrade 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.

A) Method A - For Salvage and Stockpiling. The processed materials shall not contain detrimental amounts of subgrade or soil or other foreign material. The processed material shall be loaded and hauled to storage locations indicated. 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.

B) Method B - For Use in Subgrade. The processed materials shall be incorporated into the existing base plus whatever native soil is necessary to achieve eight inches (8") compacted base course. The subgrade material will then be blended, watered and compacted to a minimum 95% standard proctor density. Soft spots will be repaired as encountered either by excavating, drying and recompacting or by replacement with aggregate material. Depth of excavation shall not exceed two feet (2') unless otherwise directed by the City Engineer. Soft spot excavation will be paid for using the Unclassified Excavation pay item and aggregate fill material, when required, will be paid for using the Aggregate Base Type A pay item.

C) Method C - For Use as Subbase. The processed materials shall be spread evenly on the previously completed and compacted subgrade and then compacted to the requirements specified for the method of subgrade preparation. The subbase material will then be blended, watered and compacted to a minimum 95% standard proctor density.

D) Method D - For Use in New Base Courses, Shoulders, or Ramps. The processed materials shall be placed on the completed subgrade as a base course, shoulders, or ramps, or it may be blended uniformly with new material for any course as required in the Plans. The suitability of the removed materials shall be determined by the City Engineer and materials used as authorized. The processed material will then be blended, watered and compacted to a minimum 95% standard proctor density.

E) Method E - For Use in New Base Courses, Shoulders, or Ramps with Chemical Additive. The processed materials shall be pulver mixed with the chemical additive and placed on the completed subgrade as a base course, shoulders, or ramps, or it may be blended uniformly with new material for any course as required in the Plans. The suitability of the removed materials shall be determined by the City Engineer and materials used as authorized. Any chemical additive required will be measured and paid for separately using the applicable pay item.

These materials shall be compacted to not less than 95 percent of standard density for shoulders, ramps, and base courses.

226.05 TESTING — VACANT

226.06 METHOD OF MEASUREMENT

Processing Existing Base and Surface will be measured by the square yards of existing base and surface processed and completed in place.

226.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) PROCESSING EXISTING BASE AND SURFACE, METHOD A	Square Yard
(B) PROCESSING EXISTING BASE AND SURFACE, METHOD B	Square Yard
(C) PROCESSING EXISTING BASE AND SURFACE, METHOD C	Square Yard

(D) PROCESSING EXISTING BASE AND SURFACE, METHOD D	Square Yard
(E) PROCESSING EXISTING BASE AND SURFACE, METHOD E	Square Yard

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 251 - JACKING

251.01 DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of Jacking as shown on the plans and in conformity with these specifications. In general, a boring head begins the tunnel excavation from an access pit and is pushed along by a hydraulic pump unit that remains in the pit. The link to the boring head is maintained by adding jacking pipe between the pushing unit and the head. By this procedure, the pipe is laid as the tunnel is bored.

251.02 MATERIALS — VACANT

251.03 EQUIPMENT — VACANT

251.04 CONSTRUCTION METHODS

The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.

Heavy-duty jacks suitable for forcing the pipe through the embankment or earth 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 pipe uniformly around the ring of the pipe. A suitable jacking frame or backstop shall be provided. The pipe to be jacked shall be set on guides properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly shall be placed to line up with the direction and grade of the pipe. In general, soil shall be excavated or augured just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment with jacks into the space thus provided. The excavation for the underside of the pipe for at least one-third (1/3) of the circumference of the pipe shall conform to the contour and grade of the pipe. The excavation for the top half of the pipe shall conform closely to the outside diameter of the pipe, and a clearance greater than two inches (2”) will not be permitted.

The pipe preferably shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the City Engineer will be permitted only to the extent of one inch (1”) in ten (10), provided that such variation shall be regular and only in one direction and that the final grade of flow line shall be in the direction indicated on the plans.

Nothing contained herein shall be construed as relieving the Contractor from his responsibility for the safety of the work and for all damages to persons or property.

251.05 TESTING — VACANT

251.06 METHOD OF MEASUREMENT

Jacking shall be measured by the lineal foot of pipe completed. Payment for *Jacking* shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials, including pipe, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

251.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) JACKING (SIZE)	Linear Foot
(B) JACKING – PIPE (SIZE)	Linear Foot
(C) JACKING – CASING (SIZE)	Linear Foot

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 252 – BORING

252.01 DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of boring as shown on the plans or specified.

Boring consists of the initial installation of a steel casing pipe, installed mechanically, and with a suitable assembly designed to produce a smooth, straight shaft at the established line and grade.

252.02 MATERIALS

The Contractor shall furnish for the City Engineer's approval, a plan showing his proposed method of handling, including the design for the equipment, equipment support of backstop, arrangement and position of jacks, pipe guides, etc., complete in assembled position. The approval of this plan by the City Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

252.03 EQUIPMENT — VACANT

252.04 CONSTRUCTION METHODS

A. General – Where pipe is required to be installed under railroad embankments or under highways, streets, or other facilities by trenchless methods, 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. During construction operations, barricades, and lights to safeguard traffic and pedestrians shall be furnished and maintained, as directed by the City Engineer, until such time as the

backfill has been completed and then shall be removed from the site.

The Contractor shall take proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages caused by excavating or blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor at his own cost and expense.

Suitable pit shafts, or trenches shall be excavated for the purpose of conducting the trenchless operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheeted securely and braced in a manner satisfactory to the City Engineer to prevent earth caving.

The removal of any obstruction that may be found to conflict with the placing of the pipe shall not be measured for payment nor paid for as a separate contract pay item. The removal of any such obstruction shall be included in the cost of other items.

Once the pipe installation has commenced it shall be continued uninterrupted around the clock until the pipe has been installed between the specified limits.

Any pipe damaged during operations shall be removed and replaced by the contractor at his expense.

The pits or trenches excavated to facilitate the operations shall be backfilled immediately after the pipe has been installed.

B. Boring Requirements - Work shall comply with the City Standard Detail for Boring. The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.

Boring without the concurrent installation of a casing pipe shall not be permitted, unless shown on plans or directed by the City Engineer. All joints in casing pipe shall be welded. Casing pipe shall extend through the entire fill and be installed in a manner that shall not disrupt traffic nor damage roadway grade and surface. The introduction of water into the excavation shall be prohibited.

The size of the bored hole shall not exceed the outside diameter of the pipe bell or casing pipe more than one inch (1”). The use of water or other fluids in connection with the boring operation shall only be permitted when approved by the City Engineer.

Nothing contained herein shall be construed as relieving the Contractor from his responsibility for the safety of the work and for all damage to persons and property.

C. Skid Supports

1. Wood Skid Supports – Wood skid supports, from bell to spigot, shall be used and fastened securely to pipe with steel strapping, cables, or clamps. Use of petroleum products shall not be allowed as a lubricant to ease installation. When wood skids are used, they shall be pressure treated with creosote pentachlorophenol, or salt type preservative in accordance with APWA C-2. Cut surfaces shall be given two (2) heavy brush coats of the same preservative. Skid support spacing and position shall be in accordance with the City Standard Detail for Boring.

2. Casing Spacers – Casing spacers shall be PVC with stainless steel bands as manufactured by Advance Products & Systems, Inc. of Lafayette, Louisiana or approved equal. Use and positioning of spacers shall be in accordance with the manufacturer's recommendations.

D. Plugging Pipe Ends - Both ends of the casing pipe shall be plugged with a grout or

concrete having a minimum compressive strength of twenty-five hundred pounds per square inch (2,500 psi) or grouted masonry and shall conform to the applicable requirements of Section 900. Each plug shall be a minimum length of eighteen inch (18”) The grouting pressure shall be in accordance with the pipe manufacturer's recommendations.

E. Filling Annular Space - The annular space between the waterline pipe and the steel casing pipe shall not be filled.

252.05 TESTING — VACANT

252.06 METHOD OF MEASUREMENT

Boring shall be measured by the lineal foot of pipe bored. Payment for *Boring* shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials including steel casing pipe, carrier pipe, grout or concrete, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work. For water construction, *Boring – Pipe* or *Boring – Casing* shall be measured by the lineal foot bored. Payment for *Boring – Pipe* or *Boring – Casing* shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials including pipe or casing, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

252.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) BORING (SIZE)	Linear Foot
(B) BORING – PIPE (SIZE)	Linear Foot
(C) BORING – CASING (SIZE)	Linear Foot

Payment will be considered full compensation for all items of work specified including all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

TABLE OF CONTENTS

CHAPTER 300

SECTION 301-GENERAL REQUIREMENTS FOR SURFACES

301.01 DESCRIPTION

This section covers of all types of surface construction.

301.02 MATERIALS

Provide materials for surface construction in accordance with the relevant section or sections of Chapter 900, “Materials.”

301.03 EQUIPMENT

A) Distributors and Supply Tanks

Provide distributors and supply tanks capable of uniformly applying bituminous material in accordance with the following:

- At the temperatures specified in the relevant specification sections;
- On variable widths of surface not to exceed 26 ft;
- At rates from 0.010 gal/yd² to 1.000 gal/yd²; and
- With constant pressure and uniform temperature.

Ensure the distributor can apply material to vertical faces of asphalt pavement at the joints between paving operations.

Prevent variation that exceeds the specified application rate by more than 0.01 gal/yd².

Provide a distributor equipped with the following:

- A tachometer,
- Pressure gauges,
- Volume-metering devices or a calibrated tank,
- A thermometer for measuring temperatures of tank contents,
- A power unit for the pump,
- Full circulation spray bars adjustable vertically and laterally,
- A positive shut-off valve, and
- Fittings that prevent bituminous material from dripping.

Frequently check and adjust the angle of the spray nozzles and the height of the spray bar to ensure uniform distribution of the bituminous material. Drilling, clogging, or streaking the bituminous material is not allowed. If any of these conditions occur, stop the operation and correct the problems creating these conditions before resuming distribution.

Regularly check the rate and ensure uniformity of distribution. Provide supply tanks in accordance with AASHTO M 156, Section 3.

B) Compactors

Provide rollers of the following type.

- Vibratory steel-wheel,
- Non-vibratory steel-wheel,
- Pneumatic tire, or
- A combination of the three types.

Provide rollers in good condition, capable of reversing without backlash, and operating at speeds that do not displace the bituminous mixture.

Equip vibratory rollers with working amplitude controls or frequency controls designed

specifically for the compaction of the specified bituminous material.

Use rollers of a type, number, and weight to complete the compaction of the bituminous material before its temperature drops below the specified minimum.

Do not use equipment that crushes the aggregate in the bituminous material.

301.04 CONSTRUCTION METHODS

A) Tolerances

Provide the required surface construction in accordance with the following:

1. Surface Elevation and Smoothness

   Finish the surface elevations for new pavement construction and overlays within ½ in of the elevations shown on the approved plans. If the approved plans do not show the elevations for overlays, provide a finished surface in accordance with the surface smoothness tolerances. Ensure the surface smoothness is within ⅛ in in 10 ft. Test for surface smoothness by placing a straightedge between two contacts on the finished surface and measuring the distance from the surface to the straightedge.

2. Width

   Finish surfaces to the minimum width shown on the approved plans.

B) Corrections

Correct material dimensions that exceed the specified surface tolerance using only methods approved by the City Engineer at no additional cost to the City or Awarding Public Agency.

C) Surface Protection

Submit a plan to the City Engineer to protect the pavement from damage by the paving operations before starting paving operations. If paving operations spall, crack, chip, rut, or deface the pavement, repair the pavement at no additional cost to the City or Awarding Public Agency.

301.05 TESTING — VACANT

301.06 METHOD OF MEASUREMENT — VACANT

301.07 BASIS OF PAYMENT — VACANT

SECTION 302-TRAFFIC-BOUND SURFACE COURSE

302.01 DESCRIPTION

This section covers construction a surface course of hard and durable particles of sand, gravel, mine chats, crushed stone, or disintegrated granite and placing the surface course material on a prepared subgrade.

302.02 MATERIALS

Provide aggregate materials in accordance with Subsection 903.05, “Aggregates for Traffic Bound Surface Course.”

302.03 EQUIPMENT - VACANT

302.04 CONSTRUCTION METHODS

A) Preparation of Subgrade

Complete the subgrade in accordance with Subsection 220.04, before placing surface course material on the subgrade.

B) Shaping and Maintenance

Shape and compact as provided in these Standard Specifications, this Section 300, and the City Standard Details, and as directed by the City Engineer if placing material adjacent to the roadway.

Correct irregularities, such as holes, ruts, waves, and undulations, with material from the working windrow on the subgrade. Continue shaping the surface material until it is compacted and free of irregularities. Place the surface course material to the elevations shown on the approved plans.

Remove excess material and stockpile at a location approved by the City Engineer on the approved plans.

C) Traffic Control

Unless otherwise specified and authorized, avoid closing the road to traffic. Minimize interference with traffic. Maintain warning signs and lights to safeguard against traffic accidents. Place windrows or piles of surface course material on the shoulders and off the traveled roadway at the end of the workday.

302.05 TESTING — VACANT

302.06 METHOD OF MEASUREMENT

For determining quantity of the *Traffic Bound Surface Course* pay item, the City Engineer will deduct the weight of moisture that is in excess of 5 percent of the oven-dry weight.

302.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) TRAFFIC BOUND SURFACE COURSE TYPE A	Ton

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tools and incidentals to complete the work as specified.

SECTION 303- CHIP SEAL

303.01 DESCRIPTION

This section covers construction of a single or double surface treatment of aggregates and bituminous materials.

303.02 MATERIALS

Provide materials in accordance with the following sections:

Cover Aggregates	903.04
Bituminous Binder	908.03

Use the following aggregates for surface treatments unless otherwise specified.
For single bituminous surface treatments, use:

- Cover Aggregate No. 2,
- Cover Aggregate No. 3,
- Cover Aggregate No. 3C
- Precoated Aggregates, or
- Light Weight Cover Aggregates (LWCA).

For double bituminous surface treatments, use:

- Cover Aggregate No. 1, and
- Cover Aggregate No. 2.

303.03 EQUIPMENT

Provide distributors, supply tanks, and compactors in accordance with Subsection 301.03, “Equipment.”

Provide self-propelled mechanical spreaders mounted on pneumatic tired traction wheels capable of the following:

- Operating independently of supply trucks;
- Receiving the aggregate from the supply truck directly into the hopper and then into the spreader box;
- Controlling the spreading of aggregate to a rate of 10 lb/yd² to 45 lb/yd²;
- Spreading the aggregate from 3 ft to 12 ft wide; and
- Spreading the aggregate up to 24 ft wide, if required by the approved plans.

303.04 CONSTRUCTION METHODS

A) Weather and Seasonal Limitations

Limit the construction of bituminous surface treatment to the following weather and seasonal limitations:

1. General

   Comply with weather and seasonal conditions for constructing bituminous surface treatment in accordance with Subsection 110.17, “Use of Section or Portion of the Work,” and Subsection 112.10, “Acceptance and Final Payment,” for acceptance of the work.

2. Seasonal Limitations

   Apply bituminous surface treatment during the construction periods provided in Table 303:1, "Construction Seasonal Limitations," or on dates requested in writing by contractor and approved by the City Engineer.

Table 303:1 Construction Seasonal Limitations	
Asphalt Type	Construction Period
Cutback Asphalt	April 1 through Nov. 15
Asphalt Cement	May 1 through Sept. 30
Emulsified Asphalt	May 15 through Sept. 15

3. Temperature and Weather Limitations

   Apply bituminous surface treatment in accordance with the temperature and weather limitations provided in Table 303:2, "Temperature and Weather Limitations."

   Measure the ambient temperatures in the shade, 4 ft above the ground, and away from artificial heat.

   Ensure the temperature and weather conditions allow completion of the work. Before starting bituminous surface treatment, verify that the minimum temperatures specified in Table 303:2 also occurred on the previous calendar day. Suspend work if the ambient temperature is forecast to fall below the specified minimum temperature within 72 hour. Suspend work during adverse weather conditions, such as wind chill, rain, fog, or abnormally high relative humidity, only as determined by the City Engineer.

Table 303:2 Temperature and Weather Limitations				
Asphalt Type	Minimum Temperature, °F			Base or Pavement Surface Condition Due to Weather
	Ambient	Surface	Aggregate	
Cutback Asphalt	50	60	40	Dry
Emulsified Asphalt	60	70	50	No visible free moisture present
Asphalt Cement	0	70	50	Dry

4. Detours and Shoo-Flys

   The City Engineer may waive the minimum temperature requirements for construction of temporary bituminous surface treatment for detours, shoo-flys, or other incidental construction.

B) Traffic

Provide traffic control that ensures the following:

- No vehicles travel on the surface treatment before the application and stabilization

of cover material;
- Construction operations pose no risk to the health, safety, or property of the traveling public; and
- No unnecessary delay to the traveling public.

C) Preparation of Base

Prepare the base as required by the approved plans before applying bituminous surface treatment.

If reconstructing a base previously sealed or patched with bituminous materials, remove areas with excess bituminous materials from the base course surface before applying the bituminous binder.

D) Protection of Structures

Protect surfaces of structures from discoloration while applying bituminous surface treatments.

E) Heating Bituminous Material

Heat bituminous material uniformly and consistently, using an effective and positive control method. Heat bituminous material in accordance with Subsection 908.03, “Asphalt Materials.” Ensure the fluidity of the heated bituminous material and prevent damage due to overheating.

Do not heat bituminous material with steam. Protect the bituminous material or its container from coming into contact with flames. Overheated or damaged bituminous material will be rejected.

F) Application of Tack Coat

Apply a tack coat in accordance with Section 307, “Fog Seal and Tack Coat,” if required by the approved plans.

G) Application of Bituminous Binder and Cover Aggregate

Before placing the first application of bituminous binder, clean the base of dirt and loose material.

Ensure the aggregate is immediately available for spreading before starting the application of bituminous binder.

1. Bituminous Binder

Uniformly apply the bituminous binder. Delineate one edge of the bituminous surfacing before the first application of bituminous binder. At transverse joints, to prevent double or no bituminous binder application created by operation starts and stops, spread building paper over the treated surface before the joint to ensure the specified distribution of bituminous binder at the nozzles when they reach the untreated surface. Remove and dispose of the paper after starting or restarting the bituminous material application.

Apply bituminous material to the full width in one pass for each application if the roadway is closed to traffic and the surface width does not exceed 24 ft.

If the roadway is not closed to traffic and traffic is maintained on one-half of the width, apply bituminous material on the closed half of the roadway width. During the bituminous material application on the second half of the roadway, ensure that the distributor nozzle nearest the center of the roadway overlaps the previous

bituminous application from half to the full width of the nozzle spray.

2. Cover Aggregate

   Apply cover aggregates in accordance with Table 303:3, "Approximate Single Treatment Application Rates," and Table 303:4, “Approximate Double Treatment Application Rates.” Immediately after applying the bituminous binder, uniformly spread the cover material at the specified rates. The City or Awarding Public Agency may allow hand-spreading in areas inaccessible to mechanical spreaders.

3. General Application Requirements

   Prevent overlaps, streaks, or gaps in the application of bituminous binder and cover aggregate. Correct overlaps, streaks, and gaps, to meet the requirements of these Standard Specifications, this Section 300, and the City Standard Details, and as approved by the City Engineer at no additional cost to the City or Awarding Public Agency. Ensure the finished surface is free of the following:
   - Bleeding,
   - Loose chips, and
   - Loss of imbedded aggregates.

   Apply the bituminous material and cover aggregate at the distribution and coverage rate shown on the approved plans.

   Use Table 303:3, "Approximate Single Treatment Application Rates," and Table 303:4, “Approximate Double Treatment Application Rates,” to estimate quantities of aggregate and bituminous binder. Rates are based on midpoint requirements of bituminous binder and aggregate.

Table 303:3
Approximate Single Treatment Application Rates

Material	Aggregate Type			
	LWCA	No. 2	No. 3	No. 3C
Aggregate	100 yd^2/yd^3	25 lb/yd^2	28 lb/yd^2	35 lb/yd^2
Bituminous binder (residual asphalt)	0.3 gal/yd^2	0.3 gal/yd^2	0.3 gal/yd^2	0.3 gal/yd^2

Table 303:4
Approximate Double Treatment Application Rates

Material	Aggregate Type and Increment		
	No. 1	No. 2	
		First	Second
Aggregate	40 lb/yd^2	20 lb/yd^2	15 lb/yd^2
Bituminous binder (residual asphalt)	0.4 gal/yd^2	0.2 gal/yd^2	0.15 gal/yd^2

Apply bituminous binder at temperatures in accordance with Section 908, “Plant

Mix Bituminous Bases and Surfaces."

Apply bituminous binder and cover aggregate in the following sequences:

i. Single Treatment

Apply bituminous binder, and spread No. 2, No. 3, No. 3C, Precoated Aggregates or LWCA cover aggregate at the rates shown on the approved plans.

ii. Double Treatment

For the first application, apply bituminous binder and spread No. 1 cover aggregate over the surface at the rates shown on the approved plans.

For the second application, apply bituminous binder on the surface of the No. 1 cover material, and spread the first application of No. 2 cover aggregate (first increment) over the surface at the rates shown on the approved plans.

For the third application, apply bituminous binder on the surface of the No. 2 cover material (first increment), and spread the second application of No. 2 cover aggregate (second increment) over the surface at the rates shown on the approved plans.

H) Rolling

Roll the entire surface after each application of cover aggregate and ensure it is firmly imbedded into the bituminous binder.

Hand spread additional aggregate to fill irregularities and cover bare spots to prevent tracking bituminous binder during rolling.

Perform final rolling of the surface with at least four passes over the entire surface with a pneumatic-type roller in accordance with Subsection 301.03.B, "Compactors." Operate the roller at a speed of 7 mph or less.

I) Maintenance

Remove unsatisfactory material. Make repairs with bituminous binder and aggregate, to establish a uniformly dense treatment with maximum retention of the cover aggregate. Maintain until project completion is accomplished in accordance with Subsection 112.10, "Acceptance and Final Payment"

Correct irregularities with additional bituminous binder and aggregate at no additional cost to the City or Awarding Public Agency.

Apply blotting material free of clay, silt, loam, or other foreign matter for excessive bleeding as provided in these Standard Specifications, this Section 300, and the City Standard Details, and as directed by the City Engineer.

303.05 TESTING — VACANT

303.06 METHOD OF MEASUREMENT

The City Engineer will measure the finished surface area of the *Chip Seal (Single Treatment)* or *Chip Seal (Double Treatment)* complete-in-place. The City Engineer will measure the *Preparation of Base* to the nearest foot along the centerline when specified on the approved plans.

303.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CHIP SEAL (SINGLE TREATMENT)	Square Yard
(B) CHIP SEAL (DOUBLE TREATMENT)	Square Yard
(C) PREPARATION OF BASE	Linear

Include the cost of bituminous binder, cover aggregate, and sand or other approved aggregate (for blotting) in the contract unit price for the appropriate chip seal pay item.

Include the cost of applying every layer of a double treatment, as required by the approved plans, to be included in the contract unit price for *Chip Seal (Double Treatment)*.

The City or Awarding Public Agency will pay for tack coat in accordance with Section 307, “Fog Seal and Tack Coat”.

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 307-FOG SEAL AND TACK COAT

307.01 DESCRIPTION

This section covers preparation and treatment of an existing bituminous or concrete surface with bituminous material.

Original Emulsion. A mixture of asphalt, water, and a small amount of emulsifying agent to maintain a uniform blend.

Diluted Emulsion. An original emulsion diluted with additional water to reduce the viscosity and to allow easier spraying, typically used for fog seals.

Residual Asphalt Content. The amount of asphalt remaining on the pavement surface after all of the water, both in the original emulsion and any additional water, has evaporated.

307.02 MATERIALS

Provide materials in accordance with Subsection 908.03, “Asphalt Materials.”

307.03 EQUIPMENT

A) General

Provide distributors, heating equipment, and supply tanks in accordance with Subsection 301.03, “Equipment.” Provide a self-contained, self-propelled paver approved by the City Engineer.

B) PMCRS-1s

When Polymer Modified Cationic Rapid Set -1s (PMCRS-1s) is required, ensure the paver has the following:

- a receiving hopper for hot mix asphalt;
- a distribution system to uniformly place and spread the HMA in front of the screed without causing HMA segregation;
- an asphalt emulsion storage tank;
- a system for measuring the PMCRS-1s volume;
- a spray bar; and
- a heated, variable width, vibratory or combination vibratory-tamping bar screed.

When PMCRS-1s followed immediately with the placement of the Hot Mix Asphalt (HMA) is required, ensure the paver is capable of the following:

- spraying the PMCRS-1s evenly across the surface at the rate prescribed by the Standard Specification or as otherwise approved by the City Engineer;
- operating at forward speeds to consistently place the mixture;
- applying the hot mix asphalt overlay;
- leveling the surface of the mat in one pass;
- placing the hot mix asphalt within 5 seconds of the application of the PMCRS-1s;
- spraying and paving at a controlled speed from 30 ft/minute to 90 ft/minute;
- spreading and finishing HMA courses on lanes, shoulders, and similar construction to the widths and thicknesses shown on the approved plans; and
- producing a finished surface that meets the specified evenness and uniform texture without tearing, shoving, or gouging the mixture or causing HMA segregation.

When using PMCRS-1s, prevent wheels and other parts of the paving machine from contacting the PMCRS-1s before applying the hot mix asphalt. Provide a machine with a screed that is capable of crowning the pavement at the center and adjusting the extensions vertically to accommodate the pavement profile.

307.04 CONSTRUCTION METHODS

A) General

Clean the existing roadbed surface before placing tack coat. Paint a thin, uniform tack coat on all surfaces of curbs and gutters, manholes, and other structures that will come in contact with hot mix asphalt. Ensure the tack coat applications minimize damage and inconvenience to traffic and allow one-way traffic without pickup or tracking the bituminous material.

Do not apply tack coat during wet or cold weather, or in windy conditions that would cause the tack coat emulsion to drift. Do not apply tack coat to wet surfaces with free standing water. The City may allow tack coat application to damp surfaces.

The following must be approved by the City Engineer before application:

- Quantity,
- Rate of application,
- Temperature, and
- Areas to be treated.

B) PMCRS-1s

Using a metered mechanical pressure spray bar, uniformly spray the PMCRS-1s at a

temperature from 120 °F to 180 °F, or as recommended by the material supplier. Ensure the sprayer accurately and continuously monitors the spray rate and applies the membrane uniformly across the width of the overlay. The City Engineer may adjust the spray rate based on the pavement surface conditions and the recommendations of the material supplier.

Apply the bonded HMA in accordance with Section 311.04 over the full width of PMCRS-1s immediately after applying the PMCRS-1s. Place the bonded HMA with a heated vibratory, or combination vibratory-tamping bar screed. Pave continuously to reduce surface imperfections.

C) Fog Seal

Apply the fog seal at a rate of 0.100 gal/yd² of diluted emulsion diluted at 5:1 water to original emulsion. Alter the application rate or dilution ratio as directed by the City Engineer (based on weather, type of emulsion, and surface type or layer).

D) Tack Coat

Apply the tack coat or NT tack material as shown in Table 307:1, unless otherwise required by the approved plans. Alter the application rate as directed by the City Engineer (based on weather and surface type or layer). Use the highest rate in the table for the surface type or layer (top or bottom).

Table 307:1
Tack Application Rates

Surface Type/Layer	Original Emulsion gal/yd2	Residual gal/yd2
New Asphalt (bottom)	0.060	0.035
Old Asphalt (bottom)	0.085	0.050
Milled (bottom)	0.085	0.050
New Fabric (bottom)	—	0.200
PFC, OGFSC (top)	0.100	0.060
UTBWC (top)	0.200	0.120
PCC (bottom)	0.075	0.045

Ensure that the tack breaks before the application of the next surfacing layer.

Re-apply tack at a rate that ensures proper bonding if the tack loses its adhesive properties or is damaged by traffic before being covered by the next surfacing layer, as directed by the City Engineer at no additional cost to the City or Awarding Public Agency.

1. Tack Coat Material

   CSS-1h or CBC-1h: The application rate must be 0.15 Gallons/Square Yard of diluted emulsion, diluted with water at a ratio of 1:1. This ratio means that one-part water and one- part emulsion is mixed to apply the tack. Therefore, if the total application rate is 0.15 Gallons/Square Yard, then the emulsion rate is 0.075 Gallons/Square Yard. The 1:1 dilution rate must not be changed by the contractor. The emulsion must be measured and paid for by the gallon before dilution. The

tack coat application rate may be adjusted slightly based on field conditions, with approval of the City Engineer. The tack coat must be completely cured before placing the hot mix asphalt.

Before the hot mix asphalt is laid, the pavement surface must be cleaned thoroughly to the satisfaction of the City Engineer. Cleaning efforts must be such that PM10 fines are removed.

The tack coat must be applied, with a sprayer approved by the City Engineer. Tests (ASTM D 2995) shall be required to verify the application rate of the distributor truck. All contact surfaces of curbs and gutters, manholes and other structures must be painted with a thin uniform coat of asphaltic material used for the tack coat.

2. A cationic organosilane additive with a minimum nonvolatile content of 38 percent. Refer to ASTM D 5095
   a. Use a dosage from 0.7 percent to 1.0 percent byi weight of the emulsion.
   b. Modify the emulsified asphalt requirements as follows: Meet a maximum cement mixing test of 10 percent.

307.05 TESTING — VACANT

307.06 METHOD OF MEASUREMENT

The City Engineer will measure the volume of emulsion for *Fog Seal, Tack Coat,* and *NT Tack Material* as delivered, before dilution.

The City Engineer will measure bituminous material by the gallon or ton.

The City Engineer will measure the *PMCRS-1s* by the gallon of product delivered by the supplier.

307.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) FOG SEAL	Gallon
(B) TACK COAT	Gallon
(C) NT TACK MATERIAL	Gallon
(D) PMCRS-1s	Gallon

The City considers the cost of water for dilution to be included in the contract unit price for *Fog Seal* and *Tack Coat*. The City or Awarding Public Agency will pay for the *PMCRS-1s* needed to construct the bonded hot mix asphalt at the contract unit price bid for *PMCRS-1s*.

Payment will be considered full compensation for furnishing all material, equipment, labor and incidentals to complete the work as specified.

SECTION 309 INTERLAYERS FOR HOT MIX ASPHALT OVERLAYS

309.01 DESCRIPTION

This this section covers providing all labor, materials, and equipment; performing all operations required for contractor project quality control; furnishing, overlapping, and placing of pavement interlayer and asphalt binder, if required, in the designated locations as detailed in the approved plans and specified herein; and maintaining the interlayer until placement is completed and accepted.

All terms and definitions outlined in ASTM D4439 shall apply in this Section.

309.02 MATERIALS

Materials must meet the requirement of Oklahoma City Standard Specifications Section 988.

All interlayer material must be from National Transportation Product Evaluation Program (NTPEP) - compliant manufacturers; material tests shall be performed by City Engineer approved independent, certified laboratories, within the last 9 months, and submitted to the City Engineer no less than 3 weeks prior to the start of the project.

For Paving Fabric, Paving Mat, Paving Grid, and Composite Paving Grid, provide asphalt binder retention or tack coat (paving grids only) application rates (ASTM D 6140), material properties specified herein, and manufacturer's recommendations for asphalt binder application to the City Engineer at the preconstruction meeting. The total minimum asphalt binder or tack coat application rate sprayed in the field must meet the manufacturer's recommendations but must be clearly totaled at the pre-construction meeting as the components of the asphalt binder retention or tack coat application rate and the additional rate based on the anticipated surface condition of pavement. All interlayer material must be recyclable.

All materials must be manufactured in the USA and must be from an ISO9001 manufacturer.

A) Paving Fabric: Type I, II & III:

Materials used for paving fabric must be nonwoven polypropylene or nonwoven polyester. All paving fabrics must meet the requirements of Table 309: 1 and have 50% retained strength after 500 hours of UV exposure when tested in accordance with ASTM D4355. PG asphalt binders must be used for the installation of paving fabrics. Refer to manufacturer's recommendations for asphalt binder application rate.

TABLE 309:1
Paving Fabric

Property	Test Method	Type I	Type II	Type III
Mass per unit area, min (oz/yd2)	ASTM D5261	6.0	4.5	4.1
Grab Tensile Strength, min (lbs.)	ASTM D4632	150	120	101
Grab Tensile Elongation, min (%)	ASTM D4632	50	50	50
Melting point, min (□F)	ASTM D276	320 1	320 1	320 [1]

[1] 320 is the softening/melting point of polypropylene. See Section IV for more on placement temperature.

B) Paving Mat: Type I & II:

Materials used for paving mat shall be a hybrid of two or more of the following material types: fiberglass, polyester, or polypropylene. Paving mat must meet the requirements of Table 309:2. PG asphalt binders must be used for the installation of paving mats. Refer to manufacturer's recommendations for asphalt binder application rate.

TABLE 309:2
Paving Mats

Property	Test Method	Type I	Type II
Tensile Strength, min (lb./in)	ASTM D5035	280	140
Ultimate Elongation, max (%)	ASTM D5035	5	5
Melting Point, min (°F)	ASTM D276	320 1	320 [1]
Mass/Unit Area, min (oz/yd2)	ASTM D5261	7.0	4.0

[1] 320 is the softening/melting point of polypropylene. See Section IV for more on placement temperature.

C) Composite Paving Grids:

Type I, II, & III: Composite paving grids must consist of a fiberglass, polyester, or polyvinyl alcohol (PVA) paving grid integrated with a nonwoven geotextile and meet the requirements of Table 309:3. PG asphalt binders must be used for the installation of composite paving grids. Refer to manufacturer's recommendations for asphalt binder application rate.

TABLE 309:3
Composite Paving Grids

Property	Test	Type I	Type II	Type III
Tensile Strength, Min (lbs./in) [1]	ASTM D6637, Method A, modified	560 x 1,120	560	280
Aperture size, Min (in)	Calipered	0.5	0.5	0.5
Elongation, Max (%)	ASTM D6637	5	5	10
Mass per area, Min (oz/yd2)	ASTM D5261	16	10	5.5
Melting Point, Min (°F) (fabric component)	ASTM D276	320 [2]	320 [2]	320 [2]

[1] For Type I, machine, and cross direction respectively. Strengths for Type II and III are in both directions.

[2] 320 is the assumed softening/melting point of PVA. See Section IV for more on placement temperature.

D) Pavement Repair and Bridge Deck Waterproofing Strip Membrane:

Materials used for strip membranes shall be comprised of composite self-adhering rubberized asphalt attached to a paving fabric, a paving mat or a paving grid and meet the requirements of Table 309:4.

TABLE 309:4 Paving Repair and Bridge Deck Waterproofing Strip Membrane		
Property	Test Method	Type I
Strip Tensile Strength, min (lb./in)	ASTM D882	50
Puncture Resistance, min (lbs.)	ASTM E154	200
Permeance-Perms, max	ASTM E-96 Method B	0.05
Pliability - 1/4" Mandrel 180º Bend at -25 ºF	ASTM D146	No cracks in fabric or rubberized asphalt

Interlayer Products that meet OKC Specifications		
Revised 8/16/2023		
Type	Weight (OZ/SY)	Manufacturer
Paving Fabric		
Type I	6	MPV 700
Type II	4.5	MPV 600; Petromat 4597; Petromat Enviro
Paving Mat		
Type I	7	Tensar Glaspave 50; Huesker G50
Type 1 Moisture Barrier	7	MPM50E
Type II	4	Tensar Glaspave 25; MPM 30; Huesker G30
Composite Paving Grid		
Type II	10	MPG4 100; Tensar CompoGrid 100; Huesker G100
Type III	5.5	MPG4 60; CG50

309.03 EQUIPMENT

A) Equipment and Installer Certification

A certified installer, certified by the interlayer manufacturer, shall be used to install an interlayer for the City of Oklahoma City.

The certified installer shall only use interlayer manufacturer certified and approved equipment. The above approvals shall be in writing from the manufacturer.

The certified installer shall use a manufacturer certified installation utility tractor capable of installing roll widths up to 13 feet, has an approved clutch tensioning system, and has adjustable height brooms. If required by the manufacturer, the certified installer shall use sanding equipment that is able to adequately spread clean sand up to 4 lb./sy uniformly over lane widths up to 13 feet.

For PG asphalt binder installations for Paving Fabrics, Paving Mats, or Composite Paving Grids, the certified installer shall supply a distributor truck that can apply PG asphalt binders uniformly with a computerized rate control mechanism (accurate to 0.01 gal/sy), at temperatures up to 350 °F, without pooling, and able to spray at any of the manufacturers recommended application rates (greater than 0.10 gal/sy). It is recommended that the distributor truck have a dual pump and that the material filter be cleaned per the truck manufacturer's recommendations. Test method ASTM D2995 must be used to verify the application rate of the distributor truck. The minimum binder application rate shall be 0.20 gallons/SY.

The certified installer shall document the above requirements for the installer and equipment during the submittal process.

309.04 CONSTRUCTION METHODS

A. Ordering, Delivery and Storage

1. When bidding / ordering the interlayer materials the paving contractor, with close collaboration with the certified installer, shall identify the lane widths and appropriate interlayer product roll widths for the given lane geometry and sequence of milling and paving.
2. The contractor must provide the installer sufficient time to order the interlayer materials for a specific project, ideally 4 weeks for standard roll widths and 6 weeks for non- standard widths.
3. For both on-site and off-site storage, the contractor must take all necessary precautions to maintain the integrity of the interlayer in a state equal to what existed at the time of testing and certification. This includes but is not limited to ultraviolet protection, protection against rodents, contaminant chemical abrasion, and any other harmful elements. Interlayer must be stored and handled in accordance with manufacturer's recommendations and must remain in supplier packaging until ready for use. The interlayer must not be removed from packaging more than 7 days before the next layer of pavement structure is installed over it. The material must be kept covered and off the ground until installation to keep the material and cores dry.
4. The City Engineer will examine all interlayer rolls for water or physical damage prior to installation. Damaged rolls should be marked, removed from site, and replaced at the contractor's expense.

B. Surface Preparation and Interlayer Placement

Manufacturer's instructions must be followed, including the following:

1. A pre-pave meeting must be held no less than 14 days prior to paving or milling operations beginning. The pre-pave meeting may be held as part of the pre-construction meeting. The meeting participants must include the certified installer, the paving contractor, the City Engineer, at a minimum.
2. The surface to be covered by the interlayer must be clean, stable, dirt/dust free

and prepared according to the manufacturer's recommendations. On milled surfaces fine particulate should be removed by forced air / blowing equipment (e.g., backpack blowers, air compressors), in addition to mechanical brooms and/or vacuum sweepers. Cleaning equipment must not use water during the cleaning operation and thereby produce a dirt slurry.

3 Asphalt binder shall be applied per manufacturer's recommendations, based on asphalt retention rate for each interlayer product and additional rate for anticipated surface condition of pavement. Asphalt binder shall be a performance grade (PG 70-28) binder. PG 64-22 may be used when ambient temperatures are lower than 70 degrees F, with advanced approval by the City Engineer. The asphalt interlayer must be installed at or above the minimum temperatures recommended by City Engineer for asphalt paving. The asphalt binder type that will be used should be submitted to the Project Manager / City Engineer a minimum of 3 weeks prior to the start of the project.

4 The paving contractor must use a qualified installer for the specific interlayer products being installed AND a manufacturer's representative must be on site for the first two days of installation. The installer must use mechanical or hydraulic interlayer laydown apparatus and/or manual installation methods capable of installing interlayer material with minimal wrinkles.

5 Where interlayers with maximum elongation of 5% or less are specified on a milled surface, milling must be in accordance with Section 309, or special provision per the approved plans, to allow a pavement macrotexture MTD (mean texture depth) of less than 8.0 millimeters. As an alternative to fine / micro-milling, a leveling course may be placed on the milled surface prior to placing the geosynthetic pavement interlayer.

6 Longitudinal and Transverse overlaps must follow the manufacturer's recommendations for each interlayer product. All overlaps should exceed a minimum of 2 inches in all cases.

7 For the installation of Paving Fabrics, Paving Mats, Composite Paving Grids, follow the manufacturer's recommendations. The City recommends, transverse joints be sanded by hand before the installation utility tractor crosses the joint. The sand should be distributed evenly across the entire transverse joint using hand or push brooms on each side of the laydown unit.

8 Any installed interlayer found to be damaged or defective must be repaired per the manufacturer's recommendations or as approved by the City Engineer or removed from the jobsite and replaced by the Contractor at no additional cost to the City or the Awarding Public Agency. Mechanical equipment other than that used for installation and the paving equipment shall not be permitted directly on the interlayer surface unless authorized by the City Engineer.

C. Sanding of Interlayer Product

For the installation of Paving Fabrics, Paving Mats, Composite Paving Grids, follow the manufacturer's recommendations. The City recommends, sand be broadcast over the entire installed interlayer surface using approved sanding equipment (e.g., Salt Dog or agricultural conical spreader) at a maximum rate of 4 lbs./sy. The sand shall not conceal the interlayer, otherwise the sand application rate will need to be reduced, and the excessive sand redistributed. If the certified installer recommends that sanding is not necessary, then the contractor must get permission from the City Engineer to not

broadcast sand.

D. Asphalt Overlay Placement

If hot mix asphalt (HMA) temperatures exceed 350°F, products with polypropylene fabrics shall not be used. HMA shall be placed at a minimum of 285°F, to ensure asphalt cement absorption into the pavement interlayers. The first lift of HMA shall be at least 1.5 inches (38mm) compacted unless a different minimum thickness is recommended by the manufacturer. The City Engineer may remove pavement interlayer from the approved plans, if field conditions will not allow for this minimum thickness.

309.05 TESTING — VACANT

309.06 METHOD OF MEASUREMENT

Paving Fabric, Paving Mat, ~~Paving Grid,~~ Composite Paving Grid, and *Strip Membrane* shall ~~all~~ be measured in square yards complete-in-place and paid for at the contract square yard price. The quantity for payment shall be measured as the actual area covered by the asphalt binder, if applicable, ~~and tack coat emulsion if applicable,~~ and interlayer installed-in-place and accepted. No separate or additional measurement shall be made for overlaps or waste unless approved by the City Engineer.

309.07 BASIS OF PAYMENT

The City or Awarding Public Agency shall pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) PAVING FABRIC (TYPE) AND PG ASPHALT BINDER	Square Yard
(B) PAVING MAT (TYPE) AND PG ASPHALT BINDER	Square Yard
(C) COMPOSITE PAVING GRID (TYPE) AND PG ASPHALT BINDER	Square Yard
(D) STRIP MEMBRANE	Square Yard

Payment shall be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 310- MICRO SURFACING

310.01 DESCRIPTION

This section covers the materials, equipment, construction and application procedures for placing Micro Surfacing material, filling ruts, and surfacing existing paved surfaces. The Micro Surfacing must be a mixture of a polymer-modified asphalt emulsion, 100 percent crushed mineral aggregate, mineral filler, water and other additives for control of set time in the field. All ingredients must be properly proportioned, mixed and spread on the paved surface in accordance with this Specification and as approved by the City Engineer.

310.02 MATERIALS

Provide materials in accordance with Section 907 “Thin Surface Courses.”

A) Aggregate Storage

Handle mineral aggregate in such a manner as to prevent segregation, mixing of the various materials or sizes, and contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the project must be uniform. Suitable equipment of acceptable size must be furnished by the contractor to maintain the stockpiles and prevent segregation of aggregates. The aggregate must be passed over a scalping screen immediately prior to transfer to the Micro Surfacing mixing machine to remove oversized material.

B) Storage of Bituminous Material

Provide bituminous storage capacity of adequate to meet the requirements of the production rate. Keep all equipment used in the storage and handling of bituminous material in a clean condition at all times and operate in such a manner that there is no contamination with foreign matter.

310.03 EQUIPMENT

Submit all equipment, tools, and machines used in the performance of this work to the City Engineer for approval. Do not attempt any work with equipment that is malfunctioning. The City Engineer may order that the work be discontinued if sufficient equipment and tools are not in use to place the materials satisfactorily.

A) Mixing Equipment

Blend paving mixture with a self-propelled, positive, non-slipping aggregate delivery system (belt over chain) Micro Surfacing mixing machine. Ensure the machine has a continuous flow mixing unit able to accurately deliver and proportion the aggregate, polymer modified emulsion, mineral filler, field control additives and water to a revolving multi-blade, twin shafted mixer and discharge the mixed product on a continuous flow basis. Thoroughly blend the mixture so no uncoated aggregate is visible upon discharge from the mixing unit. Ensure the machine has self-loading material devices to allow continuous Micro Surfacing, thereby minimizing construction joints. Use a machine equipped with opposite side driving stations to optimize longitudinal alignment. Use a machine equipped to allow the operator to have full hydrostatic control of the forward and reverse speed during the application of the Micro Surfacing material. Continuous-run equipment will be required to ensure continuity of mix and reduction of start-up joints.

In some cases and with the City Engineer’s approval, truck mounted units may be used for short narrow roadways, crossovers, and irregular areas. Ensure truck mounted units are equipped with a positive, non-slipping aggregate delivery system (belt over chain) and have the capability of applying a minimum of 10 tons of aggregate without recharging the aggregate bin.

1. Water Pressure System

   Use a mixing machine equipped with a water pressure system and nozzle type spray bar to provide a water spray ahead of and outside the spreader box as required.

2. Calibration & Proportioning Devices

   Use a machine equipped with individual volume or mass controls or other gauging devices for measuring and proportioning each material added to the mix. Calibrate, properly mark, and positively interlock each material control device. Equip the aggregate feed to the mixer with a revolution counter or similar device so that the

amount of asphalt emulsion, aggregate and mineral filler used may be determined at any time. Calibrate each mixing unit prior to commencement of the work. Perform calibrations and verify such calibrations in the presence of the City Engineer. Once calibrated, any aggregate and emulsion flow changes require the approval of the City Engineer. The water and additives may be adjusted in the field to control the mix properties to produce an acceptable mix. With the City Engineer's approval, previous calibration documentation covering the exact materials to be used may be acceptable provided they were made within the last three (3) months.

3. Emulsion Pump

   Use a heated positive displacement type emulsion pump.

   Ensure the machine has a hydraulically adjustable (adjustable while applying mixture) type spreader box and positive screed adjustment for yield control. Attach a box to the mixer equipped with ribbon flights mounted on an adjustable shaft to continually agitate and distribute the material throughout the box.

   Provide a box equipped with curb bumpers and replaceable runners with a minimum of 5-foot long end runners. Ensure the box is equipped with a sufficient walkway to provide access to either side of the spreader box without walking through the freshly applied material. The box must be capable of laying mix to a width of 14 feet. The equipment must provide sufficient turbulence to prevent the mix from setting in the box or causing excessive build-up or lumps.

   To prevent the loss of mixture from the box, attach flexible seals, front and rear, in contact with the road. Use a full width application box equipped with a secondary strike-off located approximately 2 to 3 feet behind the primary strike-off to minimize transverse corrugations. Ensure the secondary strike-off has elevation and width adjustments similar to the primary strike-off, and has a pivot point where it can be tilted for texturing or raised completely off the surface.

   The use of burlap drags or other drags necessary to obtain the desired surface texture, must be pre-approved by the City Engineer. Replace drags that have excessive build-up. Keep drags in a completely flexible condition at all times.

B) Auxiliary Equipment

   Provide suitable surface cleaning equipment, barricading equipment, hand tools and other support equipment as necessary to perform the work.

310.04 CONSTRUCTION METHODS

Produce, transport, and place the specified materials in accordance with these Standard Specifications and as approved by the City Engineer. Provide a finished micro surfacing with a uniform texture free from excessive scratch marks, tears, or other surface irregularities. Ensure the cured mixture adheres fully to the underlying surface. Based upon a visual examination or test results, the City Engineer may reject any work due to poor workmanship, loss of texture, raveling or apparent instability. Repair any areas found to be deficient at the discretion of the City Engineer and at no additional cost to the City or Awarding Public Agency.

A) Seasonal and Weather Limitations

   Not apply Micro Surfacing when weather conditions prolong opening to traffic beyond a reasonable time. Spread the Micro Surfacing mixture only when both the pavement surface and the ambient temperature is at least 50°F and rising, the weather is not foggy

or rainy, and there is no forecast of temperatures below 32°F within 48 hours from the time of placement. Paving over ponded water is not allowed. Ponded water may be broomed and removed prior to placement.

B) Surface Preparation

Thoroughly clean the area to be surfaced to remove vegetation, loose aggregate and soil. Protect manholes, valve boxes, and other service entrances from the surfacing material. Unless otherwise approved by the City Engineer, pre-wetting of the surface will be required. Spray water ahead of and outside of the spreader box at an acceptable rate to dampen the surface without any free flowing water ahead of the spreader box.

C) Tack Coat

Normally, tack coat is not required unless the surface to be covered is extremely dry and raveled or is concrete or brick. Apply tack coat at a rate of 0.05-0.15 gal/yd2 of diluted emulsion diluted at 3:1 water to original emulsion. Allow the tack coat to set sufficiently before the application of Micro Surfacing. If a tack coat is to be required, it must be noted in the approved plans.

D) Application

1. General

Construct a minimum 500 ft. length test strip for approval by the City Engineer.

Fog spray the surface with water ahead of the spreader box when local conditions warrant. The rate of application of the fog spray may be adjusted as the temperature, surface texture, humidity, and dryness of the pavement change. The fogging operation must be used to dampen the existing pavement surface and no ponding of water is permitted.

Screening aggregates at stockpile is required to eliminate oversize materials in the mix.

Fill ruts, utility cuts, and depressions in the existing surface with preliminary Micro surfacing material where indicated and before final surface course is placed. Ruts greater than ½ in. in depth must be filled independently with a rut filling spreader box, either 5 ft or 6 ft in width. For irregular or shallow rutting ½ in. or less in depth, a leveling course may be used as approved by the City Engineer. Use the same spreader box for the leveling course as used for the surface course. However, use a steel or high density strike-off in lieu of a flexible rubber. Using a rut fill spreader box, crown each individual rut fill to compensate for traffic compaction at a rate of 1/8 in. per 1 in. of rut depth. Place rut filling and open to traffic a minimum of 24 hours prior to surfacing. All materials, mixture composition, equipment, and construction procedures and requirements must be as specified above.

Ensure the Micro Surfacing is the appropriate consistency upon leaving the mixer. Carry a sufficient amount of material in all parts of the spreader at all times to obtain complete coverage. Avoid overloading the spreader box. Lumpy or unmixed aggregate will not be permitted. Do not use aggregate either spilled from the lay-down machine or existing on the road. Do not leave streaks in the finished surfaces, and do not allow excess buildup, uncovered areas, or unsightly appearance on longitudinal or transverse joints.

Provide suitable width spreading equipment to produce minimum number of longitudinal joints throughout project. Place longitudinal joints on lane lines. Use

partial width passes only when necessary. Do not use partial width passes as the last pass of any paved areas. Provide a maximum overlap of 3.0 in for longitudinal joints. Provide maximum difference in joint elevation of 0.25 in when measured by placing a 10 ft straight edge over the joint and measuring the elevation difference.

2. Mixture

   Use Micro Surfacing of sufficient stability so that premature breaking of the material in the spreader box does not occur. Provide a homogeneous mixture during and following mixing and spreading, which is free of excess liquids. Do not spray additional water into the spreader box.

3. Handwork

   For surface areas which cannot be accessed by the mixing machine, use hand squeegees to provide complete and uniform coverage. Lightly dampen the area to be hand worked, if necessary, prior to mix placement. For handwork, exhibit the same finish as that applied by the spreader box as much as possible. Complete all handwork prior to final surfacing.

4. Lines

   Provide straight lines at intersections, curbs, and shoulders to yield a good appearance. Mask off the end of streets, if necessary, to provide a straight line. Longitudinal edge lines must not vary by more than ± 2 in horizontal variance in any 96 ft of length.

5. Cleanup

   Remove micro surfacing in all utility access areas, gutters and intersections as specified by the City Engineer. Remove all debris associated with the performance of the work on a daily basis.

E) Aggregate Application Rate

Control the spread rate for all full width Micro Surfacing, not intended as a leveling course, to within plus or minus two pounds per square yard of spread rate based on the weight of dry aggregate. Provide a full width spread rate of 18 pounds (for Type I) and 25 pounds (for Type II) per square yard, unless otherwise pre-approved by the City Engineer. A five-percent (5%) reduction in unit price will be applied for each pound of aggregate per square yard outside the spread rate tolerances established above for each day's placement of material. In lieu of pay reduction, the Contractor may elect to overlay the deficient area at no additional cost to the City or Awarding Public Agency. Do not continue operation and placement of materials outside the spread rate tolerances. Make adjustments as necessary in the placement operation to maintain production within the tolerances given.

310.05 TESTING — VACANT

310.06 METHOD OF MEASUREMENT

The City Engineer will measure completed Micro Surfacing as the relevant *Mineral Aggregate* pay item, by the dry weight (including mineral filler), and as *Polymer-Modified Emulsified Asphalt* by the volume or weight of the original emulsion.

When payment for Micro Surfacing is to be by the ton of aggregate, including mineral filler, and gallon of asphalt emulsion, provide certified scales capable of providing an automated ticket printout for each truck load of material delivered to the Micro Surfacing machine. Payment

requests must also include the project number, ticket number, truck number, date and batch weight of material loaded on each ticket.

Subtract the unused portion of emulsion from the total of the bill of ladings to determine total emulsion to be paid.

310.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) POLYMER-MODIFIED EMULSIFIED ASPHALT	Gallon or Ton
(B) TYPE I MINERAL AGGREGATE	Ton
(C) TYPE II MINERAL AGGREGATE	Ton
(D) TYPE III MINERAL AGGREGATE	Ton

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 311-HOT MIX ASPHALT / WARM MIX ASPHALT

311.01 DESCRIPTION

This section covers construction of one or more courses of bituminous mixture on the prepared foundation (roadbed or base).

Asphalt mixture includes Hot Mix Asphalt and Warm Mix Asphalt.

Hot Mix Asphalt (HMA) includes Superpave, Stone Matrix Asphalt (SMA), and Rich Bottom Layer.

Warm Mix Asphalt (WMA) is defined as an asphalt binder and aggregate mixture which, by additive or process, can be produced and placed at a reduced temperature from normal HMA temperatures. WMA requirements are the same as for HMA except where noted and specifically stated on approved plans.

311.02 MATERIALS

Provide asphalt materials in accordance with Section 908, “Plant Mix Bituminous Bases and Surfaces.”

The use of RAP in Stone Matrix Asphalt (SMA), Permeable Friction Course (PFC), Rich Bottom Layer (RBL),Open Graded Friction Surface Course (OGFSC), Open Graded Bituminous Base (OGBB), or Rich Intermediate Layer (RIL) mixes will not be allowed.

311.03 EQUIPMENT

A) Mixing Plants

Provide asphalt preparation plants in accordance with AASHTO M 156 and the City’s certification requirements.

Avoid exposing reclaimed asphalt paving material to the burner flame or high temperature

combustion gases. Ensure plants modified for this purpose meet the manufacturer's requirements for the specific modifications.

Allow the City Engineer access to the mineral filler feeder systems for approval before use.

Provide a closed system for storing and feeding mixtures with mineral fillers that maintains a constant material supply with minimal loss throughout the mix production system. Ensure the mineral filler measuring device provides a consistent percentage of filler. Provide a system that includes flow indicators or sensing devices to automatically stop mix production if mineral filler introduction ceases.

Provide a separate system for mixtures with cellulose fibers to feed fibers into the mixture to obtain a uniform distribution. Ensure the fiber supply system includes low level, no-flow indicators and a file or printout that tracks the feed rate. Include a section of transparent pipe in the fiber supply for observing consistency of flow or feed.

The City or Awarding Public Agency will inspect plants every six months, and after every move, for plants that do not have a current ODOT certification.

B) Scales

Provide digital scales to weigh the bituminous mixture. For approved automatic printer systems with an automatic batching and mixing control system, use the printed batch weights or truck scales. Provide a weigh ticket for each load to record the weights. Provide ODOT certification of scales every six months, and after every move, unless otherwise pre-approved by the City Engineer.

C) Pavers

Provide self-contained, self-propelled asphalt pavers equipped with an activated heated screed, and an automatic control device for placing the mixture to the slopes and grades shown on the approved plans. Ensure the pavers can spread and finish asphalt courses on lanes, shoulders, and similar construction to the widths and thicknesses shown on the approved plans.

Equip the paver with a receiving hopper and a distribution system to uniformly place and spread the asphalt in front of the screed without causing asphalt segregation. Equipment designed to pick up asphalt from windrows will not be allowed.

Ensure the paver can operate at forward speeds to consistently place the mixture.

Use a heated strike-off assembly to produce a finished surface that meets the specified evenness and uniform texture without tearing, shoving, or gouging the mixture or causing asphalt segregation.

D) Trucks and Transports

Ensure trucks hauling asphalt comply with legal load limits. Ensure trucks hauling asphalt have tight, clean, smooth metal beds thinly coated with a minimum amount of soap solution, lime solution, or other material that prevents the mixture from adhering to the beds. Prevent ponds of these anti-adhesive solutions from forming in truck beds.

Refrain from using solutions that contain diesel fuel or other contaminating solvents during material delivery.

Provide trucks with a canvas cover or other material large enough to protect the asphalt from the weather. Insulate the truck beds and fasten the covers so that the mixture remains at the specified temperature until delivery.

Provide transports to haul liquid asphalt materials in accordance with Subsection 908.03, "Asphalt Materials." Keep a record of the following:

- Delivery date,
- Asphalt grade,
- Source,
- Quantity,
- Invoice number, and
- Material hauled in the previous load.

Provide these records to the City Engineer with each pay request.

E) Sampling Device

Provide an aggregate sampling device that can obtain a representative sample from a belt or bin discharge in accordance with ASTM D75/D75M. Allow the City Engineer access to the device for approval before use. Ensure the device obtains the sample before the aggregate enters the dryer drum or drum mixer without stopping plant production.

F) Material Transfer Vehicle

Material Transfer Vehicle (MTV) is defined as equipment that transfers asphalt from the hauling units to the spreading and finishing machine.

Provide an MTV to place Stone Matrix Asphalt (SMA) mixtures. The City Engineer may exempt use of the MTV from portions of a project.

Equip the MTV with remixing augers or paddles to remix continuously asphalt in the transfer device, the paver hopper insert, or the paver's hopper.

MTVs that exceed 20,000 lb per axle will only be allowed to cross bridges if the unit's hopper is empty, the vehicle travels at crawl speed, and the wheels are placed over the underlying beam lines. For bridges in poor condition or posted for load limits, the City Engineer may determine additional limitations.

Ensure the MTV, the haul units, and the paver provide a continuous, uniform, non-segregated flow of material. Coordinate the number of haul units, the paver's speed, the plant production rate, and the MTV's speed to avoid stop-and-go operations. Do not raise the wings of the paver-receiving hopper while paving.

In the event of equipment malfunction, continue operations to place quantities in transit or in silos and to safely maintain traffic. Discontinue further operations until equipment is repaired.

Place a 500-ton test strip. The City Engineer will evaluate the MTV's performance by measuring the temperature profile of the mat immediately behind the paver screed using a non-contact thermometer at intervals of 50 ft. Each temperature profile consists of three surface temperature measurements taken transversely across the mat from 1 ft to 3 ft from the screed during the paving operations. Each profile will include three temperature measurements; one in the middle of the mat and two at the edges (1 ft inside each edge).

Stop producing asphalt mix if two of the temperature measurements in any profile differ by more than 10 ºF. Adjust operations before restarting the paving operation. The City Engineer may take additional surface temperature profiles during the project.

Contractors must use a Material Transfer Vehicle (MTV) when laying HMA surface course on an arterial street one half mile in length, or more.

G) Compactor

Use self-propelled, steel wheel, and pneumatic tired compactors. Ensure the steel wheeled compactors weigh at least 10 ton. Ensure the pneumatic tired compactors have at least seven pneumatic tires of equal size and diameter. Ensure the total weight of the tires produces an operating weight of at least 3,500 lb per tire. Inflate the tires to at least 90 percent of the maximum pressure recommended by the tire manufacturer. Maintain the tire pressure for at least 1 hour after the start of operations and ensure the range in pressure among the tires does not exceed 10 psi.

311.04 CONSTRUCTION METHODS

A) Stockpiling Materials

Deliver and stockpile aggregates in accordance with Subsection 109.17.05, “Stored Materials.” Ensure sufficient material is on-site for each day’s operation. Provide the City Engineer with daily quality control results.

B) Preparation of Materials

1. Bituminous Material and Aggregate

   Heat bituminous material and aggregate to temperatures in accordance with Subsection 908.03, “Asphalt Materials.” Provide a continuous supply of bituminous material to the mixer. Avoid localized overheating.

2. Dried and Heated Aggregate

   Adjust heater unit flames to avoid damaging or depositing soot on the aggregate.

3. Hot Dry Aggregates

   Screen and store the aggregate for plants that control the gradation of hot dry aggregates as follows:
   - At least two bins for Type S5 and Type S6 mixtures, and
   - At least three bins for all other mixtures.

4. Lime

   Provide hydrated lime or commercial lime slurry as the anti-stripping agent as needed to meet the requirements of Section 908. Add between 0.5% and 2.0% hydrated lime or commercial lime slurry solids by weight of the aggregates treated as shown on the mix design. Incorporate the lime in a manner that thoroughly and uniformly distributes lime onto the aggregate surface or into the mixture. Use approved metering equipment, to ensure the required quantity of lime is used. Fines collected by the baghouse or other dust-collection equipment may be reintroduced into the mixing drum.

   i. Hydrated Lime

      Add to the aggregate by one of the following methods unless otherwise shown on the approved plans or mix design:
      - Add lime in an approved pug mill mixer with damp aggregate containing water at least 2% above saturated surface dry condition.
      - Add lime into the drum-mix plant immediately before asphalt binder addition or in the pug mill of the batch plant before asphalt binder addition. If a batch plant is used, add dry mix aggregates and lime before adding asphalt binder.

ii. Commercial Lime Slurry

Add to the aggregate by one of the following methods unless otherwise shown on the approved plans or mix design:

- Mix commercial lime slurry in a suitable pugmill mixer with the aggregate.
- During mixture production, mix commercial lime slurry with aggregates between the plant cold feeds and the dryer or mixing drum.

C) Plant Startup Requirements for New Construction and Overlays

Use the mix design created for mainline construction to produce enough asphalt to calibrate the plant, testing equipment, and testing procedures before placing the asphalt. The City Engineer will sample and test the asphalt for asphalt cement content, aggregate gradation, air voids, and voids in mineral aggregate (VMA). Compare contractor test results with the City Engineer's; and contractor must make adjustments as necessary.

Use asphalt from the plant startup operation only to meet control strip requirements on temporary construction; do not place asphalt from the startup operations on the mainline. Make adjustments until all requirements are met. If no temporary locations are available, the plant startup mixture becomes the contractor's property at no additional cost to the City or Awarding Public Agency. The City Engineer may waive plant startup requirements if the same plant and location have previously successfully produced the same asphalt mix design.

D) Control Strip Requirements

If the approved plans requires less than 5,000 ton of an asphalt type, a control strip for that type of asphalt will not be required, unless otherwise indicated on the approved plans.

After meeting the plant startup requirements, construct at least one control strip on a detour to verify the required production mix characteristics and establish rolling patterns. If a detour is unavailable, construct on the shoulder; if a shoulder is unavailable, construct on the mainline. Place an initial asphalt control strip not exceeding 500 ton. With the City Engineer, sample and test this mixture for asphalt cement content, aggregate gradation, air voids, VMA, and roadway density. Place additional asphalt after evaluating the results and adjusting production and placement procedures as necessary.

If the City Engineer determines the initial placement of the asphalt control strip to be acceptable in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment," the City or Awarding Public Agency will pay for the control strip quantities in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment," and allow the contractor to proceed with production paving operations.

Unacceptable asphalt will not be allowed to remain in the mainline or the shoulder. Remove and replace unacceptable asphalt at no additional cost to the City or Awarding Public Agency.

Make adjustments to production and placement procedures if the placement of the initial asphalt control strip produces failing results, and repeat the test process for a second control strip. The City or Awarding Public Agency will make pay adjustments for deviations on the second asphalt control strip at the pay factor rate in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment." If required, create additional asphalt control strips on the shoulder until an acceptable mixture is produced (within the 100 percent pay factor range). The City or Awarding Public Agency will make

pay adjustments for asphalt control strips after the second asphalt control strip placement in accordance with Subsection 311.04.N(2)(a), “Basis of Acceptance and Payment.”

E) Mixing

Combine aggregates in the mixer in accordance with the mix design. Measure or gauge the bituminous material in accordance with the mix design, and load into the mixer.

Ensure the moisture content of the asphalt is no more than 0.75 percent at the point of mixture discharge. Uncoated or non-uniform mixtures will not be accepted.

Ensure deliveries to the storage silo or roadway are in accordance with the mix design during daily startup or shutdown of plant operations. Empty the plant and fill the cold feed bins with the proper aggregates before changing mixtures.

F) Mat Irregularities

Ensure the mat is free of segregation, non-uniform texture, bleeding, fat spots, and cracking.

G) Tack Coat

If required by the approved plans, provide a tack coat in accordance with Section 307, “Fog Seal and Tack Coat.”

H) Temperature and Weather Limitations

Ensure the minimum surface temperature of the foundation is in accordance with Table 311:1.

Table 311:1
Compacted Thickness and Surface Temperature

Lift Thickness, in	Surface Temperature, °F		
	Hot Mix Asphalt	Warm Mix Asphalt (Foamed)	Warm Mix Asphalt (Non-Foamed)
>3	40	35	35
2-3	45	40	35
<2	50	45	40

Do not place asphalt if frost exists in or on the foundation. Stop operations if the material becomes too cold to be leveled and consolidated. If it starts raining, stop plant production immediately. During adverse weather conditions, the contractor may place material already in transit; however, the contractor shall assume the risk of weather related impacts.

Do not place SMA if the surface temperature is below 60 °F.

I) Spreading and Finishing

Remove foreign material from the surface of the foundation before placing asphalt. Place the asphalt on a dry surface with a paver in accordance with Subsection 311.03.C, “Pavers.” Establish the alignment along one pavement edge with a string or wire line.

Do not windrow asphalt. Deliver the asphalt to the paver at the optimum temperature

shown on the mix design ±25 °F or as approved by the City Engineer, but not to exceed plant mix temperature of 345 °F.

Use hand tools to dump, spread, rake, and compact the asphalt to the compacted thickness in areas inaccessible to mechanical spreading and finishing equipment shown on the approved plans.

To ensure a continuous operation, operate the spreading and finishing machine at a uniform forward speed consistent with the plant production rate, hauling capacities, and roller train capability. Maintain a paver speed that will minimize stopping and starting between trucks. If the City Engineer determines that sporadic material delivery is adversely affecting the mat quality, the City Engineer may direct paving operations to suspend until the contractor makes adjustments.

Spread the asphalt mixture uniformly adjacent to curbs, gutters, manholes, and other structures so that the compacted surface is ¼ in above the edges of the structures. Before placing the mixture against these structures, clean and coat them with a thin, uniform tack coat in accordance with Section 307, “Fog Seal and Tack Coat.”

Correct unsatisfactory asphalt mat immediately. The City Engineer may suspend the paving operation until the contractor produces a satisfactory result. Remove and replace unsatisfactory asphalt as directed by the City Engineer at no additional cost to the City or Awarding Public Agency.

J) Joints

1. General

   Stagger longitudinal and transverse joints on succeeding layers by 6 in.

   Construct longitudinal joints within 1 ft of the lane lines and ensure the longitudinal joints in the top asphalt layer, or in the layer upon which an open-graded friction course will be placed, are at the lane lines.

   Bond and seal longitudinal and transverse joints. If making joints between old and new pavements, or between successive days’ work, create a continuous bond between the surfaces. Cut back the transverse edge of the previous course to its full depth to expose a fresh surface. Paint the edge with a tack coat and place the asphalt mixture directly against it. Rake the mixture to the depth and grade shown on the approved plans.

2. Longitudinal Joint Density

   Perform a joint density evaluation at each pavement edge that is or will become a longitudinal joint for each lot or sublot at locations where roadway density tests are to be taken. Determine the joint density in accordance with ODOT Test Method OHD L-14. The joint density is considered failing if the density at the joint is more than 3.0 pcf below the density at the random sample location at the same station and the measured (by core or correlation) joint density is less than 90%.

   Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if two (2) consecutive evaluations fail unless otherwise approved. Resume production after the City Engineer approves changes to production or placement methods.

K) Compaction

1. General

Operate compactors (rollers) in accordance with the manufacturer's recommendations.

Perform the initial compaction for each placed layer of asphalt mixture using steel-drum rollers and follow with self-propelled pneumatic-tired rollers. Finish with a steel-drum roller. At least two coverages with the pneumatic-tired roller on each layer is required. The City Engineer may require additional coverages on each layer.

Use rakes and additional fresh material to correct the surface if mat displacement occurs during rolling. Avoid displacing the line and grade of the edges of asphalt. Ensure the mixture does not adhere to the compactors.

Compact the mixture using hot hand tampers, smoothing irons, or mechanical tampers for areas inaccessible to compaction equipment. If approved by the City Engineer, use a trench compactor to transmit compression to depressed areas.

Remove mixture that is defective, loose, broken, or mixed with dirt, and replace with new asphalt, at no additional cost to the City or Awarding Public Agency. Compact to conform to the surrounding area.

Ensure the asphalt immediately behind the paver is at least 250 °F for HMA or 215°F for WMA. Before the temperature of the asphalt drops below 140 °F, compact thicker layers to the target density and thinner layers to the optimum density in accordance with Subsection 311.04.K(2)(a), "Layers At Least 1½ in Thick," and Subsection 311.04.K(2)(b), "Layers Less Than 1½ in Thick."

2. Acceptance

The City Engineer will accept layers at least 1½ in in nominal thickness on the basis of density in accordance with Subsection 311.04.K(2)(a), "Layers At Least 1½ in Thick."

The City Engineer will accept layers less than 1½ inch in nominal thickness on the basis of compactive effort in accordance with Subsection 311.04.K(2)(b), "Layers Less Than 1½ in Thick."

The City Engineer will accept layers of all thicknesses on a lot-by-lot basis. A lot is every 1,000 ton of asphalt. The City Engineer may terminate a lot and designate a new one if the contractor makes adjustments to the material or production and placement procedures.

i. Layers At Least 1½ in Thick

The target density of each lot is 95 percent of the Maximum Theoretical Density, determined by the specific gravity of the asphalt in accordance with AASHTO T 209.

The asphalt density for each lot is the average of three random samples from the lot. At times and locations directed by The City Engineer saw or core samples from the pavement of at least 6 in on the cut side or diameter. The City Engineer will perform tests on the samples or on the mat using a nuclear density gauge that has been correlated with roadway cores in accordance with ODOT Test Method OHD L-14.

City-approved tests in accordance with the following schedule will be the basis for acceptance and pay adjustments, if any:

Table 311:2 Pay Adjustments for Lot Density	
Pay Adjustment Factor (PAF) [a] % of Maximum Theoretical Density	Average Lot Density
>97.0 [c]	Unacceptable [b]
93.0 – 97.0 [c]	1.00
92.0 – 92.9	1.00 - (0.07)(92.0 - ALD)
89.1 – 91.9	0.93 - (0.15)(91.0 - ALD)
<89.1	Unacceptable [b]

[a] Use PAF for Roadway Density in the Combined Pay Factor equation in accordance with Subsection 311.04.N(2)(a), "Basis of Acceptance and Payment."

[b] Unless otherwise directed by the City Engineer, remove and replace unacceptable lots at no additional cost to the City or Awarding Public Agency.

[c] For RIL only, replace 97.0 with 98.0.

ii. Layers Less Than 1½ in Thick

Use test strips and monitor asphalt placement daily to obtain approval for rolling patterns generating optimum compaction. While the target is 95 percent of Maximum Theoretical Density, the City Engineer may base acceptance on the contractor's performance, as approved by the City Engineer, to obtain optimum compaction.

Compaction test strips consist of 500 yd² of asphalt pavement.

Construct enough strips to determine the number, size, and weight of compactors, and the number of coverages made by the compactors to obtain the acceptable density. Use an approved nuclear or non-nuclear density gauge to determine the density of the test strip.

Construct a new compaction test strip if directed by the City Engineer or at least one of the following conditions exists:

- There is a change in the material or mix design;
- There is reason to believe a compaction test strip density is not representative of the material being placed; or
- The foundation material has changed significantly.

Compact the asphalt in accordance with the approved rolling pattern. Ensure the rolling sequence, the type of compactor, and the maximum roller speed are in accordance with Table 311:3.

Table 311:3 Rolling for Compaction		
Rolling Sequence	Type of Compactor	Maximum Roller Speed, ft/s

Initial	Steel-Drum or Pneumatic-Tired	3.7
Intermediate	Pneumatic-Tired	4.4
Finish	Static Steel- Drum	4.4

Lower the production rate or add rollers to the paving operation to avoid exceeding the maximum roller speeds.

3. Documentation

Document asphalt pavement work in accordance with Subsection 311.04.K(2)(b), "Layers Less Than 1½ in Thick" if required by the approved plans. Include records of the City Engineer's authorizations and approvals, and the resulting corrective actions. Ensure the records include a detailed description of the equipment, including weight, tire pressure, speed, and the number of coverages. Ensure the roller operators and superintendent (or other contractor representative), sign the records at the end of each day's operation. Immediately after signing, submit the records to the City Engineer for inspection. Submit the records to the City Engineer at the conclusion of work on each day in accordance with Subsection 311.04.K(2)(b), "Layers Less Than 1½ in Thick."

L) Tolerances

1. Surface

Construct a finished pavement surface as shown on the approved plans and in accordance with Subsection 301.04.A(1), "Surface Elevation and Smoothness."

2. Width and Thickness

Construct a finished pavement structure in conformance to the widths and thicknesses of individual layers and the total thicknesses of asphalt shown on the approved plans or approved by the City Engineer.

M) Opening to Traffic

Not allow traffic on the pavement until after final rolling and the pavement has cooled sufficiently to ensure traffic will not damage the pavement surface. Use water or other artificial means to assist in cooling, as approved by the City Engineer.

N) Mix Properties

1. General

Provide quality control personnel to ensure the production of acceptable products. Ensure the quality control personnel oversee the process control of asphalt materials during handling, mixing, and placing operations.

At no time will the City Engineer provide instructions to the contractor or producer as to the setting of dials, gauges, scales, or meters; however, the City Engineer may advise the contractor or producer against continuing any operations or sequences of operations that will result in non-compliance with the approved plans requirements.

2. Acceptance

The City Engineer will accept and pay for, or reject, each lot of asphalt pavement

as defined in accordance with the following:

i. Basis of Acceptance and Payment

The City Engineer will consider asphalt cement content, air voids, and roadway density to determine acceptance and payment for asphalt pavement.

The City Engineer may use several test methods to determine acceptability of asphalt cement content, air voids, and roadway density (in accordance with Subsection 311.04.K, “Compaction”). The City Engineer will only use one test method, but may perform several tests using that method to measure each characteristic. The City Engineer will calculate the average deviation for each characteristic in accordance with Table 311:4, "Acceptance Schedule," and use the average to determine acceptance and calculate pay factors. For the characteristics of asphalt cement content and air voids, the City Engineer may disregard algebraic signs of the deviations to calculate averages. The City Engineer may address deviations above or below the target for these characteristics.

Perform sieve analyses in accordance with Subsection 908.04, “Composition of Mixtures,” or as modified by the special provisions. If a sieve analysis result does not fall within the tolerances specified in the JMF, provide test results that demonstrate that the asphalt mixture meets the following requirements in accordance with Subsection 908.04, “Composition of Mixtures”:

- The gradation falls within the broad band; and
- The air voids at N_{des} and VMA fall within the ranges.

The City and Awarding Public Agency reserve the right to require a new mix design if the broad band gradation, air voids at N_{des}, or VMA requirements are not met without additional cost to the City or Awarding Public Agency.

The City Engineer may apply calculated pay factors for asphalt cement content, air voids, and roadway density to all acceptable asphalt pavement. The City Engineer may consider additional pay factors for other characteristics including but not limited to smoothness. The City Engineer will base the total pay adjustments for deficiencies on the following:

- All pay adjustments will be based on the individual pay factors shown in Table 311:2, “Pay Adjustments for Lot Density” and Table 311:4, “Acceptance Schedule.”
- Except for smoothness, pay factors will be applied on a lot-by-lot basis.
- For smoothness, pay factors will be applied on an extent-by-extent basis.

Pay adjustments on lots, (all characteristics except smoothness) as each 1,000 ton (1,000 metric ton) lot is complete, will be made for deficiencies in asphalt cement content, roadway density, and air voids using the following formulas. If test results are incomplete at that time, an interim adjustment will be made assuming pay factors of 1.00 for the then unknown characteristics and corrected later when testing is completed.

The City Engineer will determine the total pay adjustment (combined pay

factor) for asphalt pavement with deviations, using the following equation:

$$CPF = \frac{4\,RD + 3\,AC + 3\,AV}{10}$$

Where:

CPF = Combined pay factor,
RD = Pay factor for roadway density,
AC = Pay factor for asphalt cement content, and
AV = Pay factor for air voids.

For layers less than 1½ in thick, the City Engineer will use a pay factor of “one" for roadway density. For permeable friction course, open-graded friction surface course, and open-graded bituminous base mixes, that do not have a target roadway density or target for air voids, the City Engineer will use pay factors of "one" for both roadway density and air voids.

ii. City Engineer’s Acceptance Procedures

Once a lot has been defined, maintain its identity throughout the mixing and placement process.

The City Engineer may perform varying amounts of the following sampling and testing per lot.

- Asphalt cement content test: one mixture sample randomly selected, split and tested in accordance with Table 311:4.
- Roadway density: three specimens randomly selected and each tested, averaged, and considered as one test in accordance with Table 311:2. Run one maximum theoretical specific gravity test or if applicable run two and average as one test split from the mixture sample.
- Air voids (lab-molded): two specimens split from mixture sample, tested, averaged, and considered as one test in accordance with Table 311:4.

The City Engineer will use Table 311:4 for determining acceptance and calculating pay factors:

Table 311:4
Acceptance Schedule

Characteristics	1 Test	Pay Factor
Deviation from JMF (Without Regard to Sign)		
Asphalt Cement Content (Extraction, Nuclear or Ignition Oven) Target JMF Percent	0.00 – 0.40	1
	0.41 – 0.80	1.40 - (Deviation from JMF)
	>0.80	Unacceptable [b]
Asphalt Cement Content (Digital Printout from Hot-Mix Plant) Target JMF Percent	0.00 – 0.20	1
	0.21 – 0.30	1.80 - 4x(Deviation from JMF)
	>0.30	Unacceptable b

Average of Deviations from Target (Without Regard to Sign)		
Air Void (Lab Molded Samples) [a] Target (Superpave, SMA) = 4% Target (RBL) = 2% Target (RIL) = 3%	0.00 – 1.50	1
	1.51 – 2.50	-0.16X + 0.24X + 1.00
	>2.50	Unacceptable [b]

[a] X is the average of deviations.

[b] Unless otherwise approved by the City Engineer, remove and replace unacceptable lots at no additional cost to the City or Awarding Public Agency.

O) Patching

Contractor must patch existing asphalt pavement as shown on the approved plans or as otherwise approved by the City Engineer.

P) Miscellaneous

On Residential Streets and low ADT Urban Collectors, S5 Surface Courses and S6 Surface Courses contractor must use binder grade PG 64-22 OK with no Reclaimed Asphalt Pavement (RAP). Design mixes, including acceptable test results indicating a final surface performance grade of PG 64-22 OK will be required prior to approval of a mix by the City Engineer for use in the City of Oklahoma City.

On Major Collector and Arterial Streets, S5 Surface Courses and S6 Surface Courses contractor must use binder grade PG 70-28 OK with no Reclaimed Asphalt Pavement (RAP). Design mixes, including acceptable test results indicating a final surface performance grade of PG 70-28 OK will be required prior to approval of a mix by the City Engineer for use in the City of Oklahoma City.

Where PG 70-28 OK or PG 76-28 OK asphalt is specified in the approved plans or proposal, the design mix must be based on > 3 million ESAL's.

It is the intent of these specifications to place a minimum of 0.94 x maximum theoretical density of the job mix design in pounds per cubic foot of Hot Mix Asphalt (HMA) resurfacing per square yard per inch thick of pavement to be surfaced. To allow for tolerance, HMA placed will be accepted for payment up to 1.02 x maximum theoretical density in pounds per cubic foot of the job mix formula per square yard per inch thick as shown on the Typical Section. In other words, the approved plan quantity cannot be exceeded by more than 9% or no additional payment will be made for the overage.

No additional payment will be allowed for HMA placed that exceeds the width or thickness shown on approved plans or approved by the City Engineer. The total weight of HMA placed for each square yard of pavement resurfaced shall be computed by dividing the total weight of HMA placed by the total square yards of pavement as shown to be resurfaced on the Typical Section and plans.

Low hanging tree limbs must be trimmed to allow the placement of hot mix asphalt. The cost of this work shall be included in other items of work.

1. Warm Mix Asphalt Material Requirements

   Upon approval by the City Engineer, Warm Mix Asphalt may be used.

2. Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)

Use of post-manufactured RAS or post-consumer RAS is not permitted.

On Residential, Arterial and Collector Streets, a maximum of 15% RAP is allowed in S3 Base Courses.

Natural sand allowed in all mixes containing RAP will be reduced by an amount equal to the natural sand in the RAP, which is assumed to be 30%.

311.05 TESTING

A) Pavement Thickness

It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the thickness shown on the plans.

Where any pavement is found not so constructed, the following rules relative to core drilling pavement, replacement of the faulty pavement and adjustment of payment shall govern. All pavements shall be cored and measured for thickness before being accepted by the City as hereinafter provided.

Thickness verification and pay adjustments will apply to the driving lanes, unless otherwise specified in the Plans or Contract. Asphalt used for drives, street returns, shoulders, sidewalks or temporary pavements will be exempt from the thickness verification procedure.

All hot mix asphaltic pavements that will be maintained by the City will be tested according to the following:

1. Overlay Projects with Designed Thickness Less Than 3 inches Thick:

   Asphalt pavement for overlays less than 3” thick will be tested for thickness verification and accepted by the engineer on a "Lot" by "Lot" basis. For asphalt pavements less than 3” thick, a "Lot" is defined as one (1) day of plant production unless more than 2,000 tons of asphalt pavement are placed on the project during one day’s production. When one day’s production exceeds 2,000 tons, the total tons placed that day will be separated into two equal sized “Lots”.

2. Projects with Designed Thickness of 3 inches and Greater:

   Asphalt pavement for projects that are 3” thick and greater will be tested for thickness verification and accepted by the City Engineer on a "Lot" by "Lot" basis. For asphalt pavements 3” thick and greater, a "Lot" is defined as 2,000’ of 12’ driving lane.

B) Core Drilling for Pavement Thickness Determination and Payment Reduction Calculation

All costs in connection with core drilling the pavement and refilling the core holes shall be borne by the Contractor. Core holes shall be filled and compacted in an acceptable manner with material matching the pavement from which the cores were cut. The coring of the pavement shall be performed by a City approved testing lab.

All asphalt pavements shall be cored and measured for thickness at a minimum of three locations per Lot as the City Engineer selects. The locations will be randomly spaced within the lot and not grouped together. Additional exploratory core locations will be added when the amount of thickness deficiency in any individual core falls within the “No Payment” classification, as further described herein.

The City Engineer will use the applicable Table 311:5 or Table 311:6 for acceptance and calculation of pay reductions due to thickness deficiencies discovered. The resulting

Reduction in Unit Price will be applied on a "Lot" by "Lot" basis as determined from the average Deficiency in Thickness of the three cores in that Lot. However, if any single core within a Lot has a Deficiency in Thickness that is in the “No Payment” range, exploratory cores will be taken to determine the limits of excessive deficiency and that area will be subject to correction or “No Payment” as directed by the City Engineer.

Table 311:5
TOLERANCE IN PAVEMENT THICKNESS
Overlay Projects with Designed Thickness Less Than 3 inches Thick

Deficiency in Thickness (Percent)	Penalty in Percent Reduction in Unit Price
0-5%	NONE
5-6%	5%
6-7%	10%
7-8%	15%
8-9%	20%
9-10%	25%
10-12.5%	50%
12.5-15%	75%
>15%	NO PAYMENT

Table 311:6
TOLERANCE IN PAVEMENT THICKNESS
Projects with Designed Thickness 3 inches and Greater

Deficiency in Thickness (Inches in Decimals)	Penalty in Percent Reduction in Unit Price
0.00” TO 0.25”	NONE
0.26” TO 0.30”	20%
0.31” TO 0.35”	30%
0.36” TO 0.40”	40%
0.41” TO 0.45”	45%
0.46” TO 0.50”	50%
0.51” TO 0.55”	70%
0.56” TO 0.60”	80%
0.61” TO 0.70”	90%
0.71” TO 0.75”	95%
OVER 0.75”	NO PAYMENT

The thickness of the asphalt will be determined by average of 9-point gage jig measurement of the thickness of each core, and the average thickness determined from the three cores for each Lot. In calculating the average thickness of the asphalt in a Lot, the maximum thickness of an individual core will be limited for core measurements that are in excess of the thickness specified on the plans. An individual core thickness will not exceed 5% more than the Designed Thickness for Table 311:5. An individual core thickness will not exceed 0.25” more than the Designed Thickness for Table 311:6.

The average thickness of the three cores per Lot shall determine the percent of Penalty that is used to calculate the Reduction in Unit Price for the tons/square yards so deficient.

If the average thickness exceeds the Designed Thickness or is within the acceptable tolerance (i.e., 5% or less deficient for Table 311:5 or 0.25”or less deficient for Table 311:6), the contract unit price will be paid in full for the tons in that Lot. The tons subject to the Reduction in Unit Price will be the equivalent theoretical tons required to construct the designed thickness and lane width for the limits of the lane length as determined for that Lot.

Should any individual core show a deficiency that would result in a Reduction in Unit Price of “No Payment” (i.e., greater than 15% deficient for Table 311:5 or greater than 0.75”deficient for Table 311:6), exploratory cores shall be taken each direction to identify the limits of the lane subject to the “No Payment” reduction. Exploratory cores will be taken at intervals of at least 25’, or as directed by the City Engineer, until the thickness of the pavement is within a tolerance that would result in a reduced price in lieu of “No Payment”. The tons subject to the “No Payment” Reduction in Unit Price will be the equivalent theoretical tons required to construct the designed thickness and lane width for the limits of the lane length as determined by the exploratory coring.

If, in the opinion of the City Engineer, a deficiency in asphalt thickness subject to “No Payment” is sufficient to impair seriously the service expected from the pavement, the Contractor will be required to remove the deficient area and to replace it with slab of a satisfactory quality and thickness as directed. The Contractor will receive no compensation for materials or labor involved in the removal and replacement of the defective slab. If, on the other hand, in the opinion of the City Engineer, there is no probability of immediate failure, he may allow the Contractor the choice of leaving the defective slab in place and receiving no compensation or payment for same, or of removing and replacing the pavement as provided.

If the Contractor believes that the cores and measurements taken are not sufficient to indicate fairly the actual thickness of pavement, he may request that additional cores and measurements be taken. The cost of additional cores and measurements will be paid by the Contractor. Cores will not be spaced closer than ten (10) feet.

Deductions for deficient thickness may be entered on any estimate after the information becomes available. No pavement shall be accepted for payment until it has been cored and provisions of Section 311 have been adhered to.

311.06 METHOD OF MEASUREMENT

The City Engineer will measure asphalt pavement as a combined mixture including the aggregate, liquid asphalt, and other materials required in accordance with the mix design.

The City Engineer will measure bituminous material by the gallon or ton.

311.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) SUPERPAVE, TYPE S3	Ton
(B) SUPERPAVE, TYPE S4	Ton
(C) SUPERPAVE, TYPE S5	Ton
(D) SUPERPAVE,TYPE S6	Ton

(E) STONE MATRIX ASPHALT	Ton
(F) RICH BOTTOM LAYER	Ton
(G) SUPERPAVE, TYPE S3 (PATCHING)	Ton
(H) SUPERPAVE, TYPE S4 (PATCHING)	Ton
(I) RICH INTERMEDIATE LAYER	Ton

The City will pay for asphalt by the lot, in accordance with Subsection 311.04.N (2), “Acceptance,” on the basis of acceptance test results and 311.05.A for thickness testing verification.

The City or Awarding Public Agency will pay for asphalt used for control strip requirements in accordance with Subsection 311.04.D, “Control Strip Requirements,” and Subsection 105.03, “Conformity with approved plans and Specifications.”

Include the cost of startup operations in the contract unit price for the relevant asphalt pavement pay item.

Include the cost of cutting samples and replacing sample materials in the contract unit price for the relevant asphalt pay item. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

The City or Awarding Public Agency will pay for tack coat in accordance with Section 307, “Fog Seal and Tack Coat.”

SECTION 312-COLD-MILLING PAVEMENT

312.01 DESCRIPTION

This section covers cold-milling and removing pavement surfaces to the specified depth, and removing ridges, ruts, and imperfections.

312.02 MATERIALS — VACANT

312.03 EQUIPMENT

Provide a milling machine that:

- Can plane at least 1½ in deep in a single pass;
- Is self-propelled;
- Has the power, traction, and stability to maintain accurate depth of cut and slope;
- Automatically establishes profile grades along each side of the milling machine by referring to the existing pavement with a ski or matching shoe, or by an independent grade control;
- Automatically controls cross slope; and
- Has an integral loading mechanism to remove the material cut from the pavement surface and discharge it into a truck in one operation.

312.04 CONSTRUCTION METHODS

Mill the existing pavement to the line, grade, and cross section shown on the approved plans, and provide a milled surface that has a uniform texture and a smooth riding surface for traffic. Ensure no deviations are greater than 3/16 in in a 10 ft section. Make corrections as approved by the City

Engineer.

Make passes to remove irregularities and to profile the surface to the depth and cross slope shown on the approved plans. Prevent traffic hazards. At the end of the daily milling operation, ensure that milled surface is smooth. Immediately apply fog seal to the milled areas, in accordance with Section 307, "Fog Seal and Tack Coat," unless overlaying the milled area with bituminous material on the same day.

Dispose of removed materials in accordance with Subsection 104.09, “Removal and Disposal of Salvaged Materials, Structures, and Obstructions.”

A) Proof Rolling

1. Pavement (Milled and Non-milled)

   i. Cold Milled Pavement:

      Proof roll the milled pavement surface to detect areas in need of pavement repair. The vehicle provided must have an axle load of 34,000 pounds. Proof Rolling must occur within 48 hours of milling operations. The entire milled surface must be proof rolled at a walking speed so that the construction inspector can mark the areas in need of pavement repair.

   ii. Non-milled Pavement:

      For pavement that has not been milled, the contractor must use a vehicle of equivalent weight and axle loading to perform the proof rolling, as approved by the City Engineer. The other requirements and basis of payment are stated above.

2. Pavement-Locating Water Valve Boxes and Manholes

   Prior to cold milling the pavement, the contractor must locate all water valve boxes and manholes by painting a “V” or “MH” on the top of the adjacent curb and measuring the perpendicular distance from the face of curb. Said measurements must also be painted on the top of curb and be provided to the construction inspector in writing including the adjacent address. If a water valve box or manhole has been previously covered and cannot be located, the contractor must nonetheless use all reasonable and necessary resources and methodologies to locate, adjust and construct a concrete collar around them per MD 11 or MD 12.

3. Fine Milling of Hot Mix Asphalt (HMA) or Portland Cement Concrete Pavement

   The removal of HMA or concrete pavement must be accomplished using a fine milling machine. The rotary drum must utilize carbide tip tools spaced not more than 5/16 inches apart. The forward speed of the milling machine must be limited to no more than 45 feet/minute.

   Protection must be provided around existing catch basin inlets, manholes, utility valve boxes, and any similar structures. Any damage to such structures because of the milling operation is the contractor’s responsibility and shall be repaired at the contractor’s expense. To prevent the infiltration of milled material into the storm drainage system, the contractor must take special care to prevent the milled material from falling into the inlet openings or inlet grates. Any milled material that has fallen into inlet openings or inlet grates must be removed at the contractor’s expense.

   The milled surface must provide a riding surface with a uniform textured

appearance. The milled surface must be free from gouges, longitudinal grooves and ridges, oil film, and other imperfections that are a result of defective equipment, improper use of equipment, or poor workmanship. The contractor, as directed by the City Engineer, must perform random spot-checks to assure the variation of the top of two ridges must not exceed ¼ inch. The variation of the top of any ridge to the bottom of the groove adjacent to that ridge must not exceed ¼ inch.

Any unsatisfactory surfaces produced are the responsibility of the contractor and must be corrected at the contractor's expense and to the satisfaction of the City Engineer. The depth of removal will be verified by the contractor by taking measurement every 250 feet per each pass of the milling machine, or as approved by the City Engineer. These depth measurements must be used to monitor the average depth of removal.

Where a surface delamination between HMA layers or a surface delamination of HMA on Portland Cement Concrete causes a non-uniform texture to occur, the depth of milling must be adjusted +/- ½ inch or until delamination is eliminated. No additional compensation shall be provided to remedy the delaminated surface. When removing a HMA pavement entirely from an underlying Portland cement concrete pavement, all the HMA pavement must be removed leaving a uniform surface of Portland cement concrete, unless otherwise approved by the City Engineer.

312.05 TESTING — VACANT

312.06 METHOD OF MEASUREMENT

This work will be measured for payment by the number of square yards of area from which the milling of asphalt has been completed and the work accepted. No area deductions will be made for minor un-milled areas such as catch basin inlets, manholes, utility boxes and any similar structures.

Clean the surface upon milling, and maintain the milled surface if left exposed to minimize dust, along with providing an asphalt wedge for pavement protrusions (valve boxes, manholes, etc.) bumps at each end of the milled street, etc. to the satisfaction of the City Engineer at no extra cost to the City or Awarding Public Agency. Proper signage must be placed to warn citizens of the potential hazards. All resulting pavement failures must be repaired at no cost to the City or Awarding Public Agency.

312.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
COLD MILLING PAVEMENT	Square Yard

The City or Awarding Public Agency will pay for fog seal in accordance with Section 307, "Fog Seal and Tack Coat" when required by the City Engineer.

This work will be paid for at the contract unit price per square yard for "Fine Milling" to the depth(s) specified. This price shall include all equipment, tools, labor, and materials incidental thereto.

Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

No additional payments will be made for multiple passes with the milling machine to remove the bituminous surface.

No separate payments will be made for cleaning the pavement prior to paving; providing protection and doing handwork removal of bituminous concrete around catch basin inlets, manholes, utility valve boxes and any similar structures; repairing surface defects as a result of the Contractors negligence; providing protection to underground utilities from the vibration of the milling operation; removal of any temporary milled transition; removal and disposal of millings; furnishing a sweeper and sweeping after milling. The costs for these items shall be included in the contract unit price for Fine Milling.

SECTION 314-PORTLAND CEMENT CONCRETE PAVEMENT

314.01 DESCRIPTION

This section covers construction of the following types of portland cement concrete (PCC) pavement on a prepared base:

- Plain jointed (doweled or undoweled),
- Continuously reinforced,
- Bonded overlay (over existing PCC or asphalt pavements), and
- Unbonded overlay (over existing PCC or asphalt pavements).

314.02 MATERIALS

Provide materials in accordance with the following sections and subsections:

Portland Cement Concrete	901
Fly Ash	902.01
Ground Granulated Blast Furnace Slag	902.02
Steel Reinforcement, Dowel Bars & Tie Bars	923

Provide bent tie bars in accordance with AASHTO M 31/M 31M, “Deformed Billet-Steel Bars for Concrete Reinforcement,” Grade 40.

Obtain prior written approval from the City Engineer if using reclaimed PCC materials. The City Engineer will only allow the use of reclaimed PCC materials only on temporary pavement. Provide the materials in accordance with Section 901, “Portland Cement Concrete.”

314.03 EQUIPMENT

Ensure the equipment is at the job site before construction begins.

A) Plants and Equipment

Ensure the batching plant includes bins, weighing hoppers, and scales for each size of fine and coarse aggregate. If using cement in bulk, include a bin, hopper, and separate scale for cement. Seal and vent the weighing hoppers to prevent dusting. Ensure gauges and dials function properly.

Give the City Engineer documented evidence that the batching plant produces quality concrete. Ensure the mixing plant is in accordance with AASHTO M 157, “Concrete Uniformity Requirements.”

Regularly clean the mixers. Repair or replace the pickup and throw-over blades that are worn one-sixth or more of the original blade width. Provide the manufacturer’s design or permanent marks on the blades to show the blade’s dimensions and configurations in reference to original height and depth. The contractor will drilling holes with a diameter of ¼ in near the ends and midpoint of each blade as reference points.

Vent storage silos for cementitious materials during filling or use. If using a pressurized air system for discharge, ensure that it has moisture traps to reduce caking of materials during storage.

The City Engineer will inspect the plants every six months or after every move. Provide certification of scales every six months or after every move, unless otherwise approved by the City Engineer.

B) Placing and Finishing Equipment

Provide a slip form paver or fixed form method to spread, strike-off, and finish concrete, unless otherwise approved by the City Engineer.

1. Slip Form Paver

   Provide a slip form paver to spread, consolidate, screed, and float-finish the concrete in one pass of the machine, to minimize hand-finishing. Provide a machine that uses vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface. Ensure the machine vibrates for the full width and depth of the pavement.

   Provide vibrating machines with following frequency ratings:

Table 314:1
Vibrator Frequencies

Vibrator type	Minimum frequency rating, Impulses/min
Surface Vibrators	3,500
Internal Type Tube Vibrators	5,000
Spud Vibrators	7,000
Spud Type Internal Vibrators	3,500

   Ensure the spud vibrators do not come into contact with the joint, load transfer devices, subgrade, or side forms.

   Prevent sliding forms from spreading using a rigid, lateral connection.

2. Fixed Form Method

   i. Finishing Machine

   Provide a finishing machine equipped with at least two oscillating-type transverse screeds for finishing the surface to the tolerances required by the approved plans.

Provide surface pan-type vibrators for pavement thicknesses no greater than 8 in or internal-type vibrators with immersed tubes or multiple spuds to consolidate the full width and depth of the pavement. Attach vibrators to the spreader or the finishing machine, or mount them on a separate carriage. Ensure the frequency ratings are in accordance with Table 314:1, "Vibrator Frequencies."

Ensure the vibrators do not come into contact with the joint, load transfer devices, subgrade, or side forms.

ii. Vibrating or Rotary Strike-Off Screeds

Provide forms and vibrating or rotary strike-off screeds to construct radii, inlet basins, gore areas, lane tapers, intersection quadrants, and areas inaccessible to mainline paving equipment. The City Engineer will not allow segregation or grout buildup. To achieve thorough consolidation and uniformity of the pavement, ensure the spud-type hand operated vibrators have a frequency rating of at least 3,500 impulses per minute.

3. Texturing Equipment

i. Burlap Drag

Provide fabric texturing equipment that consists of a drag of seamless strips of burlap or cotton that produces a uniform, gritty texture. Ensure a strip of fabric with a width of at least 3 ft is in contact with the full width of the pavement during texturing. Ensure the drag consists of at least two layers of fabric. Ensure the bottom layer of fabric is 6 in wider than the top.

ii. Transverse Finish

Provide a texturing machine that is a vibrating roller or a comb, equipped with steel tines. Ensure the machine is self-propelled and automatically lifts the roller or tine comb bar near the edge of the pavement. The City Engineer will allow hand-texturing in areas inaccessible to mechanical equipment.

iii. Longitudinal Tining

When longitudinally tining concrete pavement, use a mechanically operated tining machine with a single row of metal tines that covers the full width in a single pass at a uniform speed and depth. Provide a tining machine with automatic horizontal and vertical controls to ensure straight and uniform grooves. Ensure the tines produced meet the dimensional requirements of Subsection 314.04.I.(6)(a).

C) Concrete Saw

Provide a concrete saw that is conventional wet cut type or early entry dry cut type. Provide at least one standby saw. Maintain an ample supply of saw blades at the work site during sawing operations. Provide artificial lighting for night sawing.

D) Forms

Provide metal straight-side forms with thicknesses of at least 7/32 in and lengths of at least 10 ft. Construct forms to a depth equal to the concrete thickness shown on the approved plans, and capable of supporting equipment operating on the forms.

Use flexible or curved forms with devices for secure settings capable of withstanding

equipment impact and vibration for curves with a radius of 100 ft or less.

Ensure the flange braces extend out on the base at least two-thirds of the form height. Remove damaged forms, and use repaired forms that the City Engineer has inspected and approved. Ensure the top face of the form varies no more than ⅛ in in 10 ft from a true plane, and alignment varies no more than ¼ in in 10 ft. Clean the forms of concrete, grout, and other materials. Before use, cover the forms with a form-release agent.

E) Header Boards

Set header boards, cut to the cross section of the paving slab, parallel to the transverse joint if stopping paving operations and header boards are used. Design the boards to ensure accurate installation of dowels or tie bars as shown on the approved plans.

F) Floats

Provide mechanical or hand operated floats to smooth the concrete after strike-off and consolidation. Ensure the trowel blade of hand-operated floats are rigid, straightedge, from 12 ft to 18 ft long, and 8 in to 12 in wide. Ensure the float is capable of working longitudinally or transversely.

A finishing machine with the float pan type finisher may be used instead of a mechanical or hand-operated float if this method obtains the surface tolerances required by the approved plans.

G) Hand Tools

Provide work bridges, 10 ft straightedges, and other hand tools to complete the pavement as required by the approved plans. Replace warped floats or straightedges and defective finishing tools.

H) Spraying Equipment

Provide fully atomizing equipment to apply the white-pigmented curing membrane. Ensure it is equipped with a tank agitator that will keep the compound mixed. Ensure the City Engineer can verify the application rate based on tank capacity. Use pressure tank hand sprayers to apply the curing membrane to vertical surfaces, irregular areas, or edges after form removal.

I) Joint Sealing Equipment

Provide joint sealing equipment in accordance with Subsection 315.03, “Equipment.”

J) Milling Machine

Provide a milling machine in accordance with Subsection 312.03, “Equipment.”

K) Shot Blasting Equipment

Provide shot blasting equipment capable of collecting used shot and waste material. The City Engineer may allow the use of recycled shot.

314.04 CONSTRUCTION METHODS

A) Preparation of Existing Surface or Grade

1. General

Trim the grade to the elevation shown on the approved plans after grading and compacting the roadbed. Extend the work at least 3 ft beyond the edges of the concrete pavement. Ensure that subgrades and bases are in accordance with

Subsection 301.04.A, “Tolerances.” Ensure that asphalt base, bond breaker, and leveling course are in accordance with Subsection 301.04.A, “Tolerances.” Ensure the milled surfaces are in accordance with Section 312, “Cold-Milling Pavement.”

Correct the alignment and grade elevations of the forms and string lines immediately before placing the concrete. Reset and check disturbed forms or string lines.

Fill low areas with concrete during paving operations, not with material trimmed from bases or subgrades. Keep the grade smooth and compacted until pavement placement.

Ensure the subgrade or base is uniformly moist when placing the concrete unless waterproof subgrade or base course cover material is required by the approved plans.

2. Unbonded Concrete Overlays

   Construct the bond breaker as specified in the approved plans. When asphalt is specified, construct the base or leveling course in accordance with Section 311, “Hot Mix Asphalt / Warm Mix Asphalt.” Clean the pavement surface before placing the asphalt. If required by the approved plans, mill the surface before concrete placement in accordance with Section 312, “Cold-Milling Pavement.” After milling, tight blade the surface to remove ridges and loose material. Evenly distribute any remaining fine particles. Notify the City Engineer, if milling operations expose underlying concrete pavement. Spray exposed concrete with tack coat and cover with separator fabric.

3. Bonded Concrete Overlays

   i. Bonded Overlays on Concrete Pavement

      Remove medium and high severity pavement cracking before surface preparation and placement of the PCC overlay and replace as indicated. High severity pavement cracks are defined as shattered slabs, D-cracks into the wheel paths, broken slab corners into wheel paths, and cracks wider than ½ in that are faulting, spalled or scaled. Determine pavement-patching limits as approved by the City Engineer.

      1. Surface Preparation

         Prepare the entire surface to be overlayed by thoroughly cleaning the surface by milling and then shotblasting, or just shotblasting. The use of water to clean the cold-milled debris from the surface will not be allowed as slurry may develop and weaken the bond between the overlay and the surface. Remove all dirt, oil, laitance, or loose material from the surface and edges. Remove excess joint sealant on the surface; leave joint sealant in the joint slot. Remove pavement markings, raised pavement markers, and adhesives. Dispose of materials removed in the cleaning operation in accordance with Subsection 104.09, "Removal and Disposal of Salvaged Materials, Structures, and Obstructions."

      2. Surface Cleaning

         Clean the entire surface with an oil-free, compressed air blast before applying the overlay to the surface. The City or Awarding

Public Agency will allow the use of water for final cleaning only after the shotblasting operation, as approved by the City Engineer. Remove all freestanding water before placing concrete. After cleaning, the City or Awarding Public Agency will only allow the paving machine and the concrete delivery trucks to use the cleaned surface. Ensure the concrete trucks drive on the prepared surface directly in front of the paving machine. Prevent contamination of the cleaned pavement surface before placing the overlay. If the concrete becomes contaminated during concrete placement, stop production until the contamination is removed.

Do not contaminate the cleaned surface with oil, grease, water, mud, or other foreign objects from a concrete truck. Remove the truck from the cleaned surface, remove the contaminants, and ensure the truck is clean and repaired before returning to the project.

3. Joint Identification

Identify the exact location of both sides of contraction, expansion, and longitudinal joints in the existing pavement for sawing locations.

ii. Bonded Overlays on Asphalt Pavement

Prepare the surface to be overlaid by cleaning and milling. Remove dirt, oil, laitance, and loose material from the surface and edges. Remove pavement markings, raised pavement markers, and adhesives.

B) Handling, Measuring, and Batching Materials

Ensure the batch plant and hauling equipment continuously supply material to the work site. Deliver fine and coarse aggregate to the plant in advance to allow time for sampling and testing. Ensure the concrete plant contains enough material for a full day of paving operations. Deliver and stockpile materials in accordance with Subsection 109.17.05, “Stored Materials.”

Measure and batch materials for concrete in accordance with AASHTO M 157, unless otherwise required by the approved plans. Weigh different aggregate sizes in separate hoppers. Measure the cementitious material by weight. Use separate scales and hoppers with devices that indicate the complete discharge of the batch.

Use an electronically-controlled automatic batch weight and printer system that indicates the net batch weight of material delivered to the transporting truck. Ensure the weights are printed on a ticket that includes the quantities of admixtures and the volume of water incorporated into the load. Ensure the system is calibrated, inspected, and certified in accordance with Subsection 112.01, “Measurement of Quantities.” Ensure the combined weights of the materials, when converted to a volume, are within 2 percent of the volume on the ticket, minus the target air content.

C) Mixing Concrete

Mix and deliver concrete in accordance with AASHTO M 157. Mix the concrete at the work site, in a central-mix plant, or in truck mixers. Obtain the City Engineer’s approval as provided in these Standard Specifications, this Section 300, and the City Standard Details, and as for the type of truck mixer. Do not exceed the manufacturer recommended capacity. Place the mixed concrete no more than 1 hour after the water, cement, and aggregate are combined.

Mix the concrete from 45 seconds to 90 seconds if at the work site or a central mixing plant. Mixing time ends when the discharge chute opens. For multiple drum mixers, include the transfer time as part of the mixing time. Remove the contents of the mixer drum before starting the next batch.

Control the mixer's drum speed in accordance with the manufacturer's recommendations. The City Engineer may allow 10 percent overload of the mixer if the concrete does not spill and the concrete test data are satisfactory.

Ensure that a portion of the mixing water enters the drum before the cement and aggregates. Keep a uniform flow of water, and ensure that all water is in the drum within the first 15 seconds of the mixing. Keep the throat of the drum free from accumulations that restrict the flow of materials.

Adjust water to improve workability if transit mixers or agitators deliver the PCC. Increase mixing by 30 revolutions when adding water, and maintain the water to cementitious material ratio.

D) Light and Weather Limitations

Mix, place, and finish concrete when there is enough natural light, unless using artificial lighting approved by the City Engineer.

1. Concrete Temperature

   Ensure the temperature of the mixed concrete is from 50 °F to 90 °F during mixing, delivery, and placement. Protect the concrete quality through all weather conditions.

2. Base Surface or Foundation Course Temperature

   Place the concrete when the base temperature is below 110°F when placing an unbonded overlay. Reduce the temperature by spraying a fine water fog on the base. Ensure water does not pond in front of the plastic concrete. For waterproof bases, the City Engineer may also allow the following temperature control measures:

   - Apply white curing compound, or
   - Apply lime slurry.

   Do not place concrete if frost exists in the base.

   Place concrete when the base temperature is below 110°F if using bonded overlays. Cease paving operations if the base temperature exceeds 110°F; do not attempt to reduce the base temperature because water and other agents prevent proper concrete bonding.

E) Setting Forms

If using formed paving equipment, set the forms to line and grade by shimming, or other methods approved by the City Engineer. Correct variations in the foundation course that prevent placing forms to the line or grade shown on the approved plans. Stake forms in place with at least three pins per 10 ft section. Place a pin at each side of the joints. Tightly lock form sections, and ensure that there is no movement. Ensure the forms do not deviate from true line by more than ¼ in. The City Engineer will not approve forms that move under the finishing machine. Clean and oil forms before placing the concrete.

F) Placing Concrete

1. General

   Minimize rehandling when placing concrete on the grade. Discharge concrete into a spreading device and mechanically spread onto the grade to prevent segregation. Use truck mixers, truck agitators, or non-agitating hauling equipment capable of discharging concrete without segregation. Between transverse joints, place the concrete continuously without using intermediate bulkheads. Hand spread concrete with appropriate tools; do not use handheld vibrators to spread concrete. Ensure soil or foreign materials are not tracked onto the recently placed concrete.

   Ensure concrete cures for at least 3 days before allowing finishing equipment on it for placement of adjacent lanes. Before allowing other equipment onto the pavement, ensure that the concrete attains a strength in accordance with Subsection 314.04.N, “Opening to Traffic.”

   Ensure continuous forward movement if using a slip-form paver. Coordinate mixing, delivering, and spreading operations to provide uniform progress, minimizing stopping and starting. Stop vibratory and tamping elements if the forward movement of the paver stops.

   Consolidate concrete against the grade, face of the forms, and joint assemblies. Minimize the operation of vibrators in a single location to that required for consolidation.

   Deposit concrete near expansion and contraction joints without displacing the joint assemblies.

   Remove foreign materials that fall onto the completed slab as approved by the City Engineer.

   Do not place concrete without an inspector present, unless otherwise approved by the City Engineer.

2. Continuously Reinforced Concrete Pavement (CRCP)

   Use a standard, white, wax-based curing compound on the asphalt at the rate of 1 gal per 150 ft² to disrupt the bond between the asphalt and the CRCP. Allow the bond breaker to dry before placing the reinforcing steel bars.

   i. Preparation of Steel Reinforcement

      Remove dirt, oil, paint, grease, mill scale, and loose or thick rust from the reinforcing steel. The City Engineer may consider minor, thin, powdery rust that does not reduce the effective cross section to not be detrimental.

   ii. Placement of Reinforcement for Continuously Reinforced Concrete Pavement

      Place reinforcement on chairs or high chair bars. Ensure the horizontal position is within ½ in of the longitudinal dimensions and within 2 in of the transverse dimensions shown on the approved plans. Place the quantity of longitudinal and transverse members as shown on the approved plans. Ensure the vertical position is within ½ in of the longitudinal and transverse dimensions shown on the approved plans. Handle the reinforcement so that the bars remain flat and undistorted during concrete placement. Ensure the bars are free from kinks or bends that prevent assembly or installation. If using forms, oil before placing reinforcement.

Install the chairs or high chair bars to support reinforcement as shown on the approved plans. Arrange the chairs to ensure the reinforcement is not permanently displaced during placement and consolidation. Ensure the base supports the chairs, and prevents overturning and penetration into the base.

Space high chair bars adjacent to other transverse members to allow for proper concrete placement; especially important at reinforcement laps.

Do not weld chairs to transverse bars.

Provide the City Engineer with a sample of the chair or high chair bar if requested. Show the chairs and layout on the Working Drawings. If the chairs do not support the reinforcement during concrete placement and finishing, take corrective action to ensure the final position of the steel as required by the approved plans.

If the reinforcement consists of loose bars constructed on the grade, secure the longitudinal bars to the transverse bars using wire ties or clips to maintain the horizontal and vertical positions as indicated.

iii. Lap Splices in Reinforcing Steel

Lap the longitudinal reinforcing bars in a staggered pattern as shown on the approved plans. Secure laps in the longitudinal reinforcement by tying, fastening with clips, or otherwise securely fastening to ensure continuous reinforcement.

3. Unbonded Concrete Overlays

Place concrete on the grade to the minimum thickness shown on the approved plans. The City Engineer may only allow deviations for profile adjustments, cross-section adjustments, or both to be above the nominal thickness. When adjustments are necessary for grade or yield improvement, the thickness must not, in any case, be less than the minimum thickness shown on the approved plans.

G) Test Specimens

Provide concrete necessary for acceptance testing.

H) Joints

Construct joints perpendicular to the surface of the slab of the type, dimensions, and locations shown on the approved plans. Align the joints using guidelines or devices approved by the City Engineer.

Ensure the sawed joints are straight and true to line; repair joints that are not. Seal the sawed joints in accordance with Subsection 315.04, “Construction Methods.”

1. Longitudinal Joints

Saw and seal longitudinal contraction joints. Do not construct joints by any other method. Place deformed steel tie bars of a length, size, spacing, and material as indicated, perpendicular to the longitudinal joint. Place tie bars using mechanical equipment after concrete placement, or secure tie bars using supports to prevent displacement during concrete placement. Repair or replace loose bars at no additional cost to the City or Awarding Public Agency. Bars will not be allowed to be painted, coated, or enclosed in tubes or sleeves.

Saw the longitudinal contraction joint to the depth shown on the approved plans, without damaging the pavement or joint. Clean the sawed areas of dust, chalk, and contaminants and fill with an approved joint-sealing material.

Allow the joint sealant to cure before allowing construction equipment and other vehicles on the pavement. Adjacent surfaces should not vary by more than ⅛ in using a 10 ft straightedge.

2. Transverse Joints

    i. Expansion or Isolation Joint

    Make the expansion joint filler continuous from form to form. Shape it along the form from the base to the keyway. Provide lengths of joint filler equal to the width of the pavement, or the width of one lane.

    Use joint filler that is not damaged or repaired.

    Punch pre-molded joint filler to the diameter of the dowels. Unless otherwise approved by the City Engineer, use lengths equal to the width of the pavement. If placing two or more traffic lanes of pavement, use pre-molded filler in sections equal to the width of one lane. Clip or lace joint filler sections together if there is more than one section per joint. Extend the bottom edge of the filler to below the bottom of the slab. Unless otherwise required by the approved plans, ensure the top edge is 1 in below the surface of the pavement. While the concrete is being placed, protect the top of the filler using a metal channel cap of at least 10-gauge material, with flanges at least 1½ in deep.

    Withdraw the installing bar after striking off and placing the concrete on both sides of the joint, and leave the pre-molded filler in place. Before removing the installing bar and channel cap, vibrate the concrete and incorporate additional, freshly mixed concrete into depressions left by the installing bar. Expose the filler for the full width of the slab. Clean and re-oil the installing bar before installing the next joint. After removing the side forms, open the ends of the transverse joints at the edges of the pavement for the depth of the slab. Before opening the pavement to traffic, seal or top out pre-molded joints with joint-sealing filler required by the approved plans. Leave a uniform strip of joint-sealing filler slightly below the surface of the pavement.

    Use steel templates or other joint-forming dividers to construct concrete curbing joints that cannot be sawed, and install them at the locations indicated during concrete placement.

    ii. Contraction Joints

    Form transverse contraction joints by sawing to the depth as indicated without damaging the pavement or joint. Saw succeeding joints consecutively from the beginning to the end of the day's run, and saw all transverse joints soon enough to prevent uncontrolled transverse cracking.

    Clean and dry the sawed area. Keep it free from dust, chalk, contaminants, and spalling. Fill the sawed area with joint sealing material. Ensure the curing period for joints is complete before allowing construction equipment and vehicles on the pavement.

iii. Transverse Construction Joints for Jointed Pavement

Construct transverse construction joints when concrete operations are interrupted for more than 30 min, or as field conditions require during concrete operations. Ensure transverse construction joints are not constructed within 10 ft of expansion or contraction joints. If, at the time of interruption, not enough concrete has been placed to form a slab at least 10 ft long, remove the concrete to the preceding joint and dispose of in accordance with Subsection 104.09, "Removal and Disposal of Salvaged Materials, Structures, and Obstructions."

Provide a rigid header with holes or slots for dowel bars with the same spacing and dimensions of an expansion joint. Submit alternative header construction methods to the City Engineer for approval.

iv. Transverse Construction Joints for Continuously Reinforced Concrete Pavement

Install a transverse construction joint at the end of each work day or when paving operations are interrupted for more than 30 min, or as field conditions require during concrete operations. Form the joint by placing the concrete against a header board. Extend the longitudinal reinforcing steel through the header board and support from the base to prevent deflections.

Cover the reinforcement that extends beyond the header board with sheets of plywood or other material so that workers can walk on the steel without displacing it and concrete does not spill on the base during screeding operations.

Make construction joints and lap splices as shown on the approved plans.

Use hand vibrators to consolidate pavement areas adjacent to the sides of transverse construction joints and refinish the surface. Extend these areas at least 10 ft from the joint. Ensure the adjacent surfaces do not vary by more than ⅛ in using a 10 ft straightedge.

3. Lightweight Early-Entry Saw Joints

The City Engineer may allow the construction of transverse joints using a lightweight, early-entry saw.

Ensure the blade is ⅛ in thick and the sawed joint is at least 1½ in deep. Saw joints in accordance with the manufacturer’s recommendation. Begin sawing the joint when the concrete is hard enough to cut without raveling, chipping, spalling, or tearing. The City Engineer will inspect the sawed faces to ensure that early cutting does not cause joint undercutting. Delay sawing if undercutting is deep enough to cause structural weakness or excessive joint roughness. Saw the joints consecutively at the spacing required by the approved plans. Immediately after sawing, clean the cut and adjacent concrete surface. Re-spray damaged membrane-cured surfaces. Inspect the lightweight early-entry saw joints the next day. If a crack is not evident within 24 hour, re-saw the joint to a depth of T/3. Clean and seal joints in accordance with the manufacturer's recommendations, unless otherwise required by the approved plans.

Saw joints directly over existing transverse and longitudinal joints for bonded concrete overlays, and using the following methods:

- Overlay sections equal to or less than 4 in thick; saw the joints ½ in deeper than the overlay concrete; and
- Overlay sections thicker than 4 in; saw joints to a depth of T/3.

Saw the joints without causing excessive raveling, chipping, spalling, or tearing. Clean and seal joints in accordance with the manufacturer's recommendations, unless otherwise required by the approved plans.

4. Load Transfer Devices

The placement method of load transfer devices is optional.

Hold or mechanically place load transfer devices as shown on the approved plans. Place dowels parallel to the surface and centerline of the slab and vary no more than ⅜ in from the position shown on the approved plans. Cap expansion joint dowels as shown on the approved plans. Check the placement of mechanically injected dowel bars using a SOILTEST Model CT-4950A Micro-Covermeter, or an approved equivalent.

I) Final Strike off, Consolidation, and Finishing

1. General

Perform strike off, consolidation, and finishing in the following sequence:

- Strike off and consolidate,
- Float and remove laitance,
- Straightedge, and
- Finish the final surface.

Do not apply water to the concrete surface to assist in finishing operations, unless the City Engineer approves otherwise. If the application of water is approved, apply as a fog spray using approved spray equipment.

2. Finishing at Joints

Compact the concrete adjacent to the joints using mechanical vibrators to prevent voids between the concrete and the joint material, load transfer devices, and joint assembly units.

3. Slip-Form Paving

Use the slip-form paver to strike-off, consolidate, and initially finish the concrete. At the beginning of the day’s paving operation, straightedge the construction joint and the initial slab longitudinally and transversely until the machine produces slab smoothness in accordance with Subsection 301.04.A, “Tolerances.”

Ensure the edge of the pavement slab meets the elevations as indicated, and test using a 10 ft straightedge perpendicular to the centerline of the roadway. Ensure the outer 6 in of the pavement does not deviate more than ¼ in from the bottom of the straightedge. Test for compliance throughout the paving operation.

Correct valleys or depressions that do not drain, at no additional cost to the City or Awarding Public Agency. Limit hand-finishing to correction of surface defects.

4. Fixed-Form Paving

i. Machine Finishing

Strike-off and screed freshly placed concrete using a finishing machine.

Ensure the machine consolidates the pavement and creates a uniform texture. Keep the tops of the forms clean. To prevent an irregular finish, ensure the machine travels on the forms without lifting, wobbling, or moving unnecessarily.

Maintain a uniform ridge of concrete in front of the screed during the first pass of the finishing machine. Use a vibrator in accordance with Subsection 314.03.B, "Placing and Finishing Equipment," to vibrate the full width of concrete paving slabs.

ii. Hand Finishing

The City Engineer will allow hand-finishing methods under the following conditions:

- If the paving equipment breaks down, the concrete deposited on grade and in transit; and
- In narrow or irregular areas.

Hand finish in accordance with Subsection 301.04.A, "Tolerances." Use a portable screed to strike-off the freshly placed concrete.

Use a screed at least 2 ft longer than the maximum width of the slab. Use a vibrator or other equipment to consolidate the freshly placed concrete.

Move the screed on the forms, in the same direction as the paving operation, with combination of longitudinal and transverse shearing motions. Ensure the ends of the screed do not rise from the side forms during strike-off. Repeat this process to produce a uniform surface and texture, free of porous areas.

iii. Floating

Use a float to smooth and true the concrete after consolidating and striking-off the concrete.

Use long-handled floats to smooth and fill-in porous areas. Maintain the crown in the pavement. After floating, remove excess water and laitance with a straightedge. Lap successive passes one-half the length of the float blade.

5. Straightedge Testing and Surface Correction

Use a 10 ft straightedge to test the smoothness of the concrete surface while the concrete is still plastic and after floating and removing excess water. Hold the straightedge against the surface parallel to the road centerline. Advance the straightedge in successive stages of no more than one-half the length of the straightedge. Fill depressions with freshly mixed concrete, then strike-off, consolidate, and refinish. Cut and refinish high areas. Ensure that the adjacent surfaces across joints are smooth. Continue straightedge testing and surface corrections until the entire surface conforms to the grade and typical section shown on the approved plans.

6. Texturing

Use a texture burlap drag before the pavement final finish to produce a uniform surface of gritty texture on the entire pavement surface. For pavement at least 16 ft wide, mount the burlap drag on a bridge. Clean the drag of encrusted mortar;

Replace permanently encrusted drags with new ones.

i. Final Groove Finish

Mechanically groove and texture the driving lanes and ramps in a longitudinal direction when dragging is complete, as approved by the City Engineer. Grooves on shoulders will not be required, unless required by the City Engineer or otherwise required by the approved plans.

Tine the surface as specified herein, on any roads or streets with a posted speed limit of 45 mph or less or obtain written approval from the appropriate local official to provide an alternate finish. At least 14 days before beginning paving, submit the proposal with documentation of local impact to the City Engineer. Written approval from the City Engineer replaces the need for a change order, price adjustment, or both.

- Transverse Finish

Construct transverse grooves perpendicular to the centerline of the pavement. Transverse grooving consists of creating transverse grooves from ⅛ in to 3/16 in wide, from ⅛ in to 3/16 in deep, and spaced on a rake as shown on the approved plans.

Repeat the grooving pattern across the pavement. Form the grooves in the plastic concrete without tearing or bringing the coarse aggregate to the surface. Ensure the machine automatically lifts the roller or tines near the edge of pavement. Ensure the overlap between grooving passes is less than 3 in.

Use hand-groove methods in areas inaccessible to mechanical grooving equipment.

Identify the location of transverse contraction joints and ensure the nearest grooves are from 1 in to 3 in from the contraction joints before tining transverse grooves.

- Longitudinal Finish

Construct longitudinal grooves parallel to the centerline of the pavement when specified in the approved plans. Longitudinal tining consists of creating longitudinal grooves from ⅛ in to 3/16 in wide, from ⅛ in to 3/16 in deep, and spaced from ½ in to 1 in apart. Ensure the tining operation is done at such a time and manner that the desired surface texture is achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Start the grooves at least 6 in from the edge of the pavement. If the concrete pavement has concrete curbs, start the grooves at least 12 in from the face of curb. Ensure a 2 in to 3 in wide strip of pavement, centered about any intermediate longitudinal joints in the concrete pavement surface, is protected from longitudinal surface tining for the length of the concrete pavement surface.

Use hand-tining methods in small, isolated areas inaccessible to mechanical grooving equipment. Alternates to longitudinal tining may be allowed with the approval of the City Engineer.

ii. Edging at Forms and Joints

Round the edges of the pavement along the sides of the slab to the radius as shown on the approved plans after the final finish, but before the concrete sets. Produce a well-defined and continuous radius and obtain a smooth, dense mortar finish. At the joints, broom the surface to eliminate tool marks adjacent to the joints without damaging joint edges.

Test the joint smoothness before the concrete has set and make corrections in accordance with Subsection 314.04.H, "Joints."

J) Curing

Cover and cure the entire surface of the newly placed concrete immediately after completing the texturing operations so marring of the concrete will not occur, in accordance with one of the following methods:

- Cotton or burlap mats,
- Impervious membrane method,
- White polyethylene sheeting, or
- Curing for cold weather.

Failure to provide sufficient cover material, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concrete operations. Concrete may not be left exposed for more than 30 min between stages of curing or during the curing period.

1. Cotton or Burlap Mats

   Cover the pavement surface with mats. Use mats long enough or wide enough to extend beyond the edges of the slab by at least twice the thickness of the pavement. Saturate the mats with water. Secure the mats to keep in contact with the surface. Ensure the mats are moist for 72 hour after concrete placement, unless otherwise required by the approved plans or approved by the City Engineer.

2. Impervious Membrane

   Uniformly spray the pavement with white-pigmented curing compound in accordance with Subsection 901.07.C, “Liquid Membrane Curing Compounds” immediately after texturing operations and before the concrete sets. If the pavement is initially cured with cotton or burlap mats, apply the curing compound after removing the mats. Avoid applying the curing compound during rain.

   Use a mechanical sprayer, in accordance with Subsection 314.03.H, “Spraying Equipment” to apply the curing compound at a minimum rate of 1 gal per 200 ft². If the temperature on the roadway is more than 100 °F, apply the curing compound at a minimum rate of 1 gal per 150 ft².

   Ensure the compound is thoroughly mixed and the pigment is uniformly dispersed. The City Engineer will allow hand spraying irregular widths, shapes, and surfaces exposed by removed forms. Ensure the curing compound is not applied to the inside faces of joints.

   Ensure the curing compound creates a film that will harden within 4 hour of application. Use additional compound to repair damage to the membrane that occurs during the curing period.

   Apply curing compound to the sides of the slabs upon removing the side forms.

   Apply the curing compound immediately after texturing operations for bonded

overlays at a minimum rate of 1 gal per 100 ft², or as recommended by the manufacturer, to prevent moisture loss.

3. White Polyethylene Sheeting

   Cover the surface and sides of the pavement with polyethylene sheeting. Use sheeting long enough or wide enough to extend beyond the edges of the slab by at least twice the thickness of the pavement. Overlap adjacent sheeting units at least 18 in. Secure the sheeting to keep it in contact with the surface. Ensure the sheeting remains in place for 72 hour after concrete placement, unless otherwise required by the approved plans or approved by the City Engineer.

4. Curing for Cold Weather

   Maintain the quality and strength of the concrete during cold weather. Replace frost-damaged concrete at no additional cost to the City or Awarding Public Agency.

K) Removing Forms

Avoid damaging the pavement while removing forms. Cure the sides of the slab in accordance with Subsection 314.04.J(2), “Impervious Membrane.” Repair honeycombed areas.

L) Sawing and Sealing Joints

Saw and seal joints in accordance with Subsection 315.04, “Construction Methods.” Provide joints as shown on the approved plans.

M) Protection of Pavement

Protect the pavement from damage due to any traffic. If damage occurs to the pavement before the area is open to traffic, repair or replace the damaged sections at no additional cost to the City or Awarding Public Agency.

N) Opening to Traffic

Not allow traffic on the pavement for at least 14 days after concrete placement, unless otherwise approved by the City Engineer. The City Engineer may approve opening the pavement to traffic when it reaches the strength requirement in accordance with Subsection 901.01, “Mix Design and Proportioning.” With the approval of the City Engineer, the contractor may use maturity meters for the basis of form removal or opening roadways to traffic, at no additional cost to the City or Awarding Public Agency. Submit an approved plan for the use of maturity meters.

O) High-Early-Strength Concrete Pavement

Use high early-strength concrete pavement in accordance with Section 901, “Portland Cement Concrete.” Do not allow traffic on the pavement until it reaches the strength requirement in accordance with Subsection 901.01, “Mix Design and Proportioning.”

P) Protection Against Rain

Protect the surface from rain. Repair or replace damage due to rain, at no additional cost to the City or Awarding Public Agency.

Q) Tolerances

1. Surface

   Construct a finished pavement surface as shown on the approved plans and in

accordance with Subsection 301.04.A(1), “Surface Elevation and Smoothness.”

2. Width

   Construct a finished pavement width as shown on the approved plans and in accordance with Subsection 301.04.A(2), “Width.”

3. Thickness

   Determine the thickness of the pavement after grinding operations using the average of three caliper measurements of cores, tested in accordance with AASHTO T 24/T24M. Thickness will be in accordance with Subsection 314.04.R, “Acceptance of Pavement.”

R) Acceptance of Pavement

While the Contractor is fully and exclusively responsible for producing an acceptable product, acceptance responsibility rests with the City Engineer.

Determination of acceptability and pay factors for gradation, air content, strength, and thickness will be made in accordance with Table 314:2, “Acceptance Schedule.” The pay adjustments for the characteristics will be based on the following equations:

$$CPF = \frac{4\,(S+T) + G + AC}{10}$$

Combined Pay Factor for optimized gradation concrete;

$$CPF = \frac{4T + 2(S + OG + AC)}{10}$$

$$PA = (CPF - 1)(Q_C \times CUP_C + Q_p \times CUP_p)$$

Where:

CPF = Combined pay factor,

S = Pay factor for strength,

T = Pay factor for thickness,

G = Pay factor for gradation,

AC = Pay factor for air content,

PA = Pay adjustment,

OG = Pay factor for optimized gradation,

Q_c = Cubic yards of concrete in a 2,500 yd² lot (partial lots prorated),

Q_p = Square yards of concrete in a 2,500 yd² lot (partial lots prorated), and

CUP_p = Contract unit price of concrete placement ($/yd²).

Note: CUP_c and Q_c include only the concrete material. CUP_p and Q_p include all other labor and materials required in the concrete pavement (reinforcing steel, dowels, curing compound, etc.).

Pay adjustments will be based on the individual pay factors shown in Table 314:2 on a lot to lot basis. A lot will normally be defined as 2,500 yd². To ensure the overall quality of the material and workmanship, the City Engineer may reduce the size of a lot when multiple concrete placements occur. If test results are incomplete at that time, the City Engineer will make an interim adjustment assuming pay factors of 1.00 for the then unknown characteristics and will correct later when testing is complete. The total adjustment in pay for the four characteristics (gradation, air content, strength, and thickness) in the Table 314:2 will be the sum of the pay adjustments on individual lots.

Random samples will be used to test concrete and will test for all control test characteristics except smoothness on a lot to lot basis in accordance with the following requirements. Determination of acceptability and pay adjustments for smoothness, when applicable, will be covered by separate specifications. However, the City Engineer will reject any load of mixture that is visually unacceptable for reasons of being too wet, excessively segregated, or otherwise obviously deficient. Furthermore, the City Engineer may extensively test sections of completed pavement that appear to be seriously inadequate based on visual observation or knowledge of other deficiencies. The City Engineer may not use the results of such tests for pay adjustment purposes, but will use them to determine whether the section is totally unacceptable and must be removed. The City Engineer may reject pavement slabs with unsound concrete, uncontrolled cracking, malfunctioning sawed joints, spalling, honeycombing, surface irregularities, insufficient thickness, or other deficiencies associated with poor quality pavements.

1. City Engineer's Acceptance Procedures

   Once a lot has been defined, maintain its identity throughout the mixing and placement process. The City or Awarding Public Agency will use pay factors, determined from random sampling and testing of a lot at the appropriate locations, in computing its pay adjustment.

   The City Engineer will use Table 314:2 for acceptance and calculating pay factors.

Table 314:2
Acceptance Schedule

Characteristics	1 Test	Pay Factor [a]
Gradation [c] - Deviation from the target (without regard to signs):		
Coarse or fine aggregates % passing No. 200 sieve Target Spec. Range, %	0	1
	0.01–0.60	1−0.10x
	0.61–1.80	1.03−0.15x
	>1.80	Unacceptable [b]
Air content [c] - Deviation from the target (without regard to signs):		
Target = 6.0%	0–1.50	1
	1.51–3.00	$-0.10x^2+0.29x+0.79$
	>3.00	Unacceptable [b]

Strength [d] – Deviation from minimum strength of target (considering signs):		
Target = 3,000 psi	0–1,000 psi	Pay Factor = (Actual Strength/Specified Strength)
	>1,000 psi	Unacceptable [b]
Thickness [e] – Deviation from minimum (considering signs) (English):		
% Deficient	0–2.0	1
	2.1–4.0	1.10−0.05(PD)
	4.1–6.0	1.30−0.10(PD)
	6.1–8.0	1.60−0.15(PD)
	>8.0	Unacceptable [b]
Optimized Gradation f - Deviation from the target (without regard to signs):		
Combined aggregates % retained on any sieve above Target Spec. Range, %	0	1.00
	0.01 - 1.00	1 - 0.10x
	1.01 - 2.00	1.03 - 0.15x
	> 2.00	1.13 - 0.20x
[f] One specimen and one test for each combined gradation per lot.		

To determine the combined aggregate deviation used for optimized gradation concrete, the City Engineer will use the largest deviation from the target range of any individual sieve or gradation equation.

[a] Where x is the Average of Deviations and PD is Percent Deficient.

[b] Unless otherwise approved by The City Engineer, products testing in this range are unacceptable and must be removed and replaced at no additional cost to the City or Awarding Public Agency.

[c] Gradation and air content – 1 specimen and 1 test for each characteristic per sublot.

[d] Strength – 3 cylinders per lot averaged and considered as 1 test in Table 314:2.

[e] Thickness – After grinding operations, determine the thickness of the pavement using the average of 3 cores at times and locations directed by the City Engineer.

To determine the average thickness for a lot, the City Engineer may only consider the minimum thickness plus 2 percent for core thicknesses greater than 2 percent thicker than the minimum thickness (e.g. if the minimum thickness shown on the approved plans equals 10 in, the City Engineer may only consider 10.2 in for the average thickness determination for a core thickness of 10.3 in).

The City Engineer may not include in its average thickness determination measurements that are more than 8 percent thinner than the minimum thickness shown on the approved plans, or the measurements from exploratory cores. If the measurement of any core is thinner than the minimum thickness shown on the approved plans by 8 percent or more, take exploratory cores at intervals of at least 10 ft, parallel to the centerline until the City Engineer finds a core that is less than 8 percent thinner than the minimum thickness.

Fill core holes with concrete as required by the approved plans.

2. Unacceptable or Rejected Work

Replace rejected slabs with new pavement at no additional cost to the City or Awarding Public Agency. When replacing rejected slabs, remove a width of at least one lane and a length of at least 15 ft. If the removal is within 15 ft of any transverse joint, remove the slab to the joint. If a deficient unit does not warrant removal, as directed by the City Engineer, the City or Awarding Public Agency will not pay for the deficient unit.

314.05 TESTING — VACANT

314.06 METHOD OF MEASUREMENT

The City Engineer will measure PCC placement, of the type shown on the approved plans, by the area of accepted and complete-in-place pavement.

314.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) P.C. CONCRETE PAVEMENT (PLACEMENT)	Square Yard
(B)DOWEL JOINTED P.C.C. PAVT. (PLACEMENT)	Square Yard
(C) CONT. REINF. P.C.C. PAVT. (PLACEMENT)	Square Yard
(D) BONDED P.C.C. OVERLAY (PLACEMENT)	Square Yard
(E) FULL DEPTH P.C.C. PATCH (PLACEMENT)	Square Yard
(F) PARTL. DEPTH P.C.C. PATCH (PLACEMENT)	Square Yard

Include the cost of placing concrete pavements, including relevant labor and material, and the cost of reinforcing steel, load transfer devices, joint fillers, and joint sealants in the contract unit price for the relevant “Placement” pay items. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

The City and Awarding Public Agency considers the cost of coring and filling core holes to be included in the contract unit price for the relevant portland cement concrete pavement pay items.

The City or Awarding Public Agency will pay adjusted prices for deficient units of pavement in accordance with Subsection 314.04.R, “Acceptance of Pavement.”

SECTION 315--CONCRETE JOINT SEALING

315.01 DESCRIPTION

This section covers sawing, cleaning, and sealing joints in existing portland cement concrete pavement.

315.02 MATERIALS

Provide materials in accordance with Subsection 901.08, “Joint Fillers and Sealer.”

315.03 EQUIPMENT

Provide the following equipment:

A) Concrete Saw

Provide concrete saws capable of sawing concrete joints to the dimensions shown on the approved plans. No hand held saws allowed.

B) High-Pressure Water Pumping System

Provide high-pressure water pumping systems capable of flushing concrete slurry from sawed joints.

C) Sand Blasting Unit

Provide compressed air sand blasting units capable of cleaning joint surfaces as specified. Ensure the units include traps to remove free water and oil from the compressed air.

D) Air Compressor

Provide air compressors capable of delivering compressed air with a pressure of at least 90 psi. Ensure the compressors include traps to remove free water and oil from the compressed air.

E) Extrusion Pump

Provide air-powered extrusion pumps to apply joint sealer. Ensure the pump output is capable of delivering the volume of the joint sealer to the joint as specified.

F) Injection Tool

Provide a mechanical injection device to insert the sealer into the joint.

G) Joint Sealer Kettle

Provide a double-bottom oil-bath indirect-flame type kettle if the joint sealant requires heating. Ensure the kettle is capable of mixing, heating, delivering, and maintaining the specified temperature.

315.04 CONSTRUCTION METHODS

A) Sawing Joints

Saw the joints to the dimensions shown on the approved plans. Produce a joint of uniform width with cut faces on both sides along its full length. Provide a walk behind saw mounted on wheels. Hand held saws are not allowed.

B) Flushing Joints

Remove the slurry from the joint area after sawing by flushing it with a high-pressure water system and other necessary equipment.

C) Cleaning Joint Faces

1. General

Clean the sawed faces of the joints of foreign material before installing the joint sealer or filler

Do not blow-dry the joints with compressed air or use portable hand saws to clean joint faces.

2. Sandblasting

   Sandblast joint faces after they dry. Attach the sandblaster nozzle to a mechanical aiming device to direct the sandblast at a 45° angle and maintain sandblasting at less than 2 in from the joint faces.

   Blow out the joints after sandblasting using filtered (oil and moisture free) compressed air at least 90 psi and 120 ft^3/min. Use a blow tube that fits into the joint. Repeat the sandblasting and blowing until no residual dust or coating remains in the joint.

3. Joint Contamination

   Clean the joints of any contaminates (due to traffic or weather) before sealing joints.

D) Backer Rod

Install a backer rod before applying sealant if indicated in the approved plans or recommended by the sealant manufacturer. Use a backer rod of the type recommended by the sealant material manufacturer. Install backer rod to the dimensions shown on the approved plans.

E) Sealing Joints

Clean and seal joints on the same day.

1. Approval of Joints for Sealing

   The City Engineer will examine joints prepared for sealing. The City Engineer will not approve joints for sealing if the joints are contaminated or wet.

2. Installation of Joint Sealers and Fillers

   The City Engineer may require that a representative of the joint filler manufacturer, joint sealer manufacturer, or both be on the job site at the beginning of the joint-sealing. The contractor must demonstrate to the City Engineer the manufacturer's installation standards.

3. Application of Joint Sealers

   Apply the joint sealer using a City Engineer approved mechanical injection tool.

   Apply the joint sealer when the joint temperature is above 40°F and joints are clean and dry.

   Inject sealers into the joint. Ensure that the sealers bond to the joint face surfaces. For surfaces of joint sealers that require tooling, use an approved mechanical device to make a concave surface from ¼ in to ½ in below the pavement surface. Complete the tooling before a skin forms on the surface of the sealer. Do not use soap or oil as a tooling aid.

   Tooling is not required for self-leveling joint sealers

4. Bonding Failures

   Repair sealants that fail to bond to sawn concrete joint surfaces, at no additional cost to the City or Awarding Public Agency.

F) Traffic

Ensure the freshly applied joint sealant is no longer sticky before allowing traffic on it.

315.05 TESTING — VACANT

315.06 METHOD OF MEASUREMENT

The City Engineer will measure the length of concrete joint sealing after the joint sealant is in place.

315.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
CONCRETE JOINT SEALING	Linear Foot

The per linear foot payment for *Concrete Joint Sealing* shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these Standard Specifications and the approved plans. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 316--DOWEL BAR RETROFIT

316.01 DESCRIPTION

This section covers restoration load transfer in existing portland cement concrete (PCC) pavement by installing epoxy coated dowel bars across transverse joints or cracks.

316.02 MATERIALS

A) Dowel Bars

Provide epoxy-coated dowel bars in accordance with Subsection 923.08, “Epoxy Coated Reinforcement Bars,” of the dimensions shown on the approved plans. Provide tight-fitting, nonmetallic end caps that allow the bar to move ¼ in at each end.

B) Foam Core Board

Provide foam core board ¼ in thick, constructed of closed cell foam, and faced with poster board material on each side.

C) Dowel Bar Chairs

Provide nonmetallic dowel bar chairs to keep the dowel bars from moving during concrete placement. Place dowel bar chairs at the locations shown on the approved plans, within the vertical and horizontal tolerances.

D) Portland Cement Concrete Patching Material

Provide PCC patching material to backfill retrofit slots in accordance with Section 901.16,

"Dowel Bar Retrofit Mortar." Mix, place, and cure PCC patching material in accordance with the manufacturer's recommendations. The PCC patching material may be extended by using aggregate in accordance with Subsection 901.05, "Fine Aggregate," and Subsection 901.06, "Coarse Aggregate," excluding the gradation requirements. Provide and use a PCC mix design for the patching material (including additives) that develops a compressive strength of at least 4,000 psi in 6 hour.

Provide curing compound in accordance with Subsection 901.07, "Curing Agents."

316.03 EQUIPMENT — VACANT

316.04 CONSTRUCTION METHODS

A) Slot Sawing

Use a gang saw capable of sawing at least three slots in the pavement at one time. Center the slots over the cracks and transverse joints, and align the slots so that the longitudinal axis of each dowel bar is parallel to the pavement centerline and the surface of the lower of the two panels. Ensure the vertical and horizontal alignment does not exceed ¼ in.

B) Concrete Removal

Remove concrete from the slot area with a jackhammer no larger than the 30 lb class. If this jackhammer damages the pavement, discontinue its use and replace with a lighter jackhammer. Before installing the dowel, sandblast exposed surfaces and cracks in the slots, and clean slots of saw slurry and loose material. Dispose of loose material in accordance with Subsection 104.09, "Removal and Disposal of Salvaged Materials, Structures, and Obstructions."

C) Foam Core Board

Place the foam core board to maintain the continuity of the existing transverse joint or crack. Size the foam core board to fit tightly around the dowel bar and to the bottom and sides of the slots. Caulk existing transverse joints or cracks with approved sealant at the bottom and sides of the slots, as specified, to prevent patch mix from entering the joint or crack. Remove excess caulking to create a smooth, level joint or crack surface. Install the foam core board so that it remains in position and tight to all edges during patch material placement. The Contractor may use tabs to hold the foam core board in place and may cut or remove existing joint sealant to accommodate the tabs. If the foam core board shifts during the placement of concrete patching material, remove and replace at no additional cost to the City or Awarding Public Agency.

D) Dowel Bars

Cover the dowel bars with a thin coat of form release oil before beginning the placement of concrete patching material over the dowel bars. The City Engineer will not allow oil to contaminate concrete surfaces to be overlaid or the surfaces of the slots.

Place the dowel bar assembly (with chairs and foam core board attached) across the transverse joint or crack as specified. Ensure that chairs hold the dowel bars in place and provide at least ½ in clearance between the bottom of the dowel and the bottom of the slot. Remove and replace dowel bars that shift during the placement of concrete patching material, at no additional cost to the City or Awarding Public Agency.

E) Existing Concrete Surfaces

Ensure existing concrete surfaces in the slots are clean and dry, or prepared in

accordance with the manufacturer recommendations. Remove excess water from the slots before placing the concrete patching material.

F) Concrete Placement

Place concrete patching material into the slot, and vibrate to completely encase the dowel bar. The vibrator head's diameter must not exceed 1¼ in. Obtain the City Engineer's approval before placing concrete in ambient temperatures below 50 °F.

G) Damage

Repair damage to the existing pavement caused by contractor operations, at no additional cost to The City or Awarding Public Agency.

H) Slot Surface

Trowel-finish the top surface of the filled slot flush with the existing concrete surface, and allow the surface to cure. If the approved plans requires diamond grinding, leave the top surface of the fill slot not more than ¼ in higher than the existing concrete surface. Do not under fill the slots. Apply curing compound before the final set of the mortar in the concrete patching material.

Saw the new joint within 24 hour, or as approved by the City Engineer.

316.05 TESTING

A) Testing Concrete Patching Material

Test the concrete patching material once for each 4 hour of production, or at least once a day. Ensure the concrete patching material has a compressive strength of at least 4,000 psi in 6 hour. The contractor may test for compressive strength up to 24 hour after making the cylinders. If the compressive strengths are not met, cease production, and resubmit a concrete mix design that corrects the problems. Do not open lanes to traffic until the patch material achieves a compressive strength of at least 3,000 psi.

316.06 METHOD OF MEASUREMENT — VACANT

316.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
DOWEL BAR RETROFIT	Each

Payment will be considered full compensation for furnishing all materials, labor, equipment, supplies, tools and incidentals, and for performing the work in accordance with this specification.

SECTION 325--DIAMOND GRINDING CONCRETE PAVEMENT

325.01 DESCRIPTION

This section covers grinding portland cement concrete (PCC) pavement to restore drainage and riding characteristics to the pavement surface.

325.02 MATERIALS — VACANT

325.03 EQUIPMENT

Provide power-driven, self-propelled grinding equipment designed to smooth and texture PCC pavement with diamond blades. Provide a machine with an effective wheel base of at least 12 ft. Ensure the front of the machine has a set of pivoting tandem bogey wheels, and the rear wheels travel in the track of the cut pavement. Place the center of the grinding head no more than 3 ft ahead of the center of the back wheels.

Provide equipment that can cut or plane at least 4 ft wide to avoid a seam in the wheel path of a travel lane. Ensure the machine's shape and dimension do not encroach on traffic movement outside the work area. Do not use equipment that causes excessive ravels, aggregate fractures, spalls, or cracks, or disturbs transverse and longitudinal joints.

325.04 CONSTRUCTION METHODS

A) Grinding Pavement

Grind the surface of pavement areas shown on the approved plans. Grind longitudinally, beginning and ending at lines transverse to the pavement centerline. Ensure the ground pavement surfaces of adjacent sides of transverse joints and cracks are on the same plane. The City Engineer may allow less than 100 percent grinding within specified areas if minor depressions occur in the pavement.

Make multiple passes as necessary to achieve acceptable results.

Ensure the pavement surface grinding produces a uniform, finished surface. Eliminate joint and crack faults. Maintain a constant cross-slope between the edges of grinding operations to provide positive lateral drainage. Transition the grinding of auxiliary or ramp lanes from the mainline edge to provide positive drainage and a smooth riding surface.

Feather-grind adjacent lanes or paved shoulders to maintain motorist safety and proper drainage for pavement grinding deeper than ¼ in.

1. Surface Texture and Grooving

   Grind the pavement surface until it has a uniform appearance, with a texture composed of longitudinal ridges and grooves. Create surface grooves from 0.09 in to 0.15 in wide, spaced up to ⅛ in apart. Ensure the ridge peaks are at least 1/16 in higher than the bottom of the grooves.

2. Slurry Removal

   Remove and collect grinding slurry or residue by vacuum or other continuous methods. Dispose of the grinding slurry and residue in accordance with applicable laws, rules, and regulations. Do not distribute the slurry evenly on the side-slopes unless the City Engineer approves of the disposal method. Ensure that slurry does not enter drainage inlets and watercourses. Prevent the slurry from flowing across lanes used by traffic, or into gutters or other drainage facilities. Conduct a final sweeping before opening the pavement to traffic.

3. Pavement Smoothness

   - Profiling Pavement Surface

   Profile ground surfaces in accordance with ASTM E 1274. Provide a

profilograph with wheels variably spaced. Ensure a pavement with a profile index of 5 in or less per mile using a 0.2 in blanking width. Profile ground surfaces in two passes; one at 3 ft and one at 9 ft from the edge of each driving lane. Average the profilograph readings from the two passes to obtain the profile index for each lane.

If the profile index exceeds 5 in per mile, grind individual high points in excess of 0.3 in across the entire lane width.

Perform additional grinding along lines parallel to the pavement edge to reduce the profile index to the specified values after grinding individual high points. Grind in neat, rectangular sections with uniform surfaces.

- Straight Edge Tolerance

  Use a 10 ft straightedge to measure surface smoothness. Ensure the maximum distance from the bottom edge of the straightedge does not exceed ⅛ in in 10 ft. Perform additional grinding at locations in excess of ⅛ in in 10 ft. Ensure that the elevation difference between passes does not exceed ⅛ in.

B) Concrete Joints

Saw and seal joints in accordance with Section 315, “Concrete Joint Sealing.” after completing diamond grinding.

325.05 TESTING — VACANT

325.06 METHOD OF MEASUREMENT

The City Engineer will measure the diamond grinding of PCC pavement by the final approved textured surface area regardless of the number of passes necessary to achieve acceptable results, including minor areas of un-textured pavement within this area.

If the City Engineer determines the need for feathering is not caused by the Contractor, the City Engineer may measure the area of feathering as Diamond Grinding Concrete Pavement.

325.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) DIAMOND GRINDING CONCRETE PAVEMENT	Square Yard

The City or Awarding Public Agency will pay for sawing and sealing joints in accordance with Section 315, “Concrete Joint Sealing.” Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

Include the cost of feathering in the contract unit price for Diamond Grinding Concrete Pavement. The City Engineer will not separately measure Diamond Grinding Concrete Pavement for pavement unless otherwise specified.

SECTION 326--PRESSURE GROUTING PAVEMENT

326.01 DESCRIPTION

This section covers pumping a fly ash cement grout under portland cement concrete (PCC) pavement or asphalt pavement to fill the voids beneath the pavement and form a hard, insoluble mass.

326.02 MATERIALS

Provide materials in accordance with Subsection 933.09, “Slurry Grout.”

326.03 EQUIPMENT

A) Grouting Equipment

1. Measuring and Proportioning Equipment

   Provide equipment capable of measuring and proportioning grout components by weight. Use prepackaged materials as approved by the City Engineer.

2. Batch Mixing Tank

   Provide a watertight batch mixing tank with a high speed mixer to blend the materials into a homogenous mixture. Ensure the mixer includes a rotor operating in close proximity to a stator, creating a high shearing action with a mixing speed from 800 rpm to 2,000 rpm. Ensure the mixing pump continuously circulates the materials through the mixer and the mixing tank.

3. Holding Tank

   Provide a holding tank with a paddle-type agitator placed between the batch mixing tank and the grout pump for continuous operation. Ensure the agitator maintains complete circulation of the grout to keep it in suspension and remove air bubbles from the mix.

4. Grout Pump

   Provide a grout pump with a single action plunger pump with a high-speed backstroke. Provide a pump with precise pressure and capacity control valves, to independently preset maximum pressure and flow. Ensure a pump capacity range from 0 gal/min to 30 gal/min and a pressure range from 0 psi to 100 psi.

5. Discharge Line

   Provide a discharge line with a positive cutoff valve at the nozzle end. Ensure the nozzle remains securely sealed in the cored holes to prevent leaks.

6. Pavement Monitoring Device

   Provide pavement-monitoring equipment that determines movement, to prevent lifting pavement or overfilling cracks. Use a standard Benkelman Beam, or other equipment approved by the City Engineer.

B) Coring Equipment

Provide coring equipment capable of cutting 2 in diameter holes through the pavement.

Prevent damage to the pavement from excessive down pressure on the core. Use an air compressor and rock drills or other devices capable of drilling the injection holes through the pavement.

Air-driven or hydraulic impact drills will not be allowed.

326.04 CONSTRUCTION METHODS

A) General

Protect the pavement from breaking and cracking.

Replace concrete slabs and pavement damaged during pressure grouting operations, at no additional cost to the City or Awarding Public Agency.

B) Weather Limitations

Pressure grout when the ambient temperature is at least 35 °F and rising. Ensure a pavement temperature of at least 35 °F during pressure grouting.

C) Coring Holes

Drill 2 in diameter core holes through the pavement for PCC pavements as indicated. The City Engineer may modify the pattern and spacing of the holes.

Drill core holes at an angle of 45° towards the bottom of the crack, deep enough to penetrate the cavity for hot mix asphalt pavements. Drill at least two core holes for each 12 ft wide travel lane, and one hole for every 4 ft of shoulder width. Drill the core holes from 4 in to 12 in from the crack. Place the holes along one side of the crack or alternate along both sides of the crack. The City Engineer may modify the hole pattern and spacing. The City Engineer will approve the location of the core holes, and determine if additional holes are necessary to fill the cracks.

Temporarily plug irregular or unsatisfactory holes, or fill them with grout at no additional cost to The City or Awarding Public Agency. Drill core holes and grout in the same day, unless otherwise approved by the City Engineer.

D) Clearing Holes

Clean the holes of debris to provide a passage for the grout after drilling the core holes to the specified depths, and within 10 min before injecting the grout.

E) Grouting

Ensure the flow rate at the pump head does not exceed 7 gal/min while injecting grout. Secure the nozzle of the grout discharge hose in the core hole to provide a seal and maintain the grout pressure.

Prevent the nozzle end from extending below the bottom of the concrete for PCC pavement. Continue injecting grout into each core hole until the slab corner lifts from 0.032 in to 0.036 in, or until the pressure at the discharge nozzle exceeds 60 psi. If no slab lift or no pressure buildup occurs, continue injecting grout until the amount of clear grout flowing up through joints or cracks equals the amount of grout injected. Repeat this procedure in other holes to fill voids. If necessary, temporarily plug adjacent core holes during grout injection operation.

Continue injecting grout into the core holes until the cracks are filled for hot mix asphalt pavement. Continue pumping until the amount of clear grout flowing up through joints or cracks equals the amount of grout injected. Repeat this procedure in other holes to fill

voids. If necessary, temporarily plug adjacent core holes during grout injection operations.

During pumping, watch the pavement monitoring device to prevent excessive lifting of the pavement or rising of the adjacent shoulders. Correct lifted joints as directed by the City Engineer. If lifted pavement joints create unsafe conditions for the traveling public, close lanes and make repairs. Complete repairs and joint corrections at no additional cost to the City or Awarding Public Agency.

F) Permanently Sealing Holes in Concrete Pavement

Remove grout from the core holes and fill the holes with a stiff sand-cement mortar made of one part portland cement to three parts fine aggregate (by volume), or a commercial premixed rapid set mixture, as approved by the City Engineer.

Repair filled holes that ravel or become damaged at no additional cost to the City or Awarding Public Agency.

G) Regrouting

Drill new core holes and regrout slabs as directed by the City Engineer.

Drill new core holes and re-grout cracks for hot mix asphalt pavement that may require additional filling, as directed by the City Engineer. Provide excess grout to hand-finish into cracks to fill the voids as directed by the City Engineer.

H) Clean Up

Remove deposits of grout on the pavement or shoulder. Clean the pavement surface before allowing traffic on the completed sections. Remove other debris, bags, and spillage from the right-of-way each day.

I) Opening to Traffic

Restrict traffic from the grouted areas for 3 calendar days, or as approved by the City Engineer.

326.05 TESTING — VACANT

326.06 METHOD OF MEASUREMENT

The City Engineer will not include the weight of water or sand in the measurements of *Portland Cement* or *Fly Ash*.

326.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) CORED HOLES	Each
(B) PORTLAND CEMENT	Ton
(C) FLY ASH	Ton

The cost of water and sand to be included in the contract unit price for *Portland Cement* or *Fly Ash*. Payment will be considered full compensation for furnishing all material, supplies, equipment, labor, tool and incidentals to complete the work as specified.

SECTION 330--PAVEMENT AND BRIDGE DECK SMOOTHNESS

330.01 DESCRIPTION

This section establishes procedures for determining acceptability and pay adjustments as they relate to smoothness requirements of pavements and bridge decks. The equipment and testing applicable to this section must be provided and/or operated by the party or parties specified in Appendix A of this provision.

Except as noted herein, these special provisions apply to all types of portland cement and asphalt concrete pavements, as well as bridge decks constructed as part of this project, or as specified on the approved plans.

330.02 MATERIALS — VACANT

330.03 EQUIPMENT

A) Equipment and Installer Certification

Provide an approved profiler as described below. Ensure the equipment is certified by the Oklahoma Highway Construction Materials Technician Certification Board, and is capable of running on Portland cement pavements having a compressive strength of 2,500 psi without causing any damage to the pavement.

B) Profilograph

1. California Profilograph

Use a California profilograph supported on multiple wheels arranged in a staggered pattern so that no two wheels cross the same bump simultaneously and without a common axle. Mount the strip chart recorder on a lightweight frame 25 ft long. Measure the relative smoothness of the pavement or bridge deck by recording the vertical movement of a sensing wheel at least 6" in diameter attached to the midpoint of the frame. Record the graphical traces of the profilogram on a 1" to 1" scale for the vertical motion of the sensing wheel. Ensure the profilogram is driven by the chart drive on a scale of 1" of chart paper equal to 25 ft of longitudinal movement of the profilograph.

2. Light Weight Profilometer

Provide lightweight profilometer equipment meeting the following requirements:

- Mounted on a lightweight, motorized vehicle such as an all-terrain vehicle, golf car, or other City Engineer approved vehicle,
- Capable of running on concrete that has not achieved its design strength without causing damage,
- Contains an onboard, precision accelerometer that measures movement of the light weight profilometer,
- Contains an infrared or laser type non-contact vertical distance sensor mounted on the vehicle,
- Measures and provides the information as specified in subsection 330.04.B, “Evaluation”, and
- Measures the road profile in accordance with ASTM E950-98, Class I.

3. High Speed Profilometer

   Provide high speed profilometer equipment meeting the requirements of AASHTO M 328-14 *Standard Equipment Specification for Inertial Profiler*.

C) Calibration

Calibrate the profilograph or profilometer within the following limits:

1. Horizontal measurements must be within ±5 feet per 1,000 feet of distance tested.
2. Vertical measurements must be the same as those of the calibration blocks measured.

Submit a profilograph or profilometer calibration report to the City Engineer after every calibration using the appropriate form provided by the City Engineer. Calibrate the profilograph or profilometer the day of the testing prior to collecting the smoothness data. Repeat the calibration as directed by the City Engineer.

D) Provision and Operation of the Profilograph/Profilometer

If specified, provide a profilograph or profilometer operator, certified by the Oklahoma Highway Construction Materials Technician Certification Board, to perform profilograph or profilometer measurements, and to interpret and analyze the produced profilograms.

330.04 CONSTRUCTION METHODS

A) Surface Testing

Notify the City Engineer by phone 24 hours before performing any surface testing. If the City Engineer is unable to be reached by phone, notify the City Engineer in writing by email. Surface testing performed without proper notification or coordination with the City Engineer will not be accepted.

Provide traffic control for smoothness measurements regardless of the provider or operator of the equipment. If specified, use an acceptable and approved profilograph or profilometer to measure pavement smoothness. Collect profilometer readings or profilograph traces beginning at a location 25 ft prior to the beginning point of a project, including any exception areas, and through all bridges and changes in the pavement types to a location 25 ft beyond the ending point of a project, including any exception areas. The surface will be tested as soon as possible after the completion of the work. If milling is not required for overlay projects, the surface will be tested immediately before construction and as soon as possible after completion of the work to determine the percent reduction in the profile index in accordance with Table 330:2. However, the contractor may request in writing the elimination of the before construction testing requirement. Elimination of such testing will also eliminate the contractor’s option of using Table 330:2 for pay purposes.

For full depth asphalt pavement, test the next to last lift and perform any corrective action on bumps and dips by fine milling of the HMA in accordance with Subsection 312.04.B or as approved by the City Engineer prior to placing the final lift. Test the final lift to determine the pay adjustment.

For concrete pavement where a longitudinal construction joint is within 6 inches of the wheel path, provide an additional test along the joint for the purpose of determining corrective action. The pay adjustment will be based on the test within the wheel path.

The City Engineer will include smoothness deviations at construction and expansion joints when calculating the profile index and when identifying bumps.

Remove objects and foreign material on the surface before testing. Remove any protective covers before testing. Properly replace protective covers after testing. While testing for smoothness, produce a final trace. Produce a second trace for segments on which allowable surface corrections have been made. The second trace must contain a minimum of 50 feet on either end of the corrected area and it must have the correct stationing.

Propel the profilograph at a speed no greater than 3 mph. Gather data at lower speeds if the pavement or bridge deck is rough or profilograms are not being produced clearly.

Operate the profilometer at a constant speed as recommended by the manufacturer, but no greater than 20 mph for a light-weight profilometer.

The testing sequence of the pavement or bridge deck to be tested will be one pass per driving lane in the wheel path farthest from the edge of a pavement or bridge deck. The profilograph/profilometer must be within the planned driving lane when making a pass.

Provide the profilogram evaluations to the City Engineer, including at a minimum:

- Company name,
- Operator name,
- Federal/state project number,
- Job piece number,
- Route number/name,
- Lane description (NB, SB, EB, WB)
- Lane location (left, center, right)
- Pass description (1st, 2nd, etc.)
- Correct time and date,
- The electronic files from which the profilograms were derived, and
- An evaluation summary extended to include pay adjustments per segment and totaled, in spreadsheet format, within 14 days after the final trace is run.

A continuous graphical trace may consist of a single trace or multiple traces including the minimum overlap, and may be submitted as an electronic file to the City Engineer.

Take additional profiles only to define the limits of an out-of-tolerance surface variation. The City Engineer reserves the right to verify the testing, the evaluation, or both. The City Engineer's test results will be considered final. If the contractor's test results contain significant errors, the City or Awarding Public Agency may assess the cost of the verification efforts.

B) Evaluation

For pay adjustment purposes, evaluation of the surface testing results will be limited to the following specifications:

1. Profile Index

   An "extent" is defined as a segment of driving lane of pavement or bridge deck 528 ft long or the entire length of bridge, including approach slabs, whichever is less. Use ProVAL or other City Engineer approved computerized profilogram reduction system to calculate a profile index for an extent. Other computerized profilogram reduction systems must be submitted in writing to the City Engineer for approval. Calculate the index by summing the vertical deviations using a zero-blanking band (0.2 for bridge decks) as indicated on the profile trace. The City Engineer may

require additional field surveys to establish bump locations. Convert the measurements from inches into inch per mile. When the quantity represented is less than a full extent in length, the contractor may combine the quantity with an adjacent full extent or treat it as a separate extent.

2. Bumps

   Bumps may appear as high points on the profile trace and correspond to high points on the pavement or bridge deck surfaces. Unacceptable bumps are defined as bumps with vertical deviations greater than 0.60 in, without using a blanking band, in a 25 foot span.

3. Exceptions

   The following areas will be considered as exceptions:

   - Shoulders,
   - Ramps,
   - Two-way, left turn lanes,
   - Acceleration, deceleration, climbing, and turn lanes less than 528 ft,
   - Tapered transitions associated with shoulders, ramps, acceleration, deceleration,
   - Climbing and turn lanes,
   - Pavement with horizontal centerline curves with radii less than 1,000 ft and the superelevation transitions of these curves,
   - In overlays only, areas in roadway within a 10 ft radius of existing inlets, street returns, and utility covers (this exception does not apply to full depth pavements), and
   - Pavement areas requiring handwork (this exception does not apply to areas placed by hand for the contractor's convenience).
   - These exception areas will not require testing for smoothness, however the requirements for tolerances defined in subsection 301.04 of the Standard Specifications will remain in effect. For the above exceptions, the profile index, calculations and associated adjustments specified in this special provision will not apply.

4. Special Evaluation Requirements

   The City Engineer will evaluate bridge approach slabs in accordance with bridge deck smoothness requirements. There will be no exceptions made for any portion of bridge decks or approach slabs. The profile measurements for the entire length of the bridge deck and approach slabs will be used for the determination of the pay adjustments.

   The City Engineer will exclude the following from the profile index calculation used for determining pay adjustments for new pavements and overlays:

   - For a secondary street, the 25 feet that ties into an existing primary street as determined by the City Engineer,
   - The 25 ft that ties into existing bridges or approach slabs (this does not apply to new bridge construction), and
   - The 25 ft at the beginning and ending stations of the project (this does not

apply to multiple adjoining projects in a single contract).

These excluded areas will be tested for smoothness, and the requirements for mandatory correction of bumps as defined in this special provision and tolerances defined in subsection 401.04of the Standard Specifications will remain in effect. Such corrections (including grinding) will not affect pay adjustments of individual extents or a possible incentive for overall smoothness.

C) Surface Correction

Ensure all ground surfaces exhibit good workmanship and are neat in appearance. Ensure all ground final surfaces are in accordance with subsection 325.04.A.(1) of the Standard Specifications. Fog seal the surfaces of ground asphalt pavements. Cores for thickness determination, as applicable, will be taken subsequent to all corrective work. Perform all corrective actions, including identifying locations needing correction, and all work associated with the correction, at no additional cost to the City or Awarding Public Agency.

Grind the concrete in the vicinity of the joint as part of the corrective process when correcting bridge decks and approach slabs. Do not grind metal expansion joints. Do not reduce the concrete cover over reinforcing steel to less than 2 inches. Retexture the surfaces of corrected areas in accordance with Subsection 409 of the Standard Specifications.

1. Pavements

   Unless otherwise permitted in writing by the City Engineer, correct all new pavement surfaces to acceptable limits as specified below:

   - Reduce pavement extents having indices in excess of acceptable limits in Table 330:1 (greater than 46.9 in/mi), not including areas defined in Subsection 330.04.B.(3) “Exception” or 330.04.B.(4) “Special Evaluation Requirements,” to a Profile Index of 35.0in/mi or less.
   - Reduce surfaces having individual bumps in excess of 0.60 inch in a 25 foot span, including any areas defined as “Exception” (subsection 330.04.B.(3)) or “Special Evaluation Requirements” (subsection 330.04.B.(4)), to a Profile Index below 0.60 inch in 25 foot span.
   - When an unacceptable pavement extent or bump is permitted to be excluded from correction in writing by the City Engineer, the location will be considered a “ground area” for the purposes of incentive determination in accordance with 330.06 “BASIS OF PAYMENT” of this provision.

2. Bridge Decks and Approach Slabs

   Unless otherwise permitted in writing by the City Engineer, correct all new bridge decks and approach slabs to acceptable limits as specified below:

   - Reduce extent of bridge decks and approach slabs having indices in excess of acceptable limits in Table 330:3 Class I to a Profile Index of 36.0 in/mi or less, or Table 330:3 Class II to a Profile Index of 40.0 in/mi or less as applicable.
   - Reduce surfaces having individual bumps in excess of 0.60 inch in a 25 foot span to a Profile Index below 0.60 inch in 25 foot span.

330.05 TESTING — VACANT

330.06 METHOD OF MEASUREMENT — VACANT

330.07 BASIS OF PAYMENT

There will be no separate payment for providing and/or operating a profilograph or profilometer. Include such costs, and any other costs related to smoothness measurements or evaluations, in the price for Contractor's Quality Control when the proposal contains a pay item for quality control and acceptance. Otherwise include such costs as incidental in the prices of other items.

Failure to provide the information listed in subsection 330.04.A for profilogram evaluations will result in a $500 pay deduction per instance to be applied on the pay adjustment.

The pay adjustments shown in the following tables are for extents of 528 feet in length. Pay adjustments for extents of different lengths will be reduced or increased proportionally. (i.e. adjustment for a 792 feet extent is equal to the pay adjustment from the Table multiplied by 1.5).

The pay adjustments shown in the following tables are for extents of 12 feet in width. Pay adjustments will not be made for extents of different widths.

A) Pay Adjustment for Pavements

The City Engineer will base pay adjustments for smoothness of pavements on the initial profile indices determined before corrective actions.

The City Engineer will base smoothness pay adjustments for pavement sections removed and replaced or overlaid as approved by the City Engineer on the profile indices determined after the corrective actions, but before grinding. The City or Awarding Public Agency will not increase pay for pavements with grinding. The smoothness pay adjustment will be determined for each extent in accordance with Table 330:1 or, when applicable, Table 330:2. In the event that the pay adjustment from Table 330:2 results in less pay than that established by using Table 330:1, the adjustment will be derived from Table 330:1.

Table 330:1
SMOOTHNESS PAY ADJUSTMENTS
Pavements

Profile Index (in/mi)[2] (greater than 45 mph)	Adjustment[1] ($ / Extent)	Profile Index (in/mi) [2] (45 mph or less and ramps)	Adjustment [1] ($ / Extent)
15.0 or less	1,250	19.0 or less	1,250
15.1 to 25.0	3,125 - 125*x*	19.1 to 29.0	3,625 - 125*x*
25.1 to 35.0	0	29.1 to 39.0	0

35.1 to 41.0	14,000 - 400*x*	39.1 to 45.0	15,600 - 400*x*
41.1 to 46.9	32,450 - 850*x*	45.1 to 50.9	35,850 - 850*x*
47.0 or more	-7,500 [3]	51.0 or more	-7,500 [4]

Where "*x*" is the profile index (in/mi.)

[1] These pay adjustments are for 10" thick asphalt and 8" thick P.C. concrete pavements. Pay adjustments for pavements or overlays of different thicknesses will be reduced or increased proportionally, based on the typical section for the extent. (i.e. pay adjustment for a 12" P.C. concrete pavement is equal to the adjustment from the Table multiplied by 1.5).

[2] Except as noted in subsection 330.04.B.(4) pay adjustments for roadways (including ramps and service roads) will be based on posted speed limits.

[3] Correct pavement extents with profile indices greater than 46.9 in/mi to 35.0 in/mi or less at no additional expense to the City or Awarding Public Agency. The required correction will not increase payment unless deficient sections are removed or overlaid. Failure to correct to 35.0 in/mi will result in zero payment for the affected extents.

[4] Correct pavement extents with profile indices greater than 50.9 in/mi to 39.0 in/mi or less at no additional expense to the City or Awarding Public Agency. The required correction will not increase payment unless deficient sections are removed or overlaid. Failure to correct to 39.0 in/mi will result in zero payment for the affected extents.

TABLE 330:2
SMOOTHNESS PAY ADJUSTMENTS
Overlays - No Milling Required

Total Nominal Thickness > 1.5 inches	
Reduction in Profile Index (%)	Adjustment ($ / Extent) [1]
90.0 or more	140
90.0 through 60.0	10*x* - 760

60.0 through 50.0	40*x* - 2,560
Less than 50.0	Unacceptable
Total Nominal Thickness < 1.5 inches	
Reduction in Profile Index (%)	Adjustment ($ / Extent) [1]
85.0 or more	140
85.0 through 55.0	10*x* - 710
55.0 through 45.0	40*x* - 2,360
Less than 45.0	Unacceptable

Where "*x*" is the reduction in the Profile Index (%)

[1] The above adjustments are for 1" thick asphalt or concrete overlays. Adjustments for overlays of different thicknesses will be reduced or increased proportionally, based on the typical section for the extent (i.e. adjustment for a 2" overlay is equal to the adjustment from the Table multiplied by 2).

B) Pay Adjustments for Bridge Decks and Approach Slabs

For those sections corrected or ground in a manner approved by the City Engineer pay adjustments for smoothness of bridge decks will be based on the profile indices determined after corrective actions. Pay for a bridge deck or approach slab extent that is corrected or ground for any reason will be limited to a maximum of full pay, including extents whose profile indices would otherwise justify incentive pay.

For projects with multiple bridges, the bridges will be evaluated independently. Corrective action on any bridge will not affect the pay adjustment on any other bridge.

The smoothness pay adjustments will be determined for each extent in accordance with Table 330:3.

TABLE 330:3 SMOOTHNESS PAY ADJUSTMENTS Bridge Decks and Approach Slabs	
CLASS I	
Profile Index (in/mi)	Adjustment ($ / Extent) [1, 3]
6 or less	7,500
6.1 through 24	10,500 - 500*x*

24.1 through 36	55,500 - 2,375*x*
More than 36	Unacceptable [2]
CLASS II	
10 or less	7,500
10.1 through 24	12,850 - 535*x*
24.1 through 40	45,010 - 1,875*x*
More than 40	Unacceptable 2

Where "*x*" is the profile index (in/mi.)

[1] These adjustments for the bridge decks and approach slabs are independent of thickness of the bridge deck.

[2] Failure to correct to maximum acceptable profile index will result in zero payment for the affected extents.

APPENDIX A
SMOOTHNESS SPECIFICATION INFORMATION SHEET FOR
PROJECT NUMBER _____

Equipment -

The profilograph / profilometer is to be **provided** by the (select one):

☐ CITY ☐ CONTRACTOR

The profilograph / profilometer is to be **operated** by the (select one):

☐ CITY ☐ CONTRACTOR

Roadway -

☐ The requirements specified in this special provision **will** govern the smoothness requirements for the paving on this project.

☐ The requirements specified in this special provision **will not** govern the smoothness requirements for the paving on this project.

Bridge -

☐ The requirements specified in this special provision **will** govern the smoothness requirements for the following bridges according to each bridge's classification:

Bridge Number	Class I or II
☐ All Bridges	

Class I bridge decks are those that do not present significant special problems due to geometry.

Class II bridge decks are those that do present significant special problems due to geometry. Geometric features include but are not limited to skews, variable widths, variations in super elevation, sharp horizontal curves, or multiple profiles. The classification specified herein is final and will be used as a basis for payment.

The requirements specified in this special provision **will not** govern the smoothness requirements for this project.

SECTION 340--ASPHALT SAFETY EDGE

340.01 DESCRIPTION

The asphalt safety edge is a beveled pavement edge to help lessen the severity of roadway departures. When a driver drifts off the paved surface, the safety edge provides greater ease for re-entering the roadway, and reduces the risk of over steering and loss of control of the vehicle.

- Safety edge is required on asphalt concrete highway construction (permanent or temporary), on all routes, for all design speeds and types of traffic, when the following conditions exists:
- the roadway is an open section (no curb),
- the increase in pavement thickness is 2" or greater, and
- the paved shoulder width is 4 feet or less.

With the City Engineer's approval, the safety edge may be constructed when the paved shoulder width is greater than 4 feet.

340.02 MATERIALS

Construct the safety edge using the same material used to construct the adjoining pavement or shoulder.

340.03 EQUIPMENT

Equip the paver to ensure a 30 ± 5 degree wedge along the outside edge(s) of the roadway (measured from the horizontal plane) is in place after final compaction of the final surface course. Use an approved mechanical device that will:

- Apply compactive effort to the asphalt mixture to eliminate objectionable voids as the mixture passes through the wedge device, and
- Produce a wedge with a uniform texture, shape, and density while automatically adjusting to varying heights encountered along the roadway shoulder.

340.04 CONSTRUCTION METHODS

When paving operations result in a drop off of greater than 2 inches at the outside edge(s), or as approved by the City Engineer, attach a device to the paver screed to confine material at the end gate and extrude the asphalt material in a wedge shape having an angle between 30 ± 5 degrees. Ensure the wedge is compacted sufficiently as to eliminate objectionable voids. Maintain contact between the device and road shoulder surface; and allow automatic transition to cross roads, driveways, and obstructions. Use the device to constrain the asphalt head, reducing the area and increasing the density of the extruded profile.

The City Engineer may allow short sections of handwork when necessary for transitions at driveways, intersections, interchanges, and bridges.

Do not construct the safety edge at longitudinal joints in the pavement section.

Safety edge shape can be constructed on each lift of asphalt, or on the full specified depth on the final lift.

340.05 TESTING — VACANT

340.06 METHOD OF MEASUREMENT

Asphalt safety edge will not be measured for payment.

340.07 BASIS OF PAYMENT

Include the cost of constructing the asphalt safety edge in the price bid for the asphalt concrete paving pay item(s) included in the contract.

SECTION 341--ASPHALT CRACK REPAIR

341.01 DESCRIPTION

This section covers sawing, cleaning, and sealing joints in existing asphalt concrete pavement.

341.02 MATERIALS

Provide materials in accordance with the following criteria:

A) ¾" Wide or Less

The asphalt crack seal material must be Crafco Polyflex Type 2 – Part No. 34518, RP FLEX 2 or approved equal.

B) Greater than ¾" to Less than 2" Wide

Asphalt cracks greater than 3/4" to less than 2" wide in pavement surfaces requires Type S6 Hot Mix Asphalt in accordance with Section 908.04.

C) 2" Wide and Greater

Transverse asphalt cracks 2" wide or wider will require the following:

- Class "C" Concrete (2400 PSI strength within 3 days) in accordance with 901.01.
- Geo-Composite Fabric Membrane (Bid Item 822-01) in accordance with the Special Technical Provisions.

341.03 EQUIPMENT

A) Concrete Saw

Provide concrete saws capable of sawing asphalt concrete to the dimensions described herein. Handheld saws are allowed when used in a manner that accomplishes that crack preparation and widening in an acceptable manner.

B) Air Compressor

Provide air compressors capable of delivering compressed air with a pressure of at least 90 psi. Ensure the compressors include traps to remove free water and oil from the compressed air.

C) Provide self-propelled steel wheel compactors.

341.04 CONSTRUCTION METHODS

The City Engineer will mark the asphalt cracks to be repaired and identify the crack width and crack repair strategy required.

A) ¾" Wide or Less

The asphalt crack seal material must be installed in accordance with the manufacturer's recommendations. The asphalt crack seal material must be placed first when also using Type S6 Hot Mix Asphalt Crack Repair to fill cracks between ¾" and 2".

Varying crack widths to be sealed by the contractor as follows:

- Cracks between 0" and ¾" are sealed only with asphalt crack seal material Crafco Polyflex Type 2 – Part No. 34518, RP FLEX 2 or approved equal.
- Cracks greater than ¾" to less than 2" are filled only with Type S6 Hot Mix Asphalt.
- When narrow cracks (0" to ¾") intersect wider cracks (3/4" to 2"), the Crafco sealant must be installed first.

Whenever a leveling course is used, 0" to ¾" cracks must be cleaned but not sealed by the contractor. Cleaning consists of 90 psi compressed air, brushing or vacuum techniques to remove debris. Include cost of cleaning in other items of work.

B) Greater than ¾" to Less than 2" Wide

Asphalt cracks greater than 3/4" to less than 2" wide in pavement surfaces to be overlaid with Hot Mix Asphalt must be cleaned by the contractor by blowing out the cracks using a 90-psi air compressor and in a manner acceptable to the City Engineer. Fill cleaned cracks by hand with Type S6 Hot Mix Asphalt prior to resurfacing. Said asphalt must be placed about 3/8" to 1/2" above the existing pavement surface to allow for compaction. A small steel wheel roller shall be used to compact the asphalt.

C) 2" Wide and Greater

Transverse asphalt cracks 2" wide or wider must be repaired by contractor by removing the asphalt and cleaning the crack. The trench width must be a minimum of 6" and the trench depth must be a minimum of 6" or the depth of the asphalt pavement, whichever is greater. The trench walls must be vertical. The trench must be filled with Class "C" Concrete (2400 PSI strength within 3 days) concrete up to the existing pavement surface. The bottom of the trench must be firm and unyielding before concrete placement. A two-foot-wide strip of "Geo-Composite Fabric Membrane" (Bid Item 822-01) must be centered and placed on the trench. The "Geo-Composite Fabric Membrane" must be installed per the Special Technical Provisions. The fabric will not be paid for separately and will be included in the cost of the Asphalt Crack Repair item.

341.05 TESTING — VACANT

341.06 METHOD OF MEASUREMENT

The City Engineer will measure the length and width classification of asphalt crack repaired that has been successfully completed in accordance with this specification. Transitions between width classifications will be measured at the greater width classification for payment.

Any Geo-Composite Fabric Membrane or Class "C" Concrete required will not be measured and paid for separately.

341.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) ASPHALT CRACK REPAIR (3/4” WIDE OR LESS)	Linear Foot
(B) ASPHALT CRACK REPAIR (GREATER THAN 3/4” TO LESS THAN 2” WIDE)	Linear Foot
(C) ASPHALT CRACK REPAIR. (2” WIDE AND GREATER)	Linear Foot

The per linear foot payment for Asphalt Crack Repair shall be full compensation for furnishing all materials (including asphalt crack seal material, fabric and Class “C” Concrete), labor, equipment, tools and incidentals, and for performing the work in accordance with this specification.

TABLE OF CONTENTS

CHAPTER 400

SECTION 401 – STRUCTURAL EXCAVATION

401.01 DESCRIPTION

401.01.01– GENERAL

This section covers structural excavation which consists of the removal of material for the construction of foundations for bridges, retaining walls, head walls for culverts, or other structures, and other excavation designated on the plans or in these specifications or in the special provisions as structural excavation, and the subsequent backfill of these same structures.

Structural backfill shall consist of furnish material, if necessary, and placing and compacting backfill material around structures to the lines designated on the plans as specified or directed by the City Engineer.

Structural excavation and structural backfill shall include the furnishing of all materials and equipment; the construction or installation of all cofferdams and other facilities which may be necessary to perform the excavations and place and compact the backfill; and the subsequent removal of such facilities, except where they are required or permitted by the plans or specifications to remain in place.

401.01.02– COFFERDAMS

Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and reasonably watertight. The interior dimensions of cofferdams shall provide sufficient clearance inside the walls for constructing forms and driving piles and to permit pumping outside the forms.

If, in the judgment of the Contractor, the clearance provided on the plans between the outside line of the footing and any pile or interior wall or surface is not sufficient to permit the driving of piles or building of forms, he may provide such necessary clearance by constructing the cofferdam sufficiently large to provide such clearance as he may deem necessary. Any such enlargement more than one (1) foot outside the dimensions of the footing as shown on the plans shall be considered as being for the sole purpose of expediting the work of the Contractor and such excavation and backfill shall be at the Contractor's expense.

Cofferdams which are tilted or moved out of position by any cause during the process of sinking shall be plumbed or enlarged to provide the necessary clearance and proper pier location and such work shall be at the Contractor's expense.

In tidal water or in streams at a time of probable flood, cofferdam walls shall be vented at low water elevation to insure equal hydrostatic head both inside and outside of the cofferdam during the period of pouring and setting of seals.

No shoring will be permitted in cofferdams which will induce stress, shock, or vibration in the permanent structure.

For substructure work, the Contractor shall submit drawings showing his proposed method of cofferdam construction and other details left open to his choice or not fully shown on the plans. The type and clearance of cofferdams, insofar as such details affect the character of the finished work, will be subject to the approval of the City Engineer, but other details of design will be left to the Contractor who will be submitted a minimum of ten (10) to thirty (30) days in advance of the time the Contractor begins construction of the

cofferdams.

After completion of the substructure, the cofferdams will all sheeting and bracing, shall be removed at least two (2) feet below the level of the stream bed, by the Contractor at his expense, and such removal shall be performed in a manner that will not disturb or mar the finished concrete or masonry.

401.02 MATERIALS — VACANT

401.03 EQUIPMENT — VACANT

401.04 CONSTRUCTION METHODS

A) Excavation

1. When footing concrete or masonry is to rest upon rock, the rock shall be removed to a depth sufficient to expose sound rock. The rock shall be roughly leveled off or cut to approximate horizontal and vertical steps and shall be roughened. Seams in the rock shall be grouted under pressure or treated as the City Engineer may direct and the cost thereof will be included for payment in the quantities for the unit of the structure for which the excavation is made. When footing concrete or masonry is to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation and final removal of the foundation material to grade shall not be made until just before the concrete or masonry is placed. Except when over excavation is directed by the City Engineer, excavation below grade shall be replaced at the Contractor's expense with the same class of concrete specified for the structure and at the time the concrete for the structure is being placed.
2. Excavated material required to be used for backfilling may be deposited by the Contractor in storage piles at points convenient for rehandling of the material during the backfilling operations. The location of storage piles shall, however, be subject to the approval of the City Engineer who may require that the survey centerline of the structure and the transverse or hub line of any unit of the structure be kept free of any obstruction.
3. Excavated material required to be wasted shall be disposed of as directed by the City Engineer, and the disposal shall be in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other part of the work.
4. For all single and multiple box culverts, pipe culverts, and pipe arch culverts where the soil encountered at established footing grade is a quicksand, muck, or similar unstable material, the following procedure shall be used unless other methods are called for on the plans:
5. All unstable soil shall be removed to a depth of two (2) feet below bottom of culvert for culverts two (2) feet or more in height, and to a depth equal to the height of culvert for culverts less than two (2) feet in height. Such excavation shall be carried at least one (1) foot beyond the horizontal limits of the structure on all sides. All unstable soil so removed shall be replaced with suitable stable material, placed in uniform layers of suitable depth for compaction as directed by the City Engineer, and each layer shall be wetted if necessary, and compacted by rolling or tamping as required to provide a stable foundation for the structure. Soil which is of sufficient stability to sustain properly the adjacent sections of the roadway embankment will be considered a suitable foundation material for the culvert.

6. When the material encountered at footing grade of a culvert is found to be partially rock or incompressible material, and partially a soil or material that is compressible but otherwise satisfactory for the foundation, the incompressible material shall be removed for a depth of six (6) inches below the footing grade and backfilled with a material like the compressible foundation used for the rest of the structure.
7. When the material encountered at footing grade of a bridge bent or pier is found to be partially of rock or incompressible material, and partially of a compressible material, the foundation shall not be placed until the City Engineer has inspected the footing and authorized such changes found necessary to provide an adequate foundation.

B) Backfill

Structural back fill shall not be placed until the structure footings or other portions of the structure or facility have been inspected by the City Engineer and approved for backfilling. As soon as practicable all spaces excavated under this item and not occupied by the permanent structure shall be backfilled, except that no backfill shall be placed against any abutment or retaining wall until such structure has been in place at least seven (7) days. No backfill shall be placed adjacent to box culverts until the top slab has been in place at least four (4) days. When called for on the plans, special backfill material, such as pit run gravel, shall be placed at the locations and in the manner called for on the plans. All other backfill material shall be earth, free of any appreciable amount of stone or gravel particles more than four (4) inches in greatest dimension, large or frozen lumps, wood or other extraneous material, and shall be of such gradation as to permit thorough compaction.

That portion of backfill which will support any portion of the roadway or embankment shall be placed in uniform layers not to exceed six (6) inches in depth (loose measurement) and compacted to that each layer and the completed backfill has a density of not less than ninety-five (95) percent of the maximum density as determined by ASTM Designation D-698.

That portion of backfill which will not support any portion of the completed roadway or embankment shall be placed in layers not more than ten (10) inches in depth and compacted to a density comparable with the adjacent, undisturbed material. The compacted layers of backfill shall be brought up uniformly on all sides of the structure or facility.

Care shall be taken to prevent any wedging action when placing backfill around abutments or wingwalls.

Compaction of structural backfill by ponding and jetting will be permitted when, as determined by the City Engineer, the backfill material is of such character that it will be self-draining when compacted and that foundation materials will not soften or be otherwise damaged by the applied water, and no damage to the structure from hydrostatic pressure will result. Ponding and jetting of the upper two (2) feet below finished subgrade will not be permitted in roadway areas. When ponding and jetting is permitted, material for use as structural backfill shall be placed and compacted in layers not exceeding four (4) feet in thickness. The work shall be performed without damage to the structure or softening of the embankment, and in such a manner that excess water will not be impounded. Ponding and jetting methods shall be supplemented using vibratory or other compaction equipment when necessary to obtain the required compaction.

401.05 TESTING — VACANT

401.06 METHOD OF MEASUREMENT

Measurement for payment will be for material excavated within the limits shown on the plans or as directed by the City Engineer.

Unless otherwise provided in the special provisions or proposals, no payment will be made for structural excavation or backfill as such; the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant.

Payment for such excavation or backfill will be made only when the special provisions or proposal provide.

When provided for, payment for work performed under these specifications will be made at the unit price bid per cubic yard for Unclassified Excavation which price shall be full compensation for all excavation and backfill and for all materials, labor, tools, and incidentals necessary to complete the work.

401.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) STRUCTURAL EXCAVATION	Cubic Yard

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

SECTION 402 – DRILL SHAFT FOUNDATIONS

402.01 DESCRIPTION

This section covers the construction of foundations consisting 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 footings and in drilled and underreamed excavation when shafts are with bell type footings. Such foundations shall be constructed in accordance with this item and in conformance with the details and governing dimensions shown on the plans.

402.02 MATERIALS

All concrete materials and their preparations shall be in accordance with the requirements of Section 901, "Portland Cement Concrete", and the additional requirements herein.

When Casing of the shaft is required, the following shall apply:

A) The maximum size coarse aggregate shall be one and one-half (1 1/2) inches.

B) The elapsed time from beginning of placement of concrete in the cased portion of the shaft until extraction of the casing is begun, shall not exceed thirty (30) minutes. If a set retarding admixture is used, this time shall not exceed one (1) hour. If nonagitating equipment is used to haul the concrete from a central mixing plant the elapsed time from discharge of concrete from the mixer to placement in the shaft shall not exceed ten (10) minutes. If a

set retarding admixture is used, this time shall not exceed thirty (30) minutes.

C) When the temperature of the air or concrete is above eighty-five (85) degrees F, an approved set retarding admixture will be required in all drilled shaft concrete.

D) Reinforcing steel shall conform to the requirements of Section 923, "Reinforcing Steel". The sizes and dimensions shall be as shown on the plans.

402.03 EQUIPMENT — VACANT

402.04 CONSTRUCTION METHODS

The Contractor shall do all excavation required for the shafts and bell footings through whatever materials are encountered, and to the dimensions and elevations shown on the plans or required by the site conditions. Unless otherwise shown on the plans, all shafts shall be bored plumb to a tolerance of one and one-half (1 ½) inches for depths up to and including ten (10) feet plus an additional tolerance of five hundredths (0.05) inch per foot for depths more than the first ten (10) feet. When bells are required, they shall be excavated to form a bearing area of the size and shape shown on the plans. Shafts and bells may be excavated either by hand or by mechanical methods. Blasting methods shall be used only with permission of the City Engineer and when used shall be so conducted as to avoid disturbance of the formations below or outside the limits of the proposed shaft concrete.

The plans indicate the expected depths and elevations at which satisfactory bearing material will be encountered, and this information will be used as a basis for the contract. If satisfactory foundation materials are not encountered at plan elevations, the footings may be raised or lowered as determined by the City Engineer. Alterations in plan depths shall be made as judged proper to satisfactorily comply with the design requirements.

Casings will be required for shaft excavations when such provision is necessary to prevent caving of the material or when necessary to shut off seepage water. Casings shall be of metal and of ample strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials and shall be watertight. The inside diameter of the casing shall not be less than the nominal size of the shaft. No extra compensation will be allowed for the concrete required to fill an oversize casing or oversize excavation.

When the drilling operation reaches a point where caving conditions and/or excess groundwater is encountered, no further drilling will be allowed until a construction method is employed which will prevent any caving that tends to make the excavation appreciably larger than the size of casings to be used. Drilling in a mud slurry without the removal of cuttings, or other construction methods which will control the size of excavation, will be permitted.

If the elevation of the top of the shaft is below ground level at the time of concrete placement, an oversize casing from ground elevation to a point below the top of the shaft shall be required to control caving of any material into the freshly placed concrete.

Any excavation for the footing bells or shafts beyond the lines required, shall be backfilled with concrete at the Contractor's expense. Where casings are used, the Contractor will be permitted to backfill around the upper portion of the casing with pea gravel or other granular material. Where a double casing is required for a portion of the shaft, no material shall be placed between the casings, but this area will be filled with concrete.

Under normal operations when the casing is to be removed, the removal shall not be started until all concrete placement is completed in the shaft. Movement of the casing for short pulls of a few inches or rotating of the casing to ensure the breaking of bond of the concrete to the casing will

be permitted. When unusual conditions warrant, the casing may be pulled in partial stages. In all cases a sufficient head of concrete shall be always maintained above the bottom of the casing to overcome hydrostatic pressure. Extraction of the casing shall be at a slow, uniform rate and the pull shall be in a truly vertical direction.

If any upward movement of the concrete and/or steel inside the casing occurs at any time during the pulling operation, the following criteria shall govern:

If the upward movement is one (1) inch or less, the casing may be left in place and the shaft used if the concrete is vibrated or rodded to reconsolidate the concrete. Vibration or rodding shall not be used to attempt to break the casing loose for extraction unless the entire shaft is to be replaced.

If the upward movement is greater than one (1) inch, all the material shall be removed, and the entire drilled shaft operation shall be redone.

Placing of drilled shaft concrete under water shall not be done without the permission of the City Engineer.

Material excavated from shafts and bells and not used in the backfill around the completed bents or piers shall be disposed of as directed by the City Engineer. The disposal of such material shall be in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the works.

At the time concrete is placed, the excavation shall be free from accumulated seepage water and all loose material shall be removed from the base area.

The Contractor shall provide suitable access and lighting for the City Engineer to inspect the completed foundation excavation and check the dimensions and alignment of drilled shafts and the underreamed excavation when underreaming is required.

At any time when a person is in the hole, provisions shall be made for pumping fresh air to the workman. Any required lighting shall be by electric lights. Any mechanical equipment used in the excavation shall be operated by air or electricity. The use of gasoline driven engines placed in the excavation for pumping or drilling will not be permitted.

In order that the City Engineer may judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings, or take cores at his expense to determine the character of the supporting materials. The depth of such soundings or cores will not be required to exceed five (5) feet below the proposed footing grade. It is the intent of this provision that soundings shall be made, or cores taken at the time the excavation in each foundation is approximately complete.

When the plans require drilled shafts in the end bents, the embankment at the bridge ends shall be made to grade shown and thoroughly compacted as provided in the governing specifications prior to drilling for end bent shafts.

A) Reinforcing Steel - The reinforcing steel cage for the shaft consisting of longitudinal bars and spiral hooping or lateral ties shall be completely assembled and placed into the shaft as a unit. Generally, the reinforcing steel unit shall not be placed until immediately before concreting operations are to be started.

   The longitudinal bars shall be tied to the spiral hooping at intervals not to exceed twelve (12) inches on centers to provide a rigid unit.

   For cased shafts where the reinforcing steel cage is over thirty (30) feet in length, the longitudinal bars shall be tied at each intersection of the spiral hooping for a distance of one-fifth (1/5) the depth of shaft from the bottom of the cage.

   The cage of reinforcing steel shall be supported from the top by some positive method to

prevent slumping downward during extraction of the casing.

In uncased shafts, side spacer blocks of concrete shall be used at intervals along the shaft to insure concentric spacing for the entire length of shaft. In cased shafts, concrete spacer blocks shall not be used, but metal "chair" type spacers shall be placed vertically at intervals around the steel cage to insure concentric spacing inside the casing.

B) Concrete - The work shall be performed in accordance with the provisions of Section 403, and in conformance with the requirements herein.

Preferably, concrete shall be placed immediately after all excavation is complete and reinforcing steel placed.

Concrete placing shall be continuous from the beginning of placing in the shaft or footing bell to the top of shaft or to construction joint as may be indicated on the plans. Time intervals will be allowed for pulling casings, for placing forms, and other operations necessarily carried on in sequence with the placing operations. The reinforcing steel cage shall be held vertical in some manner to restrain the steel from slumping during the concrete placement operation.

Concrete shall be placed through a suitable tube to prevent segregation of concrete materials and unnecessary splashing on the reinforcing steel cage. The tube shall be made in sections to permit the discharge and raising as the placement progresses. A non-jointed pipe may be used if sufficient openings of the proper size are provided to allow for the flow of concrete into the shaft.

Wherever a casing is used, the casing shall be smooth and well-oiled and shall extend sufficiently above the grade of the finished shaft to provide excess concrete to be placed for the anticipated slump due to the casing removal. Where a casing is to be pulled, the concrete placed in casing shall be of such workability as to require no vibrating or rodding.

Where a cap block or groundline strut is shown on the plans to be placed at the top of the drilled shaft, and the cap or strut is shown to be placed monolithic with the drilled shaft, a time interval will be allowed for placing the required form and reinforcing after any necessary casing removal.

After a placement is completed, the top surface shall be cured, and any construction joint area shall be treated as prescribed in Section 404.

402.04.01 TEST HOLES

When shown on the plans, or when ordered by the City Engineer in writing, test holes will be required to establish elevations for "belling" to determine elevation of groundwater, or to determine other soil characteristics.

The diameter and depth of test hole or holes shall be as shown on the plans or as directed by the City Engineer.

402.04.02 TEST BELLS

When shown on the plans, or when ordered by the City Engineer in writing, the underreaming of bells, on specified test holes, will be required to establish the ability to underream in the soil strata present.

The diameter and shape of the test bell shall be as shown on the plans or as directed by the City Engineer.

402.05 TESTING — VACANT

402.06 METHOD OF MEASUREMENT

Acceptable drilled shaft in place of the specified diameter will be measured by the linear foot. The length shall be based on the plan elevation or elevation as approved by the City Engineer. Drilled shaft length would be measured by the linear foot from the shaft base elevation to the top of the shaft elevation.

Footing bells, constructed to the specified dimensions, or to the altered dimensions as authorized by the City Engineer will be measured by the cubic yard of concrete in the acceptable footings placed. The bell shall consist of the authorized footing volume outside the dimensions of the drilled shaft, which for the purpose of measurement, will be considered as extending to the bottom of the bell.

Test holes of the specified diameter will be measured from the elevation of the ground at the time drilling begins, by the linear foot of acceptable test hole drilled.

Test bells of the specified diameter and shape will be measured by each test bell acceptably under reamed.

Drilled shafts will be paid for at the unit price bid per linear foot of the specified diameter of "Drilled Shafts", measurements being made as outlined above. Where vertical and spiral reinforcing bars from the shaft extend into footings, caps, columns, or other concrete members, the cost of such reinforcing shall be included with and paid for as a part of "Drilled Shafts".

A) Drilled Shaft will be paid for the completed length per the plan quantity or authorized by the City Engineer.

B) Footing bells, constructed to the specified dimensions or to the altered dimensions as authorized by the City Engineer, will be paid for at the contract unit price bid per cubic yard for "Bell Footings".

C) Test holes, of the specified diameter, will be paid for at the contract unit price bid each for "Test Hole".

D) Test bells, of the specified diameter, will be paid for at the contract unit price bid for each "Test Bell".

The foregoing unit prices shall be full compensation for making all excavations, for drilling all test holes and test bells, pumping, placing, and removing any required casings, furnishing and placing all concrete and reinforcing steel, all backfilling, and furnishing all tools, labor, equipment, materials, and incidentals necessary to complete the work. No extra payment will be made for casings left in place.

402.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) DRILLED SHAFT (DIAMETER)	Linear Foot
(B) BELL FOOTING	Cubic Yard
(C) TEST HOLE	Each
(D) TEST BELL	Each

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

SECTION 403 – CONCRETE STRUCTURES

403.01 DESCRIPTION

Before starting work, the Contractor shall inform the City Engineer fully of the methods of construction he proposes to follow and the amount and character of equipment he proposes to use, the adequacy of which shall be subject to the approval of the City Engineer. Plans for forms and falsework for concrete piers and concrete superstructure spans over twenty (20) feet in length and for all widening details shall be submitted to the City Engineer for review and approval. Similar plans shall be submitted for other units of structure if requested by the City Engineer. The plans shall be prepared on standard twenty-two (22) inch by thirty-six (36) inch sheets. They shall show all essential details of the proposed forms, falsework, and bracing so that a structural analysis may be made. Four (4) sets of such plans will be required.

Concurrence on the part of the City Engineer in any proposed construction methods, approval of equipment, or approval of form and falsework plans does not relieve the Contractor of the responsibility for the safety or correctness of his methods and adequacy of his equipment or from carrying out the work in full accordance with the contract.

Unless otherwise provided, the following requirements shall govern for the time sequence in which construction operations may be carried on and for the opening of completed structures to traffic.

No superstructure members, forms, falsework, or erection equipment shall be placed on the substructure before the substructure concrete has attained 80% of the 28-day specified compressive strength.

The use of completed portions of a structure for storage of materials will not be permitted until all curing requirements for that part of the structure have been met.

Forms for walls or columns shall not be erected on concrete footings until the concrete in the footing has cured at least two (2) days. Concrete may be placed in the wall or column as soon as the forms and reinforcing steel placement are approved.

The support of tie beams and/or cap forms by falsework placed on previously placed tie beams is permissible provided such supporting beams have attained 80% of the 28-day compressive strength, curing requirements completed, and are properly supported to eliminate stresses not provided for in the design.

Structures shall not be opened to construction traffic or to the traveling public until authorized by the City Engineer. Authorization may be given after the last slab concrete has been in place at least fourteen (14) days for light construction traffic not to exceed a three-fourths (3/4) ton vehicle.

Authorization may be given after the last slab concrete has been in place thirty (30) days or as authorized by the City Engineer for the structures to be opened for normal construction traffic and to the traveling public. Construction vehicles with a minimum of three (3) axles may be operated across structures if the total gross load does not exceed fifty-one thousand (51,000) pounds. Because of possible damage to the new structures, care shall be exercised to reduce impact on the new structures by limiting the speed of such vehicles to ten (10) miles per hour or less.

Where a detour is not readily available or is not economically feasible, and an occasional crossing

of a structure with overweight construction-equipment such as a concrete paving machine is necessary, the City Engineer may permit such crossing after a structural analysis is made considering the dimensions of the equipment axle spacing and axle loads.

Unless otherwise shown on the plans, the placement of roadway slabs may be by the sequence shown on the plans, using a longitudinal screed or a self-propelled transverse mechanical finishing machine; or by continuous placement using a transverse mechanical finishing machine only. The screed shall be adequately supported on a header or rail system which shall have sufficient stability to withstand the longitudinal or lateral thrust of the equipment.

Supports for a transverse finishing machine shall be installed so that they may be removed without damage to the slab. Bond between the removable supports and the concrete shall be prevented in a manner acceptable to the City Engineer. Portions of the rail support system which remain embedded in the slab shall not project above the upper mat of reinforcing steel. Attachment of the rail support system by welding to I-beams or girders will be permitted subject to the following requirements:

A) Welds shall be parallel to the web of the member. Circular or transverse welds will not be permitted.

B) Welds will not be permitted on the tension flange of the members in that area where the stress exceeds seventy-five (75) percent of the allowable stress.

C) Welds shall be made with low hydrogen electrodes.

D) Welding shall be done by a certified welder.

403.01.01– DRAINS

Weep hole drains and roadway drains shall be installed and constructed as shown on the plans in the designated locations.

Unless otherwise shown on the plans, the size of the weep holes will be three (3) inches in diameter with a permissible variation of plus or minus one-fourth (1/4) inch. A neat pocket shall be excavated at each weep hole for placing the indicated volume of gravel. Washed gravel from three-eights (3/8) inch to one and one-half (1 1/2) inch in size shall be placed in the excavated pocket. When the concrete is not formed at the weep hole location, a sheet of building paper shall be placed over the gravel to prevent the entrance of concrete into the pocket during operations.

403.01.02– EXPANSION JOINTS

Expansion joints and devices to provide for expansion and contraction shall be constructed where and as indicated herein or on the plans.

The bearing area under the expansion ends of concrete slabs, pre-stressed concrete beams, girders and slab and girder spans, shall be given a steel trowel finish. These areas shall be finished to the exact grades required. The material used to separate expansion surfaces shall be that shown on the plans and shall be placed carefully so that concrete or mortar cannot be subsequently worked around or under the material.

Concrete adjacent to armor joints and finger joints shall be placed carefully to avoid defective anchorage and to avoid porous or honeycombed concrete adjacent to same.

All open joints, and joints to be filled with joint sealing material, shall be constructed using forms adaptable to loosening or early removal. To avoid damage to the adjacent concrete caused by expansion or contraction, these forms shall be loosened as soon as possible

after final concrete set to permit free movement of the span without the necessity for full form removal.

Prior to placing the joint sealing material, the vertical faces of the joint shall be cleaned of all laitance by sandblasting or by mechanical routing. Care shall be taken to prevent spalling of adjacent surfaces. Edges which are cracked or spalled shall be removed. The joint shall be blown clean of all foreign material and sealed.

Preformed fiber joint material, whichever used, shall be anchored to the concrete on one side of the joint by means of light wire or nails sufficient to preclude the tendency of the material to fall out of the joint.

Careful workmanship shall be exercised in the construction of all joints. The finished joint shall conform to the indicated outline and the concrete sections shall be completely separated by the specified opening or joint material.

Immediately after the removal of forms and again where necessary after surface finishing, all projecting concrete shall be removed along exposed edges to secure full effectiveness of the expansion joints.

403.01.03– CONSTRUCTION JOINTS

The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. When concrete is to be placed monolithic, the term monolithic shall be interpreted to mean that the manner and sequence of concrete placing shall be such that construction joints will not be created.

Construction joints will be of the type and at the locations shown on the plans. Additional joints will not be permitted without written authorization from the City Engineer. Any additional construction joints shall have details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all joints except horizontal joints.

Construction joints requiring the use of joint sealing material shall be as detailed on the plans. The material will be specified on the plans without reference to joint type.

The top surface of a concrete placement which terminates at a horizontal construction joint shall have the surface roughened thoroughly as soon as practicable after the concrete has attained initial set. The surfaces at bulkheads shall be roughened as soon as the forms are removed.

Before joining plastic concrete to concrete that has already set, the surface of the concrete in place shall be free from all loose material, laitance, dirt, or foreign matter, shall be washed, scrubbed clean and drenched thoroughly with water until saturated, and shall be kept moist until the plastic concrete has been placed. Immediately prior to the placing of additional concrete, all forms shall be drawn tight against the existing concrete and the existing joint surface shall be flushed with a coating of grout mixed in the proportions of one (1) part cement to two (2) parts sand or painted with an approved bonding agent.

403.01.04– FALSEWORK

All falsework shall be designed and constructed to safely carry the maximum anticipated loads and to provide the necessary rigidity.

When the falsework is no longer required, it shall be removed. Falsework piling shall be

pulled or cut off a minimum of six (6) inches below finished ground level. Falsework and piling in a stream or lake shall be removed completely to a point specified by the City Engineer to prevent any obstruction to the waterway.

403.01.05– FORMS

A) General - Forms shall be of suitable material and of a type, size, shape, quality, and strength to ensure construction as designed. The forms shall be true to line and grade, mortar tight, and sufficiently rigid to resist deflection during placing of the concrete. The responsibility for their adequacy shall rest with the Contractor. All dirt, chips, sawdust, nails, and other foreign matter shall be completely removed from forms before any concrete is deposited therein. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent which will leave no objectionable film on the surface of the forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete.

   Forms for all surfaces that will not be completely enclosed or hidden below the permanent surface of the ground shall be made of surfaced lumber, or material which will provide a surface at least equal to surfaced lumber or plywood. Any lumber or material which becomes badly checked or warped, prior to placing concrete, shall not be used.

   Forms for all exposed surfaces of bridges, viaducts, overcrossings, and similar structures shall be constructed of plywood or an approved equal. Plywood for forms shall be Exterior Type, of the grade "Concrete Form Exterior", conforming to the specifications of the U.S. Department of Commerce, National Bureau of Standards, Commercial Standards, latest edition. Plywood shall be furnished and placed in forty-eight (48) inch widths and in uniform lengths of not less than ninety-six (96) inches, except where the dimension of the member formed is less than the specified panel dimension. Plywood shall be placed with the grain of the outer plies in the direction of the span.

B) Molding - Molding specified for chamfer strips and other uses shall be made of material of such grade that will not split when nailed and which can be maintained to a true line without warping. The molding shall be mill cut and dressed on all faces.

C) Form Ties and Spreaders - Metal form ties of an approved type or an approved substitute shall be used to hold forms in place. Pipe spreaders will not be permitted. Metal and wooden spreaders which are separate from the forms shall be entirely removed as the concrete is being placed. All metal ties, wire, or other appliances used inside the forms to hold them in correct alignment shall be removed to a depth of at least one-half (1/2) inch from the surface of the concrete. Burning off rods, bolts, or ties will not be permitted. The cavities produced shall be carefully cleaned and filled with retempered sand cement mortar mixed in proportions of one (1) to three (3), and the concrete shall be left smooth and even.

D) Form Supports for Overhanging Slabs - Form supports which transmit a horizontal force to a steel girder or beam or to a pre-stressed concrete beam will be permitted but shall not be used unless a structural analysis has been made of the effect on

the girder or beam and approval is granted by the City Engineer.

Holes in steel members for support of overhanging brackets may be punched or drilled full size or may be torch cut to one-fourth (1/4) inch under size and reamed full size. In no case shall the holes be burned full size.

Holes shall be left open unless specified on the plans to be filled with a button head bolt. In no case shall the holes be filled by welding.

403.02 MATERIALS

A) Concrete - All concrete shall conform to the provisions of Section 901, "Portland Cement Concrete". The class of concrete for each type of structure or unit shall be as specified on the plans, or by pertinent governing specifications.

B) Expansion Joint Material

1. Preformed Fiber Material - Preformed fiber expansion joint material shall be of the dimensions shown on the plans and shall conform to the provisions of Section 901.08. “Joint Fillers and Sealants".
2. Joint Sealing Material - Joint sealing material shall conform to the provisions of Section 901.08. “Joint Fillers and Sealants".
3. Asphalt Board- Asphalt board shall consist of two (2) liners of 0.016 asphalt impregnated paper, filled with a mastic of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat, and sufficiently rigid to permit installation. When tested in accordance with ASTM Designation D-944, the asphalt board shall not deflect from the horizontal more than one (1) inch in three and one-half (3 1/2) inches.

C) Waterstop

1. Unless otherwise designated on the plans, copper waterstop shall be sixteen (16) ounce material.
2. Rubber waterstop or PVC waterstop.
3. Other types as specified on the plans.

D) Curing Materials - The membrane curing compound shall conform to the provisions of Section 901.07, “Curing Agents”.

403.03 EQUIPMENT — VACANT

403.04 CONSTRUCTION METHODS

403.04.01– PLACING REINFORCEMENT

Reinforcement in concrete structures shall be placed carefully and accurately and rigidly supported as provided in Section 923, "Reinforcing Steel".

403.04.02– PLACING CONCRETE - GENERAL

The minimum temperature of concrete at the time of placement shall be not less than fifty (50) degrees F.

The maximum temperature of cast-in-place concrete used in bridge superstructure shall not be more than eighty-five (85) degrees F, at the time of placement. Concrete diaphragms, parapets, concrete portions of railing, curbs, and sidewalks, unless

monolithically placed with the slab, shall not be subject to the above control. Other portions of structures, when so noted on the plans, shall require the temperature control specified thereon.

A retarding admixture shall be used when the continuous placing method is used in the deck of continuous units. The initial set of the concrete shall be retarded sufficiently to ensure that the concrete remains plastic in not less than three (3) spans immediately preceding the one being placed. For simple spans retardation shall be required only if necessary to complete finishing operations.

The retarding admixture shall be in accordance with the requirements of Section 901.03, "Concrete Admixtures".

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only and shall be held to a minimum amount.

The maximum time interval between the addition of cement to the batch, and the placing of concrete in the forms shall not exceed the following:

Table 403:1
Maximum Time Intervals

Air or Concrete	
Max Temperature	Time
Non-Agitated Concrete	
80º F or Above 35º to 79º F	15 Minutes 40 Minutes
Agitated Concrete	
90º F or Above 75º F to 89º F 35º F to 74º F	45 Minutes 60 Minutes 90 Minutes

The use of an approved cement dispersing agent in the concrete will permit the extension of each of the above temperature time maximums by thirty (30) minutes, except that for non-agitated concrete, the maximum time shall not exceed thirty (30) minutes.

The Contractor shall give the City Engineer sufficient advance notice before starting to place concrete in any unit of the structure to permit the inspection of forms, the reinforcing steel placement, and preparations for casting. No concrete shall be placed in any unit prior to the completion of the formwork and the placement of the reinforcement.

Concrete mixing, placing, and finishing shall be done in daylight hours, unless adequate provisions are made to light the entire site of all operations.

Concrete placement will not be permitted when impending weather conditions may result in rainfall or low temperatures which impair the quality of the finished work. In case rainfall should occur after placing operations are started the Contractor shall provide ample covering to protect the work. In case of drop in temperature, the provisions set forth in Section 403, shall be applied.

The method of handling, placing, and consolidation of concrete shall minimize segregation or the displacement of the reinforcement, and shall produce a compact mass of uniform texture. Concrete shall not have a free fall of more than three (3) feet except in the case of thin walls such as culvert walls. The spattering of forms or reinforcement bars shall be prevented if the concrete so spattered will dry or harden before being incorporated in the mass. Any hardened concrete spatter ahead of the plastic concrete shall promptly be removed from the work.

Each part of the forms shall be filled by depositing concrete as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point in the forms and running or working it along the forms will not be allowed.

After the concrete has taken initial set, the forms shall not be jarred, or strain placed on projecting reinforcement.

Chutes, troughs, conveyors, or pipes used in placing concrete shall be arranged and used so that the ingredients of the concrete will not be separated. When steep slopes are necessary, the chutes shall be equipped with baffle boards or made in short lengths that reverse the direction of movement, or the ends of such chutes shall terminate in vertical down spouts. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in the forms. All chutes, troughs, conveyors, and pipes shall be kept clean and free from coatings of hardened concrete by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged clear of the concrete.

Successive layers or adjacent portions of concrete shall be placed in a sequence so that they can be vibrated into a homogeneous mass with the previously placed concrete without a cold joint. Not more than one (1) hour shall elapse between adjacent or successive placement of concrete. Unauthorized construction joints shall be avoided by placing required portions of abutments, piers, walls, or superstructure in one continuous operation.

For mass placements, placements on falsework where differential setting time may induce stress cracking, placement in deep girder stems, etc., and approved retarder (cement dispersing agent) in accordance with Section 901.03, "Concrete Admixtures", shall be used to control stress cracks and/or unauthorized cold joints.

Laitance or foreign matter of any kind shall not be permitted to accumulate inside the forms; and openings in forms necessary for removal of same shall be provided.

All concrete shall be well consolidated, and the mortar flushed to the surface of the forms by continuous working with mechanical vibrators of an approved type. Vibrators of the type which operate by attachment to forms or reinforcement will not be permitted, except that external vibration will be allowed when the forms are of steel.

At least one (1) standby vibrator shall be provided for emergency use in addition to the ones required for placement.

The vibrators shall be applied to the concrete immediately after deposit. Prior to the beginning of work, a systematic spacing of the points of vibration shall be established to ensure complete consolidation of the concrete being placed and the thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points

eighteen (18) to thirty (30) inches apart, and slowly withdrawn. For shallow slabs or for concrete inaccessible to vertical insertion of the vibrator, the vibrator may be inserted in a sloping or horizontal position. The entire depth of each lift of concrete shall be vibrated, and the vibrator shall be allowed to penetrate several inches into the preceding lift of plastic concrete. New concrete placed against hardened concrete or against fresh concrete that is not plastic shall be thoroughly consolidated along the joint surface. The vibration shall be of sufficient duration to produce thorough consolidation, and complete embedment of reinforcement and fixtures, but shall not be done to an extent that will cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

Holes for anchor bolts in piers, abutments, bents, or pedestals may be drilled or may be formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. The plugs or sleeves shall be withdrawn after the concrete has set. Formed holes shall be of such diameter to permit horizontal adjustments of the bolts. The bolts shall be set carefully in mortar. In lieu of the above methods of placing, anchor bolts may be set to exact locations in concrete when it is placed.

The placing of concrete for deck slabs shall be done from a mixing plant located off the structure. Carting or wheeling concrete batches over a completed slab will not be permitted until the slab has aged at least four (4) full curing days. If carts are used, timber planking will be required for the remainder of the curing period. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, when permitted, such storage shall be limited to quantities and distribution that will not induce excessive stresses.

403.04.03– 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 thirty-five (35) degrees F, or when conditions indicate that the temperature may fall to thirty-five (35) degrees F within twenty-four (24) hours, except with the written permission of the City Engineer and only after such precautionary measures for the protection of the work have been taken as he may direct.

Concrete shall be effectively protected from freezing or frost for a period of five (5) days after placing.

When the temperature of the air is above eighty-five (85) degrees F, an approved retarding mixture will be required in all concrete used in superstructures, top slabs of direct traffic culverts and cased drilled shafts.

Concrete placement shall be stopped when rainfall is sufficient to cause damage to the work.

403.04.04– PLACING CONCRETE IN WATER

Concrete shall be deposited in water only when specified on the plans or with written permission of the City Engineer. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping will not be permitted while the Concrete is being placed, nor until it has set for at least thirty-six (36) hours.

The concrete shall be placed carefully in a compact mass by means of a tremie, closed bottom dumping bucket, or other approved method that does not permit the concrete to

fall through the water without adequate protection. The concrete shall not be disturbed after being deposited. Depositing shall be regulated to always maintain approximately horizontal surfaces.

When a tremie is used, it shall consist of a tube having a diameter of not more than ten (10) inches constructed in sections having watertight connection. The tremie shall be equipped with a device for sealing the bottom of the tube, the positive opening thereof, and for the placing of the tremie through the water to the point of placement. The means of supporting the tremie shall permit the movement of the discharge over the entire surface of the work and shall permit the tremie to be lowered rapidly when necessary to choke off or retard the flow.

Shifting the location of the tremie, for any continuous placement of concrete, shall be held to a minimum. During the placing of concrete, the tremie shall be kept full. When a batch is dumped into the hopper, the tremie shall be raised slightly, but not out of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper, then the flow shall be stopped by lowering the tremie. The placing operations shall be continuous until the work is complete. If the placement is confined to a small area requiring very little movement, the tremie diameter may be increased.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than one-half (1/2) cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. Then it shall be raised very slowly during the upward travel, the intent being to maintain still water at the point of discharge and to avoid agitating the mixture.

403.04.05– PLACING CONCRETE IN SUPERSTRUCTURE

To ensure proper operation and maintenance of grades and clearances, one or more passes of the screed shall be made over the section of bridge spans to be placed prior to the placement of concrete.

For longitudinal screeding concrete shall be placed in longitudinal strips. Placing, preferably, shall be started at a point in the center of the section adjacent to one curb, and the strip thus started shall be completed by depositing concrete uniformly in both directions toward the ends except that for spans on a grade of one and one-half (1 1/2) percent or more, the placing shall start at the lowest end. The width of strips shall be such that the concrete therein will remain plastic until the adjacent strip is placed.

The forms for the bottom surface of concrete slabs, girders, and overhangs shall be maintained true to the required vertical alignment during the concrete placing. For convenience in checking the vertical alignment, an approved system of "tell-tales" attached to the forms shall be installed and maintained by the Contractor. They shall provide a convenient means of matchmarking with reference to points set on stakes or other suitable reference points set independent of the forms and falsework for the span being placed. Unless otherwise provided, the girders, slab, and curbs of deck girder spans shall be placed in one continuous operation.

The filling of girder stems ahead of placing the concrete in the slab will be permitted provided the slab concrete is placed in the time as specified in Section 403.04.02. The location of construction joints and the sequence of placements of the slab on steel and pre-stressed concrete beams shall be as shown on the plans. Where plans do not specify a particular sequence, any logical placing sequence which will not result in the overstressing of any of the supporting members will be permitted subject to the approval of the City Engineer.

On steel truss spans the falsework under the span shall be released and the span swung free on its permanent supports before placing any concrete in the floor slab.

When the curb forms are filled, the curbs shall be brought to the correct camber and alignment and struck off.

As soon as concrete is placed in a section of the slab of sufficient width to permit finishing operations, the slab shall be finished as specified in Section 403.04. When the surface of the slab is to receive an additional wearing surface or level-up (widening), the slab shall be given a reasonably smooth float or screed finish and shall not be finished as stated above.

403.04.06– PLACING CONCRETE IN BOX CULVERTS

In general, construction joints will be permitted only at the points shown on the plans.

Where the top slabs and sidewalls are placed monolithic in culverts more than four (4) feet in clear height, an interval of not less than one (1) hour nor more than two (2) hours shall elapse between the placing of the concrete in the walls and that in the top slab; such interval is to allow for shrinkage in the wall concrete.

The top surface of the base slab shall be finished accurately at the proper time to provide a smooth uniform surface. The upper surface of the top slab which will carry direct traffic shall be finished as specified for finishing roadway slabs in Section 403.04.09. On a fill type culvert which does not carry direct traffic, the top slab shall be given a reasonably smooth finish.

403.04.07– PLACING CONCRETE IN FOUNDATIONS AND SUBSTRUCTURE

Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the City Engineer and permission has been given to proceed.

The placing of concrete bases above seal courses will be permitted after the caissons or cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concreting operation shall be done from a suitable sump located outside the forms.

All temporary wales or braces on the inside of cofferdams or caissons shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints in bases or shafts.

When footings can be placed in dry foundation pits without the use of cofferdams or caissons, forms may be omitted if desired by the Contractor and approved by the City Engineer, and the entire excavation filled with concrete to the elevation of the top of footing. Where this procedure is followed, no measurement for payment will be made for concrete placed outside of the footing dimensions shown on the plans.

Concrete in columns shall be placed monolithically unless otherwise provided. Columns and caps and/or tie beams supported thereon may be placed in the same operation. To allow for shrinkage of the column concrete, it shall be placed to the slower level of the cap, or each tie beam and placement delayed for not less than one (1) hour nor more than two (2) hours before proceeding.

403.04.08– TREATMENT/ FINISHING OF HORIZONTAL SURFACES

All upper surfaces not covered by forms shall be struck off to grade and finished. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off as described above, the surface shall be floated

with a suitable float. Bridge sidewalks shall be given a wood float or broom finish or may be striped with a brush, as specified by the City Engineer. Unless otherwise specified, top of caps and piers shall be given a smooth finish with a steel trowel. Other surfaces shall be wood float finished and striped with a fine brush leaving a fine-grained texture.

403.04.09– FINISH OF ROADWAY SLABS

As soon as the concrete has been placed and vibrated in a section of a sufficient width to permit working, the surface shall be approximately leveled, struck off and screeded, carrying a slight excess of concrete ahead of the screed to insure filling of all low spots. The screed shall be designed to provide the rigidity necessary to hold true to shape and shall have sufficient adjustments to provide for the required camber. A vibrating screed may be used if it is sufficiently heavy to withstand distortion. The screeds shall be provided with a metal edge.

Longitudinal screeds shall be moved forward across the concrete with a combined longitudinal and transverse motion with ends resting on headers or templates, set true to the roadway grade or on the adjacent finished slab. The surface of the concrete shall be screeded enough times (not less than three (3)) and at such intervals to produce a uniform surface true to grade and free of voids.

Spans over fifty (50) feet in length may be screeded in two (2) or more sections if suitable intermediate templates are installed and if adequate equipment is provided. Unless otherwise provided, the templates shall be designed to permit early removal to avoid construction joints and to permit satisfactory finishing at the template site.

If necessary, the screeded surface shall be worked to a smooth finish with a long-handled wood or metal float of the proper size, or hand floated from bridges over the slab.

While the concrete is still plastic, the Contractor shall have the surface checked with a long handled ten (10) foot straightedge. The check shall be made with the straightedge parallel to the centerline. Each pass of the straightedge shall lap half of the preceding pass. All high spots shall be removed and all depressions over one-sixteenth (1/16) inch in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids, or rough spots.

Unless otherwise shown, the surface shall be given a burlap drag, wood float, broom, tine, or a belt finish. If a burlap drag is used, it shall consist of layers of continuous burlap fabric, free of seams, dirt, or hardened concrete. The burlap drag shall be kept wet when in use. The drag shall be attached to a work bridge and drawn over the surface of the slab as necessary to obtain the desired surface texture. Work bridges shall be provided from which to perform all finishing operations.

Rail support holes shall be filled with concrete and finished to match the top of the slab.

After the final set of the concrete, the roadway surface shall be tested again with a standard ten (10) foot metal straightedge for irregularities and the surface shall be corrected, if necessary, to conform to the following:

The straightedge shall be placed parallel to the centerline of road to bridge any depressions and touch high spots. Ordinates measured from the face of the straightedge to the surface of the slab shall not exceed three-sixteenths (3/16) inch. The surface shall be corrected by grinding off the high spots as required to conform to these limits. Vertical curvature and required camber shall be considered when straight edging.

In all roadway slab finishing operations camber for specified vertical curvature and

transverse slopes shall be provided.

For concrete slab or concrete girder spans which are cast-in-place on falsework, an additional amount of camber shall be provided to offset the initial and final deflections of the span. The additional amount of camber shall be determined from the dead load deflection diagram shown on the plans. When dead load deflection is not shown on the plans, the additional amount of camber shall be one-eighth (1/8) inch per ten (10) feet of span length but not greater than one-half (1/2) inch. For concrete girder spans the additional camber for initial and final deflections shall be one-half (1/2) inch for thirty (30) foot spans and three-fourths (3/4) inch for forty (40) foot spans.

Roadway slabs supported on pre-stressed concrete, steel beams, or girders shall receive no additional amount of camber, except that for slabs without vertical curvature, the longitudinal camber shall be approximately one-fourth (1/4) inch.

Dead load deflection shall be considered in the setting of headers and rail systems.

403.04.10– CURING CONCRETE

Careful attention shall be given to the proper curing of all concrete. The Contractor shall inform the City Engineer fully of the methods and procedures proposed for curing; shall provide the proper equipment and material in adequate amounts; and shall have approval of the proposed method, equipment, and material prior to placing concrete.

Inadequate curing facilities or lack of attention to the proper curing of concrete shall be cause for the City Engineer to stop all construction on the job until approved curing is provided.

All concrete shall be cured for a period of four (4) days except as noted herein:

TABLE 403.2
EXCEPTIONS TO 4-DAY CURING

Description	Required Curing
Upper Surfaces of Bridge Roadway, Median and Sidewalk Slabs and Top Slabs of Direct Traffic Culverts	8 Curing Days

A curing day is defined as a calendar day when the temperature, taken in the shade away from artificial heat, is above fifty (50) degrees F for at least nineteen (19) hours (or colder days if satisfactory provisions are made to maintain the temperature at all surfaces of the concrete above forty (40) degrees F for the entire twenty-four (24) hours).

In continuous placement of concrete, the required curing period shall begin when all concrete has been placed and attained its initial set.

The following methods are permitted for curing concrete subject to the requirements of these specifications for each method of curing:

A) Form Curing - When forms are left in contact with the concrete, other curing methods will not be required except for cold weather protection.

B) Water Curing - All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. Curing will be started immediately as soon as finishing is completed. When concrete temperature is above ninety (90) degrees F, water spray or ponding will not be allowed. The water used for curing shall meet the

requirements for concrete mixing water as specified in Section 901.

1. Wet Mat - Cotton mats shall be used for this curing method. The mats shall not be placed in contact with the concrete until such time that damage will not occur to the surfaces. Damp burlap blankets made from nine (9) ounce stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats. The mats may be placed dry and wetted down after placement. Mat curing, except for continuous placements, shall commence not later than three (3) hours after finishing of the roadway slab.

   The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time. Surfaces which cannot be cured by contact shall be enclosed with mats, anchored positively to the forms or to the ground so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

2. Water Spray - This method will be accomplished by overlapping sprays or sprinklers so that all unformed surfaces are kept continuously wet.

3. Ponding - This method requires the covering of the surfaces with a minimum of two (2) inches of clean granular material always kept wet, or a minimum of one (1) inch depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated sand.

C) Membrane Curing - Unless otherwise shown on the plans, Type 2 membrane curing compound may be used where permitted. Material requirements and construction methods shall be as required in Section 901. Membrane shall be applied in a single, uniform coating at the rate of coverage recommended by the manufacturer and as approved by the City Engineer, but not less than one (1) gallon per two hundred ten (210) feet of area. Tests for acceptance shall be at this specified rate.

   Membrane curing shall not be applied to dry surfaces but shall be applied to horizontal surfaces just before free moisture has disappeared. Formed surfaces and surfaces which have been given a first rub shall be dampened and shall be moist at the time of application of the membrane.

   When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane, which is damaged, shall be corrected immediately by reapplication of membrane. Membrane wire will not be used in areas where concrete is to be placed and bonded later.

403.04.11– REMOVAL OF FORMS AND FALSEWORK

Except as herein provided, forms for vertical surfaces may be removed when the concrete has aged not less than one (1) day for normal concrete and not less than one-half (1/2) day for High Early Strength Concrete, provided the forms can be removed without damage to the concrete.

Forms for inside curb faces may be removed in approximately three (3) hours provided the concrete has set sufficiently to permit form removal without damage to the curb.

Weight supporting forms and falsework for all bridge components and culvert slabs shall remain in place a minimum of four (4) curing days. Forms may then be removed if the concrete has attained a 80% of the 28-day specified compressive strength as evidenced by strength tests using specimens made from the same concrete and cured under the

same conditions as the portion of the structure involved. Forms for other structural components may be removed as specified by the City Engineer.

In no case shall forms under parts of structures carrying loads be removed in less time than shown by the following table. Days on which the temperature falls below fifty (50) degrees F shall not be counted.

TABLE 403.3 Form Removal Time	
Shores and Centering Under Slabs, Beams, Girders and Arches Less than 20 feet	4 days
Over 20 feet and less than 35 feet	6 days
Over 35 feet and less than 50 feet	8 days
Over 50 feet and less than 60 feet	9 days
Over 60 feet	10 days
Floor slabs on steel stringers	4 days
All other parts	3 days

After removal of forms, supports, and centering, concrete may be subjected to not more than the design load of the structure.

If all beams made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of fourteen (14) curing days.

The above provisions relative to form removal shall apply only to forms or parts of forms which are so constructed as to permit removal without disturbing forms or falsework which are required to be left in place for a longer period on other portions of the structures.

403.04.12– FINISHING EXPOSED SURFACES

All top surfaces, such as the top of retaining walls, curbs, abutments, rails, etc., shall be treated by tamping and floating with a wooden float in such a manner as to flush the mortar to the surface and provide a uniform surface, free from pits or porous places. The surface thus obtained shall be troweled to produce a smooth surface and brushed lightly with a damp brush to remove the glazed surface.

All concrete surfaces shall be reasonably true and even, free from stone pockets, excessive depressions, or projections beyond the surface. The concrete in bridge seats and walls shall be brought flush with the finished top surface and struck off with a straightedge and floated. The concrete surfaces which are not in an acceptable condition, or which are designated on the plans to be surface finished, shall be rubbed to a smooth and uniform texture with a carborundum brick and clean water as soon as the forms are removed, and the concrete is ready to hone. The loose material formed on the surface, due to the rubbing with a carborundum brick, shall be removed as soon as it dries by means of rubbing the surface with burlap or by other approved methods. The finished surface shall be free from all loose material. A neat cement wash shall not be used.

Transverse Groove Final Finish for Overlays. Do not tine finish overlays within 2 inches of a construction joint.

High Density Concrete. After completing the finishing and before applying the transverse groove final finish, seal all vertical joints with adjacent concrete by painting with thinned grout. After joint painting, apply the transverse groove final finish. Grooving passes shall

not be overlapped but shall be within 1 inch of the preceding pass.

Latex Modified Concrete. After completing the finishing, apply the transverse groove final finish. Grooving passes shall not be overlapped but shall be within 1 inch of the preceding pass. This must be done before the plastic film forms on the surface, approximately 25 minutes in hot, dry weather. Separate screed rails and construction dams from the newly placed material by passing a point trowel along their inside face. Exercise care to ensure that this trowel cut is made for the entire depth and length of rails or dams after the concrete has stiffened sufficiently to not flow back.

Unless otherwise provided on the plans, all reasonably true and even surfaces obtained by use of a form liming, which are of a uniform color, free from stone pockets, honeycomb, excessive depressions, or projections beyond the surface shall be considered as acceptable surfaces and a rubbed surface finish will not be required.

The above provisions for surface finish shall not preclude requiring the use of a dry carborundum brick for straightening molding lines, removing fins, etc., or requiring a rubbed surface finish on all portions of the structure which do not present an acceptable surface even though a form lining is used.

When so indicated on the plans, or with written permission of the City Engineer, painting of concrete surfaces in lieu of rubbing will be permitted. When painting is permitted, all surfaces to be coated shall be prepared in the following manner:

Soon after form removal any porous spots, honeycombed areas, untrue surfaces, and lines shall be corrected. All fins, form marks, runs, drips, or mortar shall be removed leaving a smooth and uniform surface.

When preparing the completed structure for final acceptance, all grease, dirt, mortar drips, and remaining curing membrane shall be removed from the pertinent surfaces after which the surfaces shall be painted with a latex-base adhesive grout.

The grout shall consist of one (1) part latex base adhesive, two (2) parts white cement, two (2) parts natural cement, two (2) parts fine masonry sand, and one (1) part water. Mixture should have the consistency of a thick paint.

The finished surface shall have a uniform appearance and texture. Thickness of coating shall be approximately one-sixteenth (1/16) to one-eighth (1/8) of an inch.

403.05 TESTING

All tests prescribed in this Section 400 and Section 900 as applicable will be made of each designated sample specified after concrete is placed. Testing to be performed by a laboratory approved by the City. Any defective work discovered after the forms have been removed shall be repaired as soon as possible. If the surface of the concrete is bulged, uneven, or shows excess honeycombing or form marks, which in the opinion of the City Engineer cannot be repaired satisfactorily, the entire section shall be removed and replaced. In repairing honeycombed areas, all loose material shall be removed before the repair work is started. No extra compensation will be allowed for the extra work or materials involved in repairing or replacing defective concrete.

403.06 METHOD OF MEASUREMENT

Concrete Structures will be measured by each, cubic yard, linear foot, or square foot in accordance with the dimensions shown on the plans or directed by the City Engineer.

403.07 BASIS OF PAYMENT

No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this item, but it shall be considered subsidiary to the pay items required by the plans and the contract.

SECTION 404 – STRUCTURAL CONCRETE

404.01 DESCRIPTION

This section covers the furnishing and placing of 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 City Engineer.

404.02 MATERIALS

Materials shall meet the requirements specified in the following Sections of 900 – Materials:

Portland Cement Concrete	901
Elastomeric Bearing Pads	935

404.03 EQUIPMENT

All concrete materials and their preparations shall be in accordance with the requirements of Section 901, "Portland Cement Concrete".

404.04 CONSTRUCTION METHODS

A) Handling, Measuring and Batching materials shall be in accordance with Section 314.04

B) Mixing - The mixing of concrete shall be in accordance with Section 314.04

C) Forms - Forms shall be so designated 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. 2 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 two (2) inches or more. Studding on all forms shall be spaced so that no bulge or deflection is apparent between the studs.

For 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 and 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.

D) Handling, Placing and Vibrating Concrete

1. General - In preparation for the placing of concrete, all sawdust, 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.

   Concrete shall be placed to avoid segregation of the materials and the displacement of the reinforcement. The City 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 five (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 concrete shall be internal unless special authorization of other methods is given by the City Engineer or as provided herein.
   - Vibrators shall be of a type and design approved by the City Engineer. The manufacturer's rated capacity shall be not less than four thousand (4000) impulses per minute.
   - The intensity of vibration shall be such as to visibly affect a mass of concrete of one (1) inch slump over a radius of at least eighteen (18) inches.
   - The Contractor shall provide enough vibrators to properly consolidate each batch of concrete immediately after it is placed in the forms.
   - Vibrators shall be manipulated to thoroughly work the concrete around the reinforcement and embedded 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 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 ensure 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 pre-cast piling, concrete cribbing, and other pre-cast members except that, if approved by the City Engineer, the manufacturer's methods of consolidation may be used.

Concrete shall be placed in horizontal layers no more than twelve (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, 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 laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. 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 six (6) inches in the succeeding layer. Work shall not be discontinued within eighteen (18) inches of the top of any face, unless provision has been made for a coping less than eighteen (18) inches thick, in which case, if permitted by the City 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 longitudinal keys so constructed as to prevent the percolation of water through the construction joint.

   Before concrete is placed in the sidewalls, 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 four (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 four (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. Girders, Slabs and Columns - Concrete, preferably, shall be deposited by beginning at the center of the span and working from the center toward the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers not more than twelve (12) inches thick.

   Concrete in girder haunches less than three (3) feet or more, the abutment or columns, the haunch and the girder shall be placed in three (3) successive stages; first up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

   Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided.

   The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified. When placement is not continuous, special shear anchorage shall be provided to insure monolithic action between girder and floor.

   Concrete in T-beam or deck girder spans may be placed in one continuous operation or may be placed in two (2) separate operations. Each separate operation shall be continuous; the first, to the top of the girder stems; and the second, to completion. The bond between stem and slab shall be positive and mechanical and shall be secured by means of suitable shear keys in the top of the girder stem unless other methods are approved by the City Engineer. The size and location of these keys shall be computed. In general, suitable keys may be formed using timber blocks approximately two (2) inches by four (4) inches in cross section and having a length four (4) inches less than the width of the girder stem. These key blocks shall be spaced along the girder stems as required, but the spacing shall be not greater than one (1) foot center to center. The blocks shall be beveled and oiled in such manner as to ensure their ready removal, and they shall be removed as soon as the concrete has set sufficiently to retain its shape.

   Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least two (2) 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 bents until they have been in place at least five (5) days, unless otherwise permitted by the City Engineer.

4. Pneumatic Placing - Pneumatic placing of concrete will be permitted only if specified in the special provisions.

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.

E) Placing Concrete under Water - Concrete shall be deposited in water only with the permission of the City Engineer and under 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 concrete pump 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 forty-eight (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 (10) percent of additional cement shall be added to all concrete placed under water. No allowance will be made 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 concrete pump.

F) 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, 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 City 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 City 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 City Engineer. Shear keys or continuous reinforcement shall be used to transmit shear and/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.

To maintain the proper alignment of the different parts of the work, they shall be provided with keys at approximately one-third (1/3) of the area of the cross sections of the wall or with the equivalent thereof in dowels.

G) Curing Concrete - All concrete shall be cured as provided in these specifications for the various parts of structures. Specific references are as follows:

Concrete Bridge Floors	409

The side forms on all piers, abutments, retaining walls, wingwalls, and reinforced concrete boxes may be left in place for at least three (3) days or if removed before the three (3) days have elapsed, the surfaces shall be cured for the remaining part of the three (3) day period by one of the following methods:

1. Cured for at least three (3) days with an approved polyethylene burlap.
2. Cured for at least three (3) days with three (3) layers of wet burlap.
3. Cured for at least three (3) days with wetted cotton mats as specified. The surface of the concrete 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 slab 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 the covering shall be maintained fully wetted and in position for seventy-two (72) hours after the concrete has been placed unless otherwise specified.

4. Cured with an approved membrane curing compound (Red) as specified below and in Section 901.

   The 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 always close to the finishing and all finished concrete shall be sprayed immediately after the superficial water, if any, has subsided.

   Formed surfaces shall be coated with the curing compound as soon as practicable after removal of the forms.

   The 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 shall not affect concrete surface bond.

   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 in Standard Specifications for the work under construction.

   If discontinuities, or 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 twenty-four (24) hours after application. If any abrasions occur within twenty-four (24) hours, they shall be corrected using additional compound.

H) Rate of Application - The curing compound shall not be applied at a coverage rate lighter than specified below:

Steel Trowel Finish	225 SF/GAL
Rough float Finish	200 SF/GAL

Whenever the atmospheric temperature is one hundred (100) degrees F or more, the City Engineer may require an additional coat at a rate of approximately two hundred seventy (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 thirty (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 these specifications.

I) Removal of Forms - To make possible the obtaining of satisfactory surface finish, forms on ornamental work, railings, parapets, and vertical surfaces which do not carry loads, and which require a special concrete surface finish shall be removed as soon as practicable.

Forms supporting the main slabs and girders shall remain in place at least twenty-one (21) days and during unfavorable curing conditions as much longer as the City Engineer may direct.

The above specified time may be decreased in case test beams are cast at the time the concrete is placed. Beams shall be made, cured, and tested as provided in Section

404.05.

The forms may be removed when the test beams meet strength requirements as provided in Section 403.04.11, except as modified hereafter.

In no case shall the forms supporting main slabs, girders or concrete beams be removed in less than ten (10) days after the concrete is placed. Forms for vertical walls on columns, piers, abutments, and retaining walls requiring a concrete surface finish shall be removed in warm weather within twenty- four (24) hours after the concrete is placed and in the cool weather within forty-eight (48) hours - at least as soon as they may be removed without damaging the concrete. Forms under concrete caps on pile bents and under web walls shall remain in place at least five (5) days, if test beams have the required strength as provided above.

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 one-fourth (1/4) inch below the surface and the 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.

J) 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.

K) 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 City Engineer.

L) 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.

M) 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.

404.05 TESTING

Slump will be determined using AASHTO T-119, and air content using AASHTO T-152 for gravel and stone aggregate and AASHTO T-196 for slag and other highly porous coarse aggregate. Test specimens will be made and cured in accordance with AASHTO T-23 except that after the initial curing, quality control specimens will be cured in a medium maintained at forty (40) degrees F to eighty-five (85) degrees F until they are delivered to the laboratory. Specimens will be tested in accordance with AASHTO T-22 for cylinders or AASHTO T-97 for beams (third point loading) or AASHTO T-177 for beams (center loading).

Unless otherwise provided, the minimum modulus of rupture when test beams are permitted as a criterion for removal of forms, placing a structure in service, driving piling, etc., shall be five hundred fifty (550) psi when tested with the third point method or six hundred fifty (650) psi when tested with the midpoint method and the minimum compressive strength of cylinders shall be thirty-five hundred (3500) psi.

404.06 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 City Engineer.

404.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) STRUCTURAL CONCRETE	Cubic Yard

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

SECTION 405 – PRE-STRESSED CONCRETE FOR STRUCTURES

405.01 DESCRIPTION

This section covers the furnishing and placing in the structure of the pre-stressed beams or other members in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established by the City Engineer.

Plans for members will show Pre-stressing by one of the following methods:

A) Pre-tensioning: In which the reinforcing tendons are stressed initially, after which concrete is placed and cured and the stress is released from anchorages to concrete after development of specified concrete strength.

B) Post-tensioning: In which the reinforcing tendons are installed in voids or ducts within the concrete and are stressed and anchored after the development of specified concrete strength. As a final operation under this method the voids or ducts are pressure grouted.

C) Combined Method: In which part of the reinforcing is pre-tensioned and part post-tensioned. Under this method all applicable requirements for Pre-tensioning and for Post-tensioning shall apply to the respective reinforcing elements using these methods.

405.02 MATERIALS

Materials shall meet the requirements specified in the following Section 900 – Materials:

Portland Cement Concrete	901
Joint Fillers and Sealers	901.08
Reinforcing Steel	923
Bearing Pads	933.06

405.03 EQUIPMENT — VACANT

405.04 CONSTRUCTION METHODS

A) Concrete for Pre-stressed Members - The concrete shall have the minimum compressive strength at twenty-eight (28) days as shown on the plans and as specified in Section 901. The strength of the concrete at transfer of Pre-stress shall be eighty (80) percent off, or four thousand (4000) psi, whichever is greater.

B) If steam curing is used, the methods shall meet the following requirements:

1. Steam curing shall be done under a suitable enclosure to contain the live steam to minimize moisture and heat losses. The initial application of the steam shall be from two (2) to four (4) hours after the final placement of concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam shall be increased from four (4) to six (6) hours.

2. The steam shall be at one hundred (100) percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Live steam shall not be applied directly on the concrete or in harmful, concentrated jets of the forms.

3. During application of the steam the ambient air temperature shall increase at a rate not to exceed forty (40) degrees F per hour until a maximum temperature of one hundred-forty (140) degrees F to one hundred-sixty (160) degrees F is reached.

4. The maximum temperature shall be held until the concrete has reached the desired strength. In discontinuing the steam, the ambient air temperature shall not decrease at a rate to exceed forty (40) degrees F, per hour until the approximate temperature of the air to which the concrete will be exposed has been reached.

C) Forms - Forms and centering shall be made and maintained during their use true to the shapes and dimensions shown on the approved drawings.

Forms shall be well braced and stiffened against deformation under pressure of the wet concrete and shall have smooth joints and inside surfaces accessible for adequate cleaning before each use.

Forms may be treated with a commercial quality form oil or other equivalent coating which will permit the ready release of the forms and will not discolor the concrete. Adequate measures shall be taken by the Contractor, as approved by the City Engineer, to prevent the contamination or corrosion of the Pre-stressing steel.

D) Stressing Requirements - General - In all methods of tensioning, the stress induced in the reinforcing members shall be measured both by jacking gauges and by elongations of the reinforcement. Elongations and jacking pressures shall make appropriate allowance for friction and all possible slippage or relaxation of the anchorage. All jacks shall be equipped with accurate and calibrated gauges for registering jacking pressures. Means shall be provided for measuring the elongation of reinforcement to at least the nearest one thirty-second (1/32) inch.

Prior to use in manufacture of pre-stressed members under these specifications, all jacks to be used, together with their gauges, shall be calibrated by a reputable testing laboratory at the expense of the Contractor. Calibration of jacks and gauges shall be repeated at intervals of not more than one (1) year. During progress of the work if any jack or gauge appears to be giving erratic results, or if gauge pressure and elongation indicate materially

differing stresses, recalibration will be required.

It is anticipated that there may be a possible difference in indicated stress between jack pressure and elongation of about five (5) percent. In such event the error shall be so placed that the discrepancy shall be on the side of a slight overstress rather than under stress. In the event of an apparent discrepancy between gauge pressure and elongation of more than five (5) percent, the entire operation shall be carefully checked, and the source of error determined before proceeding further.

Straight tendons may be tensioned from one end. The draped tendons shall be stressed by jacking from both ends of the bar unless otherwise provided on the plans or in the proposal.

In all stressing operations the stressing force shall be kept symmetrical about the vertical axis of the members.

E) Stressing Procedure - The Contractor shall submit his plan and procedure for stressing each type of unit to the City Engineer for approval prior to fabrication. The procedure should include, but not be limited to initial tensioning force to equalize stresses and eliminate slack in the strands; uplift and hold down devices; method of Pre-tensioning and detensioning; measurement of elongation; and anchorage details.

1. Pre-tensioning - The amount of stress to be given each cable shall be as shown on the plans. Cable stress shall be maintained between anchorages until the concrete has reached the required compressive strength.
2. Post-tensioning - For all Post-tensioned bars, the anchor plates shall be set exactly normal in all directions to the axis of the bar. Parallel wire anchorage cones shall be recessed within the beams. Tensioning shall not be done until the concrete has reached the required compressive strength.
3. Combined Method - If the girders are manufactured with part of the reinforcement pre-tensioned and part post-tensioned, the applicable portions of requirements listed above shall apply to each type.
4. Ducts for Post-tensioning Bars - Ducts in the girders for the post-tensioning bars or parallel wire cables shall be formed by means of flexible metal conduits, metal tubing, or other approved means. They shall be mortar tight, accurately placed, and accurately held in place. Metallic conduit shall be of a ferrous metal.
5. The ducts through post-tensioned members in which the bars or cables are installed shall be equipped with approved grouting vents. After completion of stressing, the annular space between sides of the bar or cable and sides of hole shall be grouted in a manner approved by the City Engineer.

F) Construction, Testing, and Inspection - Construction methods and testing shall be in accordance with the AASHTO Standard Specifications for Highway Bridges and as supplemented herein.

The Contractor shall notify the City Engineer of the time at which the stressing procedure, casting procedure, or releasing of strands are to take place so that an Inspector can be present during casting and Pre-stressing of the beams.

After the stressing of pre-tensioned strands has been completed and before side forms are erected, the Inspector shall examine the strands, and any strand found contaminated with the bond breaking substance used on the forms shall be replaced or satisfactorily cleaned with a solvent.

The Inspector shall inspect batching and placement and make six (6) cylinders for each casting operation: three (3) of the cylinders shall be used to determine when concrete has reached the required strength and is ready for stressing, and the remaining cylinders shall be tested at twenty- eight (28) days to determine that the design strength has been reached. Cylinders shall be cured in the same manner as the structural member which is represented by the cylinders until the requirements for stressing have been attained and the remaining period for the twenty-eight (28) day cylinders shall be in accordance with AASHTO T-23. Cylinders shall be tested in accordance with AASHTO T-22.

G) Transportation and Storage - Pre-cast girders should be maintained in an upright position, and points of support and directions of the reactions with respect to the girder shall be approximately the same during transportation and storage as when the girder is in its final position.

Care shall be taken during storage, hoisting, and handling of the pre-cast units to prevent cracking excessive camber, side bow, or other damage. Units damaged by improper storing or handling shall be replaced by the Contractor at no additional cost to the City. Minor chipping, spalling and scars may be repaired if approved by the City Engineer.

H) Erection, Bearings and Anchorage - All bearing areas on the pre-stressed members, as well as on the bridge seats, shall be finished to a true surface to give full and uniform bearing over the entire bearing area. In case such a uniform bearing is not obtained, the defect shall be corrected in a manner approved by the City Engineer.

All anchorages shall be carefully constructed as shown on the plans. Before any member is erected, the City Engineer will check the elevations of all bridge seats. Any elevation which is off more than .02 feet shall be corrected in a manner approved by the City Engineer. Pre-stressed beams shall be blocked or braced as they are set in place to assure lateral stability.

I) Tolerances - Maximum dimensional tolerances are listed below. It is intended that the dimensions of all members shall be well within these tolerances and the maximum values shall be permitted to be approached or equaled only occasionally. The Inspector shall document to the City Engineer any unit with dimensions out-of-tolerance.

TABLE 405:1 Pre-stressed Concrete I-Beams Tolerance in Inches	
Depth (flanges, web and fillets)	¼”
Depth (overall)	½” to -¼”
Width (flanges and fillets)	⅜” to -¼”
Width (web)	⅜” to -¼”
Length of Beams	1”
Exposed Beam Ends Deviation from Square or Designated Skew – Horizontal	½”
Diaphragm Bolt Holes (spacing between centers of inserts and from the centers of inserts to the ends of the beams)	½”
Bearing Plates (spacing between the centers of bearing plates)	1/8” per 10 LF
Bearing Plates (spacing from the centers of bearing plates to the ends of the beams)	½”
Bearing Plat or Bearing Area Deviation from Plane	1/8”
Stirrup Bars – Projection Above Top of Beam	¾”
Stirrup Bars – Longitudinal Spacing	1”
End Stirrup Bars	½” from Plan
Horizontal Alignment (deviation from a straight line parallel to the centerline of beam)	1/8” per 10 LF
Camber Differential between Adjacent Beams 1/8 per 10 ft. of span to maximum of 1	¼”
Center of Gravity of Strand Group	½”
Center of Gravity of Depressed Strand Group at end of Beam	¼”
Position of Post-Tensioning Duct	6”
Position of Hold Down Points for Depressed Strand	6”
Position of Handling Devices	6”

Variations greater than specified above shall be corrected to within these tolerances or be subject to a structural review by the City Engineer for acceptance.

J) Finish - The facia girder on grade separation structures shall receive a surface finish consistent with other areas of the superstructure. Surface finish shall be in accordance with Section 403.

405.05 TESTING — VACANT

405.06 METHOD OF MEASUREMENT

Accepted Pre-stressed concrete beams will be measured by the linear foot of pre-stressed concrete beam complete in place as specified and as shown on the plans.

Joint fillers, joint sealers, shoes, bearing plates, and elastomeric bearing pads will not be a separate pay item, but the cost of same shall be included in the price of other bid items unless otherwise shown on the plans. When approved by the City Engineer, twenty (20) percent additional cement and admixture can be used in lieu of High Early Strength Portland Cement.

405.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) PRE-STRESSED CONCRETE BEAMS	Linear Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

SECTION 406 – HIGH EARLY STRENGTH CONCRETE

406.01 DESCRIPTION

High Early Strength Concrete shall be composed of High Early Strength Portland Cement, fine and coarse aggregate, and water, each measured separately and mixed as provided in Section 901. It shall be used for structures or portions of structures only when approved by the City Engineer or called for on the plans or in the special provisions.

406.02 MATERIALS

Materials shall meet the requirements specified in Section 901.

406.03 EQUIPMENT — VACANT

406.04 CONSTRUCTION METHODS

A) Tests - Test specimens shall be in accordance with Section 901.

B) Curing

1. Floor slabs shall be cured as provided in Section 409.
2. The side forms on curbs and piles may be left in place for at least three (3) days or if removed before the three (3) 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 three (3) day curing period has elapsed.

C) Removal of Forms - To obtain a satisfactory surface finish, forms on ornamental work, railings, parapets, curbs, and vertical surfaces, which do not carry loads and will be exposed in the finished work, shall be removed within forty-eight (48) hours, depending upon weather conditions, and in any event while a satisfactory finish can still be obtained.

Before forms are removed or the concrete placed in service on portions of structure carrying loads the compressive strengths of test cylinders or modulus of rupture of test beams shall be as provided in Sections 403.04.11 and 404.05 as applicable.

D) Reinforced Concrete Piling - High Early Strength Concrete piling shall not be moved and stacked in less than three (3) days after casting, nor driven in less than seven (7) days after casting, and in no event until a compressive strength of thirty-five hundred (3,500) psi or a modulus of rupture of six hundred (600) psi when tested with third point method

or seven hundred (700) psi when tested with midpoint method in accordance with Section 901.

406.05 TESTING — VACANT

406.06 METHOD OF MEASUREMENT

Measurement of the various structures when High Early Strength Concrete is used will be in the same manner as elsewhere provided in these specifications for items of the same kind.

Payment for the various items in which High Early Strength Concrete is used shall be made on the same basis as provided elsewhere in these specifications for items of the same kind. No additional compensation will be allowed when the Contractor uses High Early Strength Concrete at his own option.

406.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) HIGH EARLY STRENGTH CONCRETE	Cubic Yard

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 407 – PNEUMATICALLY PLACED CONCRETE

407.01 DESCRIPTION

This section covers premixed sand and Portland Cement pneumatically transported through a pipe or hose in a dry state to a nozzle where hydration takes place immediately prior to expulsion.

407.02 MATERIALS

The cement, water, and sand shall conform to the requirements of Section 901, "Portland Cement Concrete". The sand, when tested by approved laboratory methods, shall conform to the following gradation requirements:

Passing No. 4 Sieve	98-100% (by weight)
Passing No. 20 Sieve	60-85%
Passing No. 50 Sieve	15-35%
Passing No. 100 Sieve	0-5%

Bar reinforcement and wire fabric reinforcement shall conform to the requirements of Section 923, "Reinforcing Steel".

Expansion joint material shall conform to the requirements of Section 901.08, "Preformed Expansion Joint Filler for Concrete".

Steel drive pins or studs used for the attachment of reinforcing when covering designed portions

of concrete structures with pneumatically placed concrete shall be capable of being driven to the specified depth without deforming or otherwise becoming unsuitable for the purpose intended. The pins shall have a minimum diameter of one-eighth (1/8) inch and a minimum length of two (2) inches. Size and location of drive pins or studs and method of attachment of reinforcing shall be as specified herein or as detailed on the plans.

The equipment used for driving the pins or studs shall be of the type which uses an explosive for the driving force and shall be capable of inserting the stud or pin to the required depth without damage to the concrete. The City Engineer may require that a test be made of the equipment prior to approving it for use.

Unless otherwise specified, the concrete shall consist of a mixture of cement and sand in the proportions by volume of one (1) part cement to four and one-half (4 1/2) parts sand. The sand shall contain not less than three (3) percent nor more than six (6) percent of moisture by weight. The sand and cement shall be mixed thoroughly in a power mixer for at least one and one-half (1 1/2) minutes before placement in the chamber of the gun mechanism. The dry mixed material shall be used promptly after mixing and any material that has been mixed for more than forty-five (45) minutes shall be rejected and removed from the worksite.

The mixer shall be cleaned at regular intervals to remove all adherent material from the mixing vanes and from the drum.

At the beginning of work the City Engineer may require that cylinders be made to represent the quality of the pneumatically placed concrete. Additional cylinders will be made during prosecution of the work as directed by the City Engineer. If, in the opinion of the City Engineer, the cylinder strengths are indicating undesirable variation in the concrete, the Contractor may be required to change the mix design and/or method of placing to correct this condition.

The Contractor shall furnish especially constructed cylinders six (6) inches in diameter and twelve (12) inches high, made of three-fourths (3/4) inch square mesh hardware cloth. Test cylinders for pneumatically placed concrete shall be shot with the same air pressure and nozzle tip as the pneumatically placed concrete. At the end of the first twenty-four (24) hours curing period the hardware cloth form shall be removed and the cylinders stored and cured as directed by the City Engineer.

The use of approved admixtures conforming to the requirements of Section 901, "Concrete Admixtures", will be permitted at the option of the Contractor.

407.03 EQUIPMENT

The gun mechanism should be operated at a minimum air pressure of forty-five (45) pounds per square inch on the gun tank when one hundred (100) feet or less of material hose is used and the pressure should be increased five (5) pounds for each additional fifty (50) feet of hose required. Nozzles used for guniting shall have a maximum size of one and five-eighths (1 5/8) inch unless otherwise permitted by the City Engineer.

Water used for hydration shall be maintained at a uniform pressure, which shall be at least fifteen (15) pounds per square inch above air pressure at the gun.

407.04 CONSTRUCTION METHODS

A) Placement - Earth surfaces to which concrete is to be applied shall be neatly trimmed to line and grade and shall be free of all loose material.

   No high subgrade will be permitted. Excavation made below subgrade shall be backfilled with compacted fill or, at the Contractor's option, with concrete. However, no additional

compensation will be allowed for such compacted fill nor for increased thickness of concrete placed because of low subgrade.

Asphaltic concrete surfaces shall be thoroughly cleaned of any organic Material, silt and clay, or any other material detrimental to the concrete and then washed with water under pressure.

Masonry, rock, and concrete surfaces shall be examined, and all loose material removed therefrom. The surface shall be thoroughly cleaned with steel scrapers or brushes to remove all dust, dirt, mortar, grease, or other deleterious substances and then washed with water.

Whenever brushing and scraping do not secure suitable results, sandblasting may be required.

All surfaces shall be wetted with water before application of concrete. Concrete shall not be applied to surfaces on which free water exists.

The velocity of the material as it leaves the nozzle shall be maintained uniformly at a rate determined for given job conditions. Material which rebounds and does not fall clear of the work, or which collects on the surfaces shall be blown off or otherwise removed. Rebound shall not be used in any portion of the work and no payment will be made for rebound or other concrete losses.

The nozzle shall be held at such distance and position that the stream of flowing material will impinge at approximately right angles to the surface being covered. Any portion of the placed concrete which tends to sag, or which shows soft or sandy pockets or is otherwise unsatisfactory, shall be cut out and replaced with new concrete. Reinforcement damaged or destroyed by such repairs shall be replaced by trimming the concrete back and properly lapping and tying additional steel as may be required by the City Engineer.

Reinforcement shall be firmly supported in the position shown on the plans. Mortar blocks, metal chairs, clips, or spacers with wire ties or other acceptable means shall be used to anchor and place the reinforcement properly.

Where material is placed on overhead surfaces the amount of water used shall be so adjusted that approximately three-fourths (3/4) inch of the placed material shall adhere without support. The limit of thickness shall be considered to have been exceeded when the material begins to sag or slough.

B) Forms and Ground Wires - The forms shall be built in accordance with applicable provisions of these specifications, except all forms shall be built to permit the escape of air and rebound.

Ground wires shall be installed in such a manner that they accurately outline the finished surface as indicated on the plans. They shall be located at intervals sufficient to insure proper thickness throughout. Wires shall be stretched tight and shall not be removed prior to application of the finish coat.

Headers will be required where the plans indicate a formed edge and at plan joints.

C) Joints - Construction joints shall be sloped off at an angle of approximately forty-five (45) degrees to the surface to which the concrete is being applied. Before applying concrete in the adjacent sections, the sloped portion shall be thoroughly cleaned and wetted by means of air and water blast. The plan joints shall be formed in accordance with and placed in the locations designated on the plans.

D) Finish - Upon reaching the thickness and shape outlined by forms and ground wire, the

surface shall be rodded off to true lines. Any low spots or depressions shall be brought up to proper grade by placing additional concrete. Ground wires shall then be removed, and unless otherwise specified, the surface shall then be broom finished to secure a uniform surface texture. Rodding and working with a wood float shall be held to a minimum. Rebound or accumulated loose sand shall be thoroughly cleaned up and disposed of by the Contractor. In no case shall it be floated into the surface of the work.

When a nozzle finish is specified on the plans, ground wires shall not be used, and the surface shall be left as uniform as possible without rodding. Nozzle finishes will not be permitted where the underlay has been floated. Concrete shall not be applied to a surface containing frost or ice. Where standing or running water is encountered it shall be removed before applying the concrete. No work shall be done without the permission of the City Engineer when the temperature is lower than forty (40) degrees F. After placing, the concrete shall be protected from freezing or quick drying.

E) Curing - Pneumatically placed concrete shall be cured in accordance with Section 403, "Concrete Structures".

F) Workmen - Only experienced foremen, gunmen, nozzlemen, and rodmen shall be employed, and satisfactory written evidence of such experience shall be furnished the City Engineer or his representative upon demand.

407.05 TESTING — VACANT

407.06 METHOD OF MEASUREMENT

Measurement for pneumatically placed concrete will be made by the square foot in place. For encasement of structural steel members and covering portions of structures, the actual contact area shall be the basis for measurement.

Pneumatically placed concrete, measured as provided above, will be paid for at the unit price bid per square foot for "Pneumatically Placed Concrete", of the type specified. The unit price bid per square foot shall be full compensation for all cement, sand, water, reinforcement, furnishing and driving all steel drive pins, for mixing and placing pneumatically placed concrete, and for all labor, tools, equipment, and incidentals necessary to complete the work. Excavation for channel and canal lining will be paid for in accordance with Section 200, “Excavation”. Shaping and fine grading of channel or canal slopes and floors are not to be paid for directly but shall be included in the unit price bid for "Pneumatically Placed Concrete".

407.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) PNEUMATICALLY PLACED CONCRETE	Square Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

SECTION 408 – STEEL STRUCTURES

408.01 DESCRIPTION

This section covers the fabrication and erection of structural steel and other metals, except reinforcing steel, which are used for steel structures or steel portions of structures.

408.02 MATERIALS

408.02.01– GENERAL

The metal used for the various portions of the structure shall be as specified and shall conform to the requirements of the applicable sections of Parts 1 through 12 of the ASTM Specifications.

408.02.02– SHOP DRAWINGS

Unless otherwise provided on the plans, the Contractor shall prepare and submit detailed shop drawings for each detail of the general plans requiring the use of structural steel, forgings, wrought iron, castings, or bearings. Camber and erection diagrams will be required. The drawings shall be prepared on sheets twenty-four (24) inches by thirty-six (36) inches, or as designated by the City Engineer.

All shop drawings shall be checked by the fabricator before being submitted for approval by the City Engineer. The Contractor shall furnish to the City as many prints of the drawings as are necessary for carrying out the work. The Contractor shall be responsible for the correctness and completeness of the drawings and for shop fit and field connections, although the drawings have been approved by the City Engineer.

408.02.03– STORING MATERIALS

All materials shall be handled in such manner that no injury will result. Material to be stored shall be placed on skids above the ground and shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns, shall be supported on skids placed closely enough to prevent excessive deflection.

408.03 - EQUIPMENT

Before starting work, the Contractor shall inform the City Engineer fully as to the method of erection he proposes. Follow and as to the amount and character of the equipment he proposes to use; the adequacy of which shall be subject to the approval of the City Engineer. The approval of the City Engineer shall not be considered as relieving the Contractor of the responsibility for the safety or adequacy of his methods or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the City Engineer.

The Contractor shall prepare and submit erection plans for the erection of plate girders (riveted, bolted, or welded), trusses, and for all railroad underpass structures. Field erection plans for I-beam units will not be required unless specified on the plans. The plans shall be complete in all details of procedure, sequence of work, equipment to be used, etc., so that a check can be made of the adequacy of the proposed erection procedure.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together

while riveting will not be permitted.

The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of the work. Drift pins sufficient to fill at least one-fourth (1/4) of the field holes for main connections shall be provided.

408.04 CONSTRUCTION METHODS

408.04.01– WORKMANSHIP

Workmanship and finish shall be equal to the best general practice in modern steel fabricating shops. Rolling tolerances for rolled shapes, plates, and bars shall conform to the requirements of ASTM Designation A-6.

Before being laid out or worked, rolled material shall be straight. If straightening is necessary, it shall be done by methods approved by the City Engineer. Kinks and bends in the material will be cause for rejection. Heat shrinking of low alloy structural steels will not be permitted.

If straightening is necessary in the field, only methods approved by the City Engineer shall be used.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping will be done carefully and accurately. Undercut gusset plates will not be accepted. All sharp corners and edges, and edges that are marred, cut, or roughened in handling or erection, shall be slightly rounded by grinding or other suitable means.

408.04.02– RIVETED AND BOLTED STRUCTURES

Unless prohibited by the plans, high strength bolts may be used where rivets are designated. In these specifications where reference is made to pitch, edge distance, preparation of holes, etc., for rivets, the same criteria shall govern for high strength bolts. Pitch and edge distance not shown on the plans shall be in accordance with AASHTO Standard Specifications for Highway Bridges.

Unless otherwise specified or shown on the plans, fabrication of riveted structures shall conform to the current edition of AASHTO Standard Specifications for Highway Bridges.

408.04.03– HOLES FOR BOLTS OR RIVETS

Holes shall be either punched full size, punched, and reamed, or drilled. The finished hole shall be one- sixteenth (1/16) inch larger than the nominal diameter of the rivet.

Holes punched full size shall have all burrs and sharp edges removed. The diameter of the die shall not exceed that of the punch by more than three thirty- seconds (3/32) inch.

A) Holes for Shop Rivets shall be sub punched, or subdrilled at the fabricator's option, one-fourth (1/4) inch less in diameter than that of the finished holes and shall be reamed to size with the parts assembled, with the following exceptions:

    1. Holes in material thicker than seven-eighths (7/8) inch shall not be punched; however, at the fabricator's option, they may be subdrilled to the diameter specified for sub punching or may be drilled full size with the parts assembled,

provided that the parts are adequately bolted or clamped together.

2. Holes in rolled beams and plate girders, including stiffeners and active fillers at bearing points, may be sub punched one-eighth (1/8) inch less in diameter than that of the finished holes and reamed to size (after assembly) in material not thicker than the nominal diameter of the rivet less one-eighth (1/8) inch.

3. Holes in material not more than seven-eighths (7/8) inch thick, for rivets which do not transfer stress caused by external vertical loading, may be punched full size or, at the fabricator's option, may be sub punched one-eighth (1/8) inch less in diameter than the finished holes and reamed to size after assembly. This applies to holes for stitch rivets, lateral, longitudinal or sway bracing and their connecting material, lacing, stay plates, diaphragms which do not transfer shear or stress, inactive fillers, and stiffeners not at bearing points. However, holes through assembled material shall not pass through both reamed plies and plies punched full size unless the reamed holes have been sub punched for the fabricator's convenience, or the assembled material is not over five (5) plies thick, of which the main material consists of not more than three (3) plies.

B) Holes for Field Rivets shall be sub punched or subdrilled at the fabricator's option, one-fourth (1/4) inch less in diameter than that of the finished holes, and shall be reamed to size through steel templates with hardened steel bushings, with the following exceptions:

1. Field splices in plate girders and in the chords of trusses shall be reamed with the members assembled. Other field connections may be reamed with the members assembled, at the fabricator's option. Chord splices or truss members shall, in all cases, be reamed or drilled with at least three (3) abutting sections assembled and with milled ends of compression chords in full bearing.

2. Assemblies such as floor systems to girders, complete trusses, rolled beam spans connected by diaphragms, and portals to trusses shall be reamed with the members assembled if so indicated on the plans, and otherwise at the fabricator's option.

3. Field connections of lateral, longitudinal, or sway bracing shall conform to the requirements of holes for shop rivets.

4. Holes in material thicker than seven-eighths (7/8) inch shall not be punched but shall be subdrilled to the diameter specified for sub punching or drilled full size with parts assembled.

   The accuracy of the punching shall be such that for any group of holes when assembled, seventy- five (75) percent shall admit a rod equal to the diameter of the cold rivet at right angles to the plane of the connection. Otherwise, the holes shall be reamed. When the extent of the reaming is such that the holes cannot be properly filled or accurately adjusted after reaming, the faulty member shall be discarded and replaced.

   Mis-punched members shall not be corrected by welding without the approval of the City Engineer.

408.04.04– REAMED WORK

Reaming shall be done after the pieces forming a built-up member are assembled and so firmly bolted together that the surfaces are in close contact. Burrs and sharp edges of

each reamed hole under both rivet heads shall be removed with a countersinking tool making one-sixteenth (1/16) inch fillets. The pieces shall be taken apart before riveting, if necessary, and any shavings removed. If it is necessary to take the members apart for shipping or handling, the pieces reamed together shall be so marked that they may be reassembled in the same position. Reamed parts shall not be interchanged.

408.04.05– DRILLED HOLES

Drilled holes shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. Burrs and sharp edges of each drilled hole under both rivet heads shall be removed with a countersinking tool making a one-sixteenth (1/16) inch fillet. Burrs on the outside surfaces shall be removed. If members are drilled while assembled, the parts shall be held securely together while the drilling is being done.

Drilled holes shall be drilled to finish size while all the thicknesses of metal are assembled or subdrilled and reamed as required for punched and reamed holes.

Holes shall be clean cut, without torn or ragged edges. Holes that must be enlarged to admit rivets shall be reamed. Drilling shall be done accurately.

408.04.06– ASSEMBLING STEEL

Steel parts shall be assembled in the shop or in the field in accordance with the following:

A) Shop Work - At the time of assembling and riveting, bolting, or welding, steel surfaces in contact for shop or field connection shall be thoroughly cleaned of rust, loose mill scale, dirt, grease, or other material foreign to the steel. No paint shall be applied to contact surfaces prior to riveting, bolting, or welding.

   Riveted or bolted trusses, continuous plate girder and I-beam spans, skew portals, skew connections, rigid frames, bents, and towers, shall be completely assembled in the shop and accurately adjusted to line and camber and holes for field connections and shall be drilled or reamed while assembled. Holes for other field connections, except those in lateral, longitudinal, and sway bracing, shall be drilled or reamed in the shop with the connecting parts assembled or drilled or reamed to a metal template with hardened bushings, without assembling.

   Long span truss work shall be assembled in lengths of not less than three (3) abutting panels, the members adjusted for line and camber, and holes for field connections drilled or reamed while assembled.

   Field riveted or bolted joints for girders shall be completely assembled, the members adjusted for line and camber, and holes for field connections drilled or reamed while assembled.

   Field butt joints for welded girders shall be completely assembled with the members adjusted for line and camber and prepared to fit for welding.

   All machinery shall be completely assembled. All bearings shall be fitted to the specified clearances and alignment. Gear reductions and all line gears shall have gear center distances set and the gears properly matchmarked.

B) Field Work - The parts shall be accurately assembled as shown on the plans and all matchmarks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be permitted. Bearing surfaces and surfaces to be

in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted or bolted and all other truss connections pinned and bolted. Rivets or bolts in splices of butt joints of compression members and rivets or bolts in railings shall not be driven or torqued until the span has been erected in place, temporarily bolted, and the member is supporting its own weight.

Splices and field connections shall have one-half (1/2) of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting or bolting. Splices and connections carrying traffic during erection shall have three-fourths (3/4) of the holes so filled. Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be one thirty-second (1/32) inch larger.

The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be matchmarked and a diagram showing such marks shall be furnished to the City Engineer.

408.04.07– RIVETING

Shop and field riveting shall conform with the following provisions:

A) Shop Work - Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. Rivets, when heated and ready for driving, shall be free from slag, scale, and other adhering matter. When driven they shall completely fill the holes. The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins, and in full contact with the surface of the member.

   Loose, burned, or otherwise defective rivets shall be replaced. In removing rivets care shall be taken not to injure the adjacent metal. Caulking or recupping will not be permitted.

   Rivets shall be driven by direct acting riveters where practicable. If rivets are driven with a pneumatic hammer, a pneumatic bucker shall be used if practicable.

B) Field Work - Pneumatic hammers shall be used for field riveting. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge he holes or distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Cup faced dollies fitting the head closely to ensure good bearing shall be used. Sufficient air capacity shall be maintained to keep the air pressure at one hundred (100) pounds per square inch at the hammers. Caulking or recupping will not be permitted. In removing the rivets, the surrounding metal shall not be injured. The removal of loose or defective rivets by flame cutting will not be permitted, except upon written permission of the City Engineer.

408.04.08– BOLTED CONNECTIONS

When high strength bolts are required or permitted, the bolts shall be in conformance with ASTM A- 325-81 and ASTM A-194.

408.04.09– JOINTS AND CONNECTIONS

A) Edge Planing - Sheared edges of plates more than five-eighths (5/8) inch in thickness and carrying calculated stress shall be planed to a depth of one-fourth (1/4) inch.

B) Facing of Bearing Surfaces - Surfaces of bearing and base plates and other metal bearing surfaces that are to meet each other, with ground concrete surfaces, or with asbestos sheet packing shall be machined flat to within one thirty-second (1/32) inch tolerance in twelve (12) inches and to within one-sixteenth (1/16) inch tolerance overall. Surfaces of bearing and base plates and other metal bearing surfaces that are to meet preformed fabric pads, elastomeric and elastic bearing pads, or Portland Cement grout shall be machined flat to within one-eighth (1/8) inch tolerance in twelve (12) inches and to within three-sixteenths (3/16) inch tolerance overall.

   At the option of the Contractor, steel slabs, where not in contact with other metal bearing surfaces, may be heat straightened in lieu of machining, provided the above tolerances are met.

C) Abutting Joints - When shown on the plans abutting joints shall be faced and brought to an even bearing. Where joints are not faced the opening shall not exceed one-fourth (1/4) inch.

D) End Connection Angles - Floor beams, stringers, and girders having end connection angles shall be built to exact length back-to-back of connection angles. If end connections are faced, the finished thickness of the angle shall not be less than that shown on the detail drawings.

E) Web Plates - In girders having no cover plates and which are not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than one-eighth (1/8) inch below at any point.

F) Fit of Stiffeners - End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. All fillers under stiffener angles shall fit sufficiently tight to exclude water after being painted.

G) Pin and Bolted Connections - Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members will take full bearing on them. In field assembling, the pin nuts on pin connections and the bolts on bolted connections shall be screwed up tight and the threads, except when high strength bolts are used, burred at the face of the nuts with a pointed tool.

H) Pins and Rollers - Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. The final surface shall be produced by a finishing cut.

   Pins and rollers more than seven (7) inches in diameter shall be forged and annealed.

In pins larger than nine (9) inches in diameter, the forging shall be permitted to cool to a temperature below the critical range cooling and a hole not less than two (2) inches in diameter shall be bored full length along the axis of the pin before being annealed.

Pin holes in structural members shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than one thirty-second (1/32) inch. Holes in built-up members shall be bored after riveting, bolting, or welding is completed.

The diameter of the pin hole shall not exceed that of the pin by more than one-fiftieth (1/50) inch for pins five (5) inches or less in diameter, or one thirty- second (1/32) inch for larger pins.

l) Screw Threads - Screw threads shall make close fits in the nuts and shall be Unified Standard Series conforming to USASI B1.1-1960.

408.04.10– BEARINGS AND ANCHORAGE

Anchor bolts shall be either headed bolts, installed with or without pipe sleeves, or swedge bolts installed in drilled holes as detailed on the plans. The anchor bolts shall be carefully installed to permit true positioning of the bearing assemblies.

When anchor bolts are installed in pipe sleeves, the pipes shall be filled with grout at the time the grout pads are constructed or at the time the bearing assemblies or masonry plates are placed. Swedge bolts installed in holes shall be either sulphured in or grouted in as shown on the plans.

All bearing assemblies shall be set level and to the elevations shown on the plans. Adjustments in the horizontal positions of bearing assemblies shall be made for temperature as directed by the City Engineer.

In conformance with the details shown on the plans, masonry plates and the bearing plates of bearing assemblies shall be set on ground concrete surfaces, on preformed fabric pads, or on grout pads.

Grout to be placed below masonry plates or bearing plates of the bearing assemblies and in anchor bolt sleeves shall consist by volume of one (1) part Portland Cement and three (3) parts clean concrete sand. Concrete areas to be in contact with the grout shall be cleaned of all loose or foreign matter that would in any way prevent bond between the mortar and the concrete surfaces and shall be kept thoroughly saturated with water for a period of not less than twenty-four (24) hours immediately prior to placing the grout. The grout shall contain only sufficient moisture to permit packing and shaping. The grout shall completely fill the anchor bolt sleeves and shall be tightly packed under the masonry or bearing plates to provide full bearing. After placing all exposed surfaces of the grout pads shall be kept covered with a heavy thickness of burlap saturated with water for a period of three (3) days. All improperly cured or otherwise defective grout shall be removed and replaced at the Contractor's expense.

408.04.11– EXPANSION AND ROTATION ASSEMBLIES

Before leaving the shop or foundry the rockers or roller nests shall be completely assembled with the bearing plates for checking and approval by the City Engineer.

408.04.12– WELDING

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 Highway Bridges.

Radiographic and Magnetic Particle Inspection of welds will be paid for by the City as part of the structural steel inspection.

Unless otherwise shown on the plans or specified, bearing assemblies that are to be machined after welding shall be stress relieved by heat treatment before machining in accordance with AWS Specifications.

Portions of members in bearing assemblies or in direct bearing shall be straightened, planed, or otherwise corrected after fabrication as necessary to provide full bearing on bearing assemblies or bearing areas on level bearing plates.

Where the end of a stiffener plate is shown "tight-fit" on the plans, the end of the plate shall be so fitted that it bears on the beam flange with at least point bearing. Local clearances between the end of the plate and the flange shall not exceed one-sixteenth (1/16) inch.

Unless otherwise shown on the plans or specified, erection bolts required for welded splices or welded connections may be left in place and the ends of all such erection bolts which project beyond the nut shall be burned off flush with the face of the nut. Where the bolt does not project, the end of the bolt and nut shall be tack welded to prevent loosening of the nut. Burning off projecting bolt ends, and tack welding shall be performed prior to painting.

408.04.13– PAINTING

The painting of metal structures shall include, unless otherwise provided in the contract, the cleaning and preparation of the metal surfaces; the application, protection and drying of the paint coatings; and the supplying of all tools, tackle, scaffolding, labor, and materials necessary for the entire work. In the event no particular paint system is specified, any of those listed in Section 984 suitable for the structure indicated may be used. However, paints will be applied only as a complete and compatible system and once selected will be used throughout the project.

Shop painting, field painting, and maintenance painting are covered under these specifications. The prime coat shall be applied as soon as possible after cleaning and before deterioration of the surface occurs.

A) Cleaning - Cleaning shall remove all dirt, rust, scale, loose rust, loose mill scale, welding flux and slag, oil, grease, corrosive chemicals, and other detrimental foreign matter which may impair the adhesion of the coating to be applied.

   Unless cleaning is to be done by blast cleaning, all weld areas, before cleaning is begun, shall be neutralized with a proper chemical after which it shall be thoroughly rinsed with water. Five methods of cleaning, including Solvent Cleaning, Hand and Power Tool Cleaning, Flame Cleaning, Commercial Blast Cleaning, and Near White Blast Cleaning or combinations of these methods are permitted. All new

structural steel or painting requiring removal to the base metal shall be cleaned by the Commercial Blast Cleaning method unless otherwise specified.

Regardless of the method specified or used, the cleaned surface shall be primed or prepared as soon as possible and before any detrimental corrosion or recontamination occurs. Surfaces not intended to be painted shall be suitably protected from the effects of cleaning and painting operations.

1. Solvent Cleaning is a procedure for removing foreign matter such as oil, grease, soil, drawing and cutting compounds and other contaminants from steel surfaces using solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods which involve a solvent or cleaning action.
2. Hand and Power Tool Cleaning is a method of preparing metal surfaces for painting using power impact tools, power sanders, power grinders, hand tools or a combination of this equipment to remove all detrimental foreign matter as defined above. All tools shall be operated in such a manner that no burrs or sharp ridges are left on the surface and no sharp cuts are made into the steel.
3. Flame Cleaning is a method of preparing metal surfaces for painting using oxyacetylene torches with power or hand operated steel brushes to remove detrimental foreign matter as defined above. When this method is used all metal, except the inside of boxed members and other surfaces which will be inaccessible to the Flame Cleaning operation after the member is assembled, shall be Flame Cleaned in accordance with the following operations:
    i. Oil, grease, and similar adherent matter shall be removed by washing with a suitable solvent. Excess solvent shall be wiped from the work before proceeding with subsequent operations.
    ii. The surfaces to be painted shall be cleaned and dehydrated (freed of occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least one (1). The inner cones of these flames shall have a ratio of length to port diameter of at least eight (8) and shall be not more than 0.15-inch center to center. The oxyacetylene flames shall be traversed over the surfaces of the steel in such manner and at such speed that the surfaces are dehydrated and dirt, rust, loose scale, scale in the form of blisters or scabs, and similar foreign matter are freed by the rapid, intense heating by the flames. The flames shall not be traversed so slowly that loose scale or other foreign matter is fused to the surface of the steel, or the temperature of the steel raised above three hundred (400) degrees F. The number, arrangement and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated.
    iii. Promptly after the application of the flames, the surfaces of the steel shall be wire brushed, hand scraped wherever necessary, and then swept and dusted to remove all free material and foreign particles. Compressed air shall not be used for this operation.
    iv. Paint shall be applied promptly after the steel has been cleaned and while the temperature of the steel is still above that of the surrounding atmosphere so that there will be no recondensation of moisture on the cleaned surfaces.

Unless otherwise provided, the inside surfaces of boxed members and other surfaces which will be inaccessible to the flame cleaning operation after the member is assembled shall be cleaned by Hand Cleaning. If Flame Cleaning of such surfaces is required, it shall be so stated in the special provisions and the following will apply:

The inside surfaces of boxed cleaning operation after the member is assembled shall be cleaned as specified in paragraphs 1 and 2 above and wire brushed but not painted before the member is boxed or assembled. After all fabrication of the member is completed, its inside surfaces shall be hand wire brushed or hand scraped wherever necessary to remove dirt and other foreign substances which may have accumulated after the surfaces were originally cleaned. The outside surfaces of the members shall then be cleaned and dehydrated, wire brushed, and hand scraped wherever necessary. All surfaces shall then be swept and dusted to remove free material and foreign particles and the member completely painted.

4. Commercial Blast Cleaning is a method by which all steel shall be cleaned by either the centrifugal wheel or the air blast method. The cleaning shall remove all mill scale and other substances down to the bare metal except for slight shadows, streaks or discolorations caused by rust stains, mill scale oxides or, if the surface is pitted, slight residues of rust in the bottom of the pits. At least two-thirds (2/3) of each square inch of surface area shall be free of all visible residues and the remainder shall be limited to light discoloration, slight staining or light residues mentioned above.

   The maximum size of sand, crushed grit or shot shall be no larger than that passing the No. 16 sieve.

   The height of the profile of the anchor pattern produced on the surface shall be limited to a maximum height that will not be detrimental to the life of the paint film. The maximum particle sizes specified may produce an anchor pattern that is too high or too rough for the paint systems used. In such cases, the abrasive sizes should be reduced. If the application of the second coat of paint is deferred, an adequate reduction in anchor pattern height shall be made (reduction in abrasive size).

   Special attention shall be given to the cleaning of the corners and reentrant angles. Before painting, all metallic shot and grit or sand shall be removed from the surfaces. The cleaning shall be approved by the City Engineer prior to painting.

5. Near White Blast Cleaning will be done with the same methods and procedures outlined in Commercial Blast Cleaning except for the degree of cleaning. Near White Blast cleaned surface finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint, and other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks, or slight discolorations caused by rust stains or mill scale oxides. At least ninety-five (95) percent of each square inch of surface area shall be free of visible residues, and the remainder shall be limited to the light discoloration mentioned above.

B) Storage of Paint - All paint and thinner shall be stored in an area that is well ventilated and protected from sparks, flames, direct rays of the sun and from excessive heat. Paint susceptible to damage by low temperatures shall be kept in a heated storage space when necessary.

C) Mixing - The paint shall be mixed in a manner which will insure breaking up of all lumps, complete dispersion of settled pigments, and a uniform composition. Paint shall be carefully examined for uniformity after mixing.

All pigmented paint shall be strained after mixing except where application equipment is provided with adequate strainers. Strainers shall remove only skins and undesirable matter but will not remove the pigment.

Thinner shall not be added to the paint unless necessary for proper applications without approval of the City Engineer. Paints to be sprayed, if not specifically formulated for spraying, may require thinning when proper adjustment of spray equipment and air pressure does not result in satisfactory paint application. In no case shall more than one (1) part thinner to eight (8) parts paint be added unless paint is intentionally formulated for greater thinning. The type of thinner shall comply with the paint consistency during the mixing process.

D) Application of Paint - Paint may be applied by brushing, air spraying, airless spraying, or hot spraying or a combination of these methods. Daubers or sheepskin may be used when no other method is practicable for proper application in places of difficult access.

Paint shall not be applied when temperatures of the steel or paint are below forty (40) degrees F Paint shall not be applied when the surface temperature is expected to drop below thirty-two (32) degrees F before the paint has dried, or when steel temperature is below the dew point resulting in condensation of moisture. Paint shall not be applied to frosted or ice coated surfaces. Paint shall not be applied to steel which is at a temperature that will cause blistering or porosity or otherwise be detrimental to the life of the paint.

A coat of paint shall not be applied until the preceding coat has dried. The paint shall be considered dry for recoating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats.

Paint shall not be force dried under conditions which will cause checking, wrinkling, blistering, formation of pores, or detrimentally affect the condition of the paint.

Driers shall not be added to paint on the job unless specifically called for in the specification for the paint.

If stripe painting is specified, all edges, corners, crevices, rivets, bolts, weld, and sharp edges shall be stripe painted with the priming paint before the steel receives its full prime coat of paint. Such striping shall extend for at least an inch from the edge. When practicable, this stripe coat shall be permitted to dry before the prime coat is applied; otherwise, the prime coat shall set to touch before the full prime coat is applied. However, the stripe coat shall not be permitted to dry for a period long enough to allow rusting of the unprimed steel.

Shop and field paint shall be applied to the minimum dry mil film thickness specified for the paint system to be applied. The dry mil thickness will be measured in place with a calibrated magnetic film thickness gauge and repainting will be required for

areas deficient in thickness.

Paint shall be worked into all crevices and corners possible.

Any runs or sags shall be immediately brushed out or after setting the paint shall be removed and the surface repainted in a manner approved by the City Engineer.

When using the brush method, the brushes shall be of a style and quality that will enable proper application of the paint. Uniform brushing shall be done so that a smooth coat as nearly uniform in thickness as possible is obtained. There shall be a minimum of brush marks left in the applied paint.

The equipment used for all spray applications of paint whether air spray, airless, or hot spray, shall be suitable for the intended purpose. Any solvents left in the equipment shall be completely removed before applying paint to the surface to be painted.

Blind sides of all rivets, bolts, and all other areas inaccessible to the spray gun shall be painted by brush, daubers or sheepskins. Brushes shall be used to work paint into cracks, crevices and blind spots which are not adequately painted by spray.

Areas of steel surfaces to be in direct contact with the concrete, paving or footing or encased or embedded in concrete or coated with concrete shall not be painted.

Contact surfaces of members to be joined by high strength bolts in friction type connections shall be left unpainted unless specifically authorized and shall be free of oil and grease coatings.

Shop contact surfaces shall not be painted, but any resulting crevices shall be sealed off in the paint application.

Steel shall not be painted within two (2) inches of edges to be welded.

Steel surfaces to be in contact only after field erection shall be painted except where the paint will interfere with assembly.

Steel surfaces not in direct bonded contact but inaccessible after assembly shall receive the full specified paint system before assembly.

Machine finished surfaces shall be coated with white lead or tallow, or an approved protective lubricant, before shipment or before rusting can occur.

1. Shop Painting - The number of coats and the type of paint shall be as specified. Unless otherwise specified, all structural steel shall be painted with at least one (1) coat of primer in the shop where fabrication is done. If the shop coat is damaged in fabrication, it shall be repaired before leaving the shop. Erection marks and weight marks shall be copied on areas that have been previously painted with the shop coat.

2. Field Painting - Shop coated steel members shall preferably be field painted after erection of such members is completed. Steel members may be field painted on the ground before erection providing such painting where damaged is touched up with the same number of coats and kind of paint after erection and provided the final complete coat of paint is applied after erection.

   Steel which has been shop coated shall be touched up with the same type of paint as the shop coat. This touch up shall include cleaning and painting of field connections, welds or rivets, and all damaged or defective paint and rusted

areas. For areas requiring rust removal or paint repair the degree of surface preparation shall be at least equal to that required for structural steel under these specifications. The Contractor may at his option clean and apply one (1) overall coat in place of touch up or spot painting.

The final field coat shall not be applied until all concrete work is finished. All concrete spatter and drippings shall be removed before application of paint. If concreting or other operations damage any paint, the damaged surface shall be cleaned and repainted.

All dirt, sand, drift, and other foreign material shall be removed from the bridge seats before applying paint to the shoes, bearing plates and other steel parts of the structure to be painted in the immediate vicinity of bearing areas. Cleaning and painting shall be so programmed that detrimental amounts of dust or other contaminants do not fall on wet, newly painted surfaces.

3. Painting of Existing Structures - Only loose, cracked, brittle or nonadherent paint, loose mill scale, and loose rust shall be removed unless otherwise specified. All exposed edges shall be feathered, and spot cleaned. Rust spots shall be thoroughly cleaned, and the edges of all old paint shall be scraped back to sound materials.

   The Contractor shall always adequately protect traffic, the bridge floor and concrete surfaces from paint spray or splashes. Any paint spilled or sprayed on vehicles, curbs, bridge seats or bridge floors shall be removed by the Contractor at his expense.

   Empty paint cans, paper, or cloth which have meet paint, and paint spilled on the vegetation, shall not be left in the channel or right-of-way or adjacent private property, but shall be removed from the work.

   The Contractor will be always responsible for safeguarding both public and private property from all hazards and damage resulting from the work.

408.04.14– FALSEWORK

The falsework shall be properly designed for the loads to be supported and shall be constructed substantially and maintained. The Contractor shall prepare and submit plans for falsework to the City Engineer for approval.

The falsework plans shall be complete in all details of members, connections, equipment, etc., so that a structural check can be made of the falsework.

Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

408.04.15– GRADING DECK ON CONTINUOUS UNITS

Forms shall not be erected, or concrete placed until after all welding, bolting, or riveting is complete, the unit positioned, and bearings properly set.

An accurate measurement shall be made of the elevations of girder or beam flanges at all grading control points as shown on the plans.

Subsequent grading of forms and placing and finishing of concrete shall be governed by these measurements only, considering the dead load deflection of the slab and rail as

shown on the dead load deflection diagram.

408.04.16– MISFITS

Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered a legitimate part of the operation. Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the City Engineer, and his approval of the method of correction shall be obtained. The correction shall be made in the presence of the City Engineer who will check the material. Such work is to be done at the entire expense of the Contractor.

408.05 TESTING — VACANT

408.06 METHOD OF MEASUREMENT

No direct compensation will be made for "Steel Structures". Measurement and payment for quantities of structural metal, concrete, reinforcement, railing, and other proposal items which constitute the completed and accepted structures will be made in accordance with the provisions of pertinent specifications. When identified in the bid items, the steel structures shall be paid by structural steel in pounds.

408.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) STRUCTURAL STEEL	Pounds

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

SECTION 409 – CONCRETE BRIDGE FLOORS

409.01 DESCRIPTION

This section covers the construction of concrete bridge floors in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established by the City Engineer.

409.02 MATERIALS

Materials shall meet the requirements specified in the following Materials:

Portland Cement Concrete	901
Joint Fillers and Sealers	901.08
Reinforcing Steel	923
Curing Materials	901.07

409.03 EQUIPMENT — VACANT

409.04 CONSTRUCTION METHODS

A) Construction Joints - Construction joints shall be made only where located on the plans, shown in the concrete placing schedule, or as directed by the City Engineer. Shear keys or inclined reinforcement shall be used where necessary to transmit shear and/or bond the two (2) sections together.

B) Forms - All forms shall conform to the requirements of Section 404.04 (C).

C) Placing Reinforcing Steel - All reinforcing steel shall be placed in accordance with Section 411.

D) Expansion Devices - Expansion devices shall be those shown on the plans. They will be carefully checked for line, grade, and crown.

E) Placing and Finishing Concrete - An Approved self-propelled finishing machine shall be used on all bridge decks. Supports for the finishing machine shall be parallel to the centerline of the structure, firmly fastened in place and set to correct line and grade with proper allowances for dead load deflections. A transverse finish shall be provided throughout the entire bridge length unless otherwise approved in writing by the City Engineer.

   Concrete bridge floors shall not be struck off longitudinally unless approved by the City Engineer. In such case the templates shall be supported on header boards cut to the crown of the roadway. The header boards shall be surfaced with steel plates unless otherwise approved by the City Engineer. These templates shall be of sufficient weight and rigidity or trussed so that the desired finish camber is obtained longitudinally.

   Before placing floor concrete, the forms shall be thoroughly wetted. The concrete shall be placed slightly higher than the finished surface of the floor. Immediately after the concrete has been placed and compacted as specified under Section 404.04 (D), it shall be carefully struck off to proper crown and finished to a smooth, even surface.

   While the concrete is still plastic, the surface of the concrete shall be tested for trueness with a ten (10) foot straightedge. Any depressions found shall be filled immediately with freshly mixed concrete, and any high areas shall be cut down. The surface shall be struck off, consolidated and refinished. Special attention shall be given to ensure that the surface across joints fully meet the requirements for smoothness. Final finish shall be uniformly textured by transverse brooming or other methods approved by the City Engineer unless otherwise specified on the plans.

   The Contractor shall furnish enough work bridges, a minimum of two (2), to enable his workmen to satisfactorily perform the floating, straight-edging, curing and final finishing at the proper times. The surface shall be given a further test for trueness using a ten (10) foot straightedge or other specified device before final acceptance. Areas showing high spots of more than one-eighth (1/8) inch shall be marked and immediately ground down with an approved grinding tool to tolerance requirements. The skid resistant surface shall then be restored in all ground down areas in a manner approved by the City Engineer.

   Tops of curbs shall be finished with a wooden float. Chamfer strips on curbs shall be set to established line and grade after the floor is placed.

   Transverse Groove Final Finish for Overlays. Do not tine finish overlays within 2 inches of a construction joint.

High Density Concrete. After completing the finishing and before applying the transverse groove final finish, seal all vertical joints with adjacent concrete by painting with thinned grout. After joint painting, apply the transverse groove final finish. Grooving passes shall not be overlapped but shall be within 1 inch of the preceding pass.

Latex Modified Concrete. After completing the finishing, apply the transverse groove final finish. Grooving passes shall not be overlapped but shall be within 1 inch of the preceding pass. This must be done before the plastic film forms on the surface, approximately 25 minutes in hot, dry weather. Separate screed rails and construction dams from the newly placed material by passing a point trowel along their inside face. Exercise care to ensure that this trowel cut is made for the entire depth and length of rails or dams after the concrete has stiffened sufficiently to not flow back.

F) Curing Floors and Parapets - Floors, curbs and parapets shall be cured in accordance with Section 403.04.10. with approved materials immediately after the finishing operations have been completed and marring of the concrete will not occur. The curing shall be maintained for a period of seven (7) days. Materials shall meet the requirements of Section 901.

If a penetrating sealer is called for in the plans, application shall be made following the minimum curing period.

G) Removing Forms - The side curb and parapet forms shall be removed in warm weather within twenty-four (24) hours after the concrete is placed and in cool weather within forty-eight (48) hours or at least as soon as they may be removed without damaging the curb. All wires shall be cut one- fourth (1/4) inch back of the surface of the concrete and the holes shall be filled with stiff cement mortar at once.

Forms supporting concrete floors placed on truss or I-beams, plate girder or pre-stressed girder spans shall be left in place at least fourteen (14) days. In unfavorable weather, the specified time shall be increased at the discretion of the City Engineer.

The above specified time may be decreased in case test beams or test cylinders made, cured, and tested in accordance with Section 901 meet the specified minimum requirements.

In no case shall the forms supporting concrete floors on truss or I-beams, or girder spans be removed in less than five (5) days after the concrete is poured.

H) Load on Floors - Loads shall not be placed on floor slabs for a period of seven (7) days or until forms are removed. Pneumatic-tired concrete carts or "buggies" holding not more than six (6) cubic feet of concrete per tire and holding not more than twenty-one (21) cubic feet of concrete per cart or "buggy", may pass over the floor after forty-eight (48) hours have elapsed after the completion of the placement. Plank runways of three (3) inch minimum thickness placed on a sand cushion having a depth of not less than four (4) inches must be provided for the carts or "buggies". If High Early Strength Concrete is used, the carts or "buggies" may pass over the floor after twenty-four (24) hours on runways with sand cushion as provided above. In no case shall a mixer be operated on concrete bridge floors without prior approval of the City Engineer. Stockpiles of material placed on concrete floors shall not exceed sixty-four (64) pounds per square foot.

I) Opening to Traffic - Concrete bridge floors on I-beams, girders and trusses may be opened to traffic after a period of twenty-one (21) days has elapsed since the last concrete was placed in the floor.

The above specified time may be decreased if test beams, or test cylinders are cast at the

time the last concrete was placed in the floor. Test beams and test cylinders shall be made, cured, and tested in accordance with Section 901. The bridge may be opened to traffic when the test beams meet strength requirements as provided in Section 901 or when test cylinders have a minimum compressive strength of three thousand (3000) psi. In no case shall bridge floors on I-beams, plate girders, pre-stressed concrete girders, and trusses be opened to traffic in less than seven (7) days after the last concrete is placed in the floor.

When unusually low temperatures prevail during the curing period, the time of opening to traffic may be extended beyond the limits designated above, if required by the City Engineer.

When the use of High Early Strength Concrete is approved by the City Engineer in bridge floors, the time of opening to traffic will be governed by Section 406.

409.05 TESTING — VACANT

409.06 METHOD OF MEASUREMENT

The accepted quantities which constitute the completed floor will be measured by the cubic yard of concrete according to the plans. Additional concrete required to take care of deflection will be included under this item, unless otherwise shown on the plans.

409.07 BASIS OF PAYMENT

Concrete bridge floors, measured as provided above, will be paid for at the contract unit price for Section 404.07 Structural Concrete which shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

SECTION 410 – PORTLAND CEMENT CONCRETE OVERLAY OF BRIDGE FLOORS

410.01 DESCRIPTION

A) Repair. Repair of bridge decks consists of removing loose, delaminated, spalled, or deteriorated concrete from the existing surface, replacing with new high-density concrete, or latex modified concrete and other necessary work as specified in the contract documents. When the bridge deck is to be overlaid, the replacement material for Class A and Class B repair shall be the same as the overlay material.

The City Engineer will make a field inspection of all bridge decks and determine the areas of concrete deck to be repaired. These areas will be marked by the City Engineer and repaired by the Contractor. The lower limit for Class A and Class B bridge deck repair shall be to suitable existing concrete, as determined by the City Engineer. Bridge deck repair shall be classified as follows:

1. *Class A Bridge Deck Repair.* Class A bridge deck repair consists of:
    i. Removing unsound concrete down to the top mat of reinforcing steel.
    ii. Disposing of concrete removed.
    iii. Replacing the excavated volume of concrete with high density concrete or latex modified concrete.

2. *Class B Bridge Deck Repair.* Class B bridge deck repair consists of:
    i. Removing unsound concrete below the top mat of reinforcing steel.
    ii. Cleaning existing concrete from the top mat of reinforcing steel in the repair area.
    iii. Disposing of concrete removed.
    iv. Replacing the excavated volume of concrete with high density concrete or latex modified concrete.
3. *Class C Bridge Deck Repair.* Class C bridge deck repair consists of:
    i. Removing all unsound concrete for the full depth of the deck.
    ii. Cleaning existing concrete from both mats of reinforcing steel in the repair area.
    iii. Disposing of concrete removed.
    iv. Replacing the excavated volume of concrete with Class AA concrete.

B) Overlays. Overlay of bridge decks consists of deck preparation and overlaying with either high density concrete or latex modified concrete, and other necessary work as specified in the contract documents. Unless otherwise specified, the overlay shall raise the roadway surface and shall cover the entire concrete deck. Deck preparation and overlaying consist of:
    1. Sandblasting and/or chipping the concrete to a depth as necessary to remove rust, oil, and other foreign matter leaving a clean etched concrete surface free of any laitance; (Where the original deck concrete was cured by linseed oil emulsion, the entire deck shall be scarified to a depth of ¼ inch (6mm) below the original surface.)
    2. Disposing of concrete removed.
    3. Overlaying with the specified overlay concrete to the depth designated in the contract documents.
C) Thickness of the concrete overlay shall be measured from the level of the original surface to the specified final raised surface as shown on the Plans. When the deck is to receive Class A or Class B repairs, the replacement material may be placed monolithically with the overlay course or separately prior to the overlay.

410.02 MATERIALS

Use materials conforming to the following Sections:

High Density Concrete	901.10
Latex Modified Concrete	901.11

For repairs and overlays, use either high density concrete or latex modified concrete as specified in the contract documents. Limit the maximum concrete temperature to 85°F (30°C).

410.03 EQUIPMENT

Provide all equipment with suitable traps, filters, drip-pans, or other devices to prevent oil or other deleterious matter from being deposited on the deck.

A) Surface Preparation Equipment. Use the following types of surface preparation

equipment:

1. Sawing Equipment. Use sawing equipment capable of sawing concrete to the specified depth.
2. Sandblasting Equipment. Use sandblasting equipment capable of removing rust and old concrete from the exposed reinforcement.
3. Power Driven Hand Tools. Power driven hand tools for removal of concrete will be permitted with the following restrictions:
    - Limit the nominal size class of jack hammers to a maximum of 30 pounds (125n).
    - Operate jack hammers or mechanical chipping tools at an angle less than 45° measured from the surface of the slab.
    - For removing concrete from beneath any reinforcing bar, limit the nominal size class of chipping hammers to a maximum of 15 pounds (65N).
4. Scarifying equipment. Use a scarifier for preparing an existing deck for an overlay. Use a power-operated mechanical scarifier capable of uniformly scarifying or removing the old surface to the depths required.

B) Proportioning and Mixing Equipment.

1. For High Density Concrete. Use proportioning and mixing equipment meeting the requirements of Section 901 for high density concrete. Use a construction or stationary concrete mixer of the rotating-paddle type, or a continuous mixer used in conjunction with volumetric proportioning.
2. For Latex Modified Concrete. Use proportioning and mixing equipment of a self-contained, mobile, continuous-mixing type meeting the following requirements:
    i. The mixer shall be self-propelled and shall be capable of carrying sufficient unmixed, dry, bulk cement, sand, coarse aggregate, latex modifier, and water to produce on the site not less than 5 cubic yards (5m 3) of concrete.
    ii. The mixer shall be capable of positive measurement of cement being introduced into the mix. The recording meter visible always and equipped with a ticket printout shall indicate this quantity.
    iii. The mixer shall provide positive control of the flow of water and latex emulsion into the mixing chamber. Water flow shall be indicated by a flowmeter and shall be readily adjustable to provide for minor variations in aggregate moisture.
    iv. The mixer shall be capable of being calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation and shall discharge mixed material through a conventional chute directly in front of the finishing machine. Sufficient mixing capacity of mixers shall be provided to permit the intended placement of the mixed material without interruption.

C) Placing and Finishing Equipment.

1. Placing Equipment. For placing and rough finishing, use adequate hand tools for placement of stiff plastic concrete to approximately the strike off level of the screed.
2. Finishing Machines.

i. Repairs. For deck repairs, use a vibrating screed to finish the deck surface.

ii. Overlays. Place and finish overlays with an approved finishing machine meeting the following requirements.

Use a finishing machine capable of screeding concrete within 12 inches (300mm) of the face of the existing curb or parapet wall. Make the screed sufficiently long to extend at least 6 inches (150mm) beyond the sides of the placement section, overlapping previously placed courses, overlay forms, and existing and planned sawcut edges. Provide each screed with positive control of the vertical position, the angle of tilt, and the shape of the crown.

Power and gear the finishing machine to maintain smooth finishing operations under all conditions in forward and reverse. Make provisions for raising the screeds to clear the screeded surface for traveling in reverse.

Use a finishing machine capable of final screeding within 10 minutes of depositing the concrete on the deck under normal operating conditions.

Support the finishing machine on rails that are fully adjustable, not shimmed, to obtain the correct profile.

When placing concrete in a lane abutting a previously completed lane, equip the finishing machine to travel on the completed lane without marring or damaging its surface.

For high density concrete overlays, use a mechanical strike-off to provide a uniform thickness of concrete in front of the oscillating screed. Equip the oscillating screed(s) to consolidate the concrete to 98% of the unit weight determined by AASHTO T 121. Install identical vibrators along the screed length on 5-foot maximum centers. Make the bottom face of this screed at least 5 inches wide with a turned up or rounded leading edge to minimize tearing of the surface of the plastic high density concrete.

For latex modified overlays, use a finishing machine equipped with not less than two finishing devices:

A vibrating screed designed to consolidate the modified composition to 98% of the rodded unit weight, and one of the following,

A vibrating oscillating screed, or

A finishing device consisting of one or more rotating cylindrical drums not exceeding 4 feet in length.

Equip the vibrating screed(s) for latex modified concrete with positive control of vibration so that vibration frequency can be varied between 3000 and 6000 vibrations per minute. Make the bottom face of the screed at least 4 inches wide.

410.04 CONSTRUCTION METHODS

A) General. Comply the requirements of Section 403 unless otherwise specified.

B) Work Plan. Before starting the work, submit a work plan to the City Engineer and obtain approval. Allow 14 days for the City Engineer’s review. Include descriptions of the material, equipment, and forms to be used, and the labor requirements.

C) Preparation of Surfaces.

1. General Requirement for Repairs. Remove all unsound deck concrete as specified. Repair areas will be enlarged, reduced, or reclassified as directed by the City Engineer, based upon inspection. Do not revise the size of a repair area without permission.

   Provide a saw-cut vertical edge around the perimeter of the repair areas. Make the saw cut at least 1 inch (25mm) deep measured from the original surface of the deck. Avoid cutting, stretching, or damaging any exposed reinforcing steel. Blast clean reinforcing steel to remove all concrete. Replace damaged reinforcing steel, lapping new and old reinforcing as directed.

   After removing all unsound concrete, clean and dry the repair area using sandblasting and filtered air blast. Remove all rust, oil, and other foreign matter to provide a clean, dry, etched concrete surface.

2. Class A Bridge Deck Repair. For Class A repair, remove unsound concrete by chipping with power hand tools. In Class A repair areas, notify the City Engineer before removal below the top mat. Where removal of material beneath the top mat of reinforcing steel is directed, the repair will be classified as Class B repair.

3. Class B Bridge Deck Repair. For most Class B repair, remove unsound concrete by the methods used for Class A repair. If removing unsound concrete deeper than 50% of the original deck thickness, use 15-pound (65N) chipping hammers or hand tools to prevent damage to remaining concrete. In Class B repair areas, notify the City Engineer before removing concrete below the mid-depth level. Remove concrete at least 1 inch (25mm) below the top mat. If the depth of the bottom mat is reached, remove the full depth of the deck. Full depth removal will be classified as Class C repair.

4. Class C Bridge Deck Repair. For Class C repair, remove the concrete for full depth of the deck, leaving the reinforcing steel intact. Provide forms enable placement of new concrete in the full depth opening. For areas of one square yard or greater, support forms from the existing superstructure. For smaller areas, the forms may be suspended from existing reinforcing bars by wire ties. Remove all forms when completed. Show typical forming details in the work plan submittal.

5. Overlays. Clean the entire existing concrete deck area uniformly using sandblasting alone or chipping followed by sandblasting. Sandblast that portion of the curb or parapet wall against which new concrete is to be placed. Remove all rust, oil, and other foreign matter to provide a clean, etched concrete surface free of laitance. If the original deck concrete was cured with linseed oil emulsion, scarify to a depth of 1 / 4 inch (6mm) below the original deck before cleaning. Place expansion joints as shown on the contract drawings. The longitudinal and transverse profile and the elevation of all expansion joints will be established by the City Engineer.

D) Mixing.

1. High Density Concrete. Mix high density concrete at the project site in accordance with Section 901.

2. Latex Modified Concrete. Comply with the following requirements for the proportioning and mixing latex modified concrete materials:

   i. Measurement of Materials. Accurately proportion all materials for the specified mixture using a mobile continuous mixer. Calibrate the

proportioning equipment for each material in the presence of the inspector. Operate the proportioning equipment at the manufacturer recommended speed during calibration, checks, and normal operation. Make yield checks as needed.

ii. Mixing of Materials. Mix materials in accordance with the specified requirements for the equipment used. The mixture, as discharged from the mixer, shall be uniform in composition and consistency. Mixing capability shall be such that finishing operations can proceed at a steady pace with final finishing completed before the formation of the plastic surface film.

3. Class AA Concrete. Comply with Section 901.

E) Placing and Finishing Concrete for Repairs.

1. General. Concrete for repairs may be placed either monolithically with overlays or separately. In addition to the surface screed vibration, vibrate the fresh concrete internally if the concrete thickness is 3 inches (75mm) or more.

   If to be overlaid, leave the repair rough textured. If not to be overlaid, match the surface texture of the repair with the existing deck. Unless part of an overlay, place concrete to the level to the existing deck.

2. Surface Preparation Immediately before Concreting

   i. Grouting for High Density Concrete. Before placing high density concrete, scrub a thin coating of bonding grout into the dry, prepared surface. Exercise care to ensure that all parts receive a thorough, even coating, and excessive grout does not collect in pockets. Limit the application rate of grout to ensure the grout does not dry before concrete placement. Since grout will dry on a vertical surface more rapidly than the flat deck surface, give special attention to maintaining the grout in the required condition.

   ii. Surface Wetting for Latex Modified Concrete. Before placing latex modified concrete, clean the repair areas with air blast followed by flushing with water. Keep the surfaces wet for an hour or more before placing latex modified concrete. Remove puddles of free water before concrete placement.

F) Placing and Finishing Concrete for Overlays.

1. Dimensions. Make high density overlays 2 inches (50mm) ± ¼ inch (6mm) thick and latex modified overlays 1 ½ inches (38mm) ± ¼ inch (6mm) thick. Limit the width of each overlay pass to a maximum of 26 feet (8m).

2. Joints.

   i. High Density Concrete. Saw the previously placed high density concrete overlay course to have straight and vertical edges at transverse and longitudinal joints, before placing the adjacent overlay course. Remove all slurry produced by wet sawing of concrete joints from prepared areas before placing new concrete.

   ii. Latex Modified Concrete. Install transverse bulkheads, equal in depth to the thickness of the latex modified concrete, to the required grade and profile before placing concrete. 3. Finishing Machine Setup. Adjust the finishing machine to provide the required overlay profile. Place finishing machine rails outside the area to be concreted. Positively anchor the rails

to provide horizontal and vertical stability for the rails. Do not use a hold-down device shot into the concrete unless the concrete is to be subsequently resurfaced. Submit working drawings for anchoring support rails for approval.

3. Trial Run. Before concrete is placed, make a dry run with the finishing machine to check anticipated overlay thickness. Attach a filler block having a thickness 1 / 8 inch (3mm) less than overlay thickness to the bottom of the screed. With screed guides in place, pass the screed over the area to be concreted. Correct, in an approved manner, those areas not having the required clearance.

4. Surface Preparation Immediately before Concreting. Prepare the surface to be overlaid in the manner specified for repairs using like concrete type.

5. Placement. Place concrete in a continuous operation throughout the pour. In case of a long delay in latex modified concrete placement, install a transverse bulkhead. During shorter delays of less than one hour, protect the end of the placement from drying with several layers of wet burlap.

   Place and mechanically strike off the new concrete overlay slightly above the final grade. Mechanically consolidate to 98% of the unit weight, determined by AASHTO T 121, and screed to final grade. In addition to the surface screed vibration, vibrate fresh concrete internally if 3 inches (75mm) or more in thickness. Hand finish with a wood float as required to produce a tight, uniform surface.

6. Work Bridges. Always keep a minimum of two movable work bridges on hand during concrete placement. Use one of the work bridges for nuclear density measurements and surface finishing and texturing. Use the other work bridge to apply the curing.

7. Evaporation Control and Curing. Control evaporation of moisture from the fresh overlay concrete and cure. Cracking or other damage caused by improper curing will be cause for rejection of the work.

8. Ambient Temperature Limitations. Do not place concrete when the air or deck temperature is cooler than 45°F or the deck temperature is hotter than 85°F.

   The City Engineer may require placing concrete during the nighttime hours during hot weather. The City Engineer will inform the Contractor, in writing, if night placing becomes necessary.

G) Straightedge Testing and Surface Tolerance. Immediately after completing the surface of either a repair or overlay and before final finishing, test the surface for trueness with a 10-foot (3m) straightedge. When the straightedge is laid on the repaired pavement or overlay in a direction parallel to the centerline, the surface shall not vary more than 1/8 inch (3mm) from the lower edge of the straightedge. The transverse slope of the pavement shall be uniform to a degree such that no depression greater than 1/8 inch is present when tested with the 10-foot straight edge laid in a direction transverse to the centerline and extending from edge to edge in a traffic lane.

   After completing curing, retest the surface and grind any high areas more than the specified tolerances. Groove the ground surfaces to have a texture equal to the surrounding surfaces.

H) Transverse Groove Final Finish for Overlays. Do not tine finish overlays within 2 inches (50mm) of a construction joint.

   1. High Density Concrete. After completing the finishing and before applying the

transverse groove final finish, seal all vertical joints with adjacent concrete by painting with thinned grout.

2. After joint painting, apply the transverse groove final finish.
3. Latex Modified Concrete. After completing the finishing, apply the transverse groove final finish. This must be done before the plastic film forms on the surface, approximately 25 minutes in hot, dry weather. Separate screed rails and construction dams from the newly placed material by passing a point trowel along their inside face. Exercise care to ensure that this trowel cut is made for the entire depth and length of rails or dams after the concrete has stiffened sufficiently to not flow back.
4. Limitation of Operations.
    i. Traffic Control. During the construction period of the project, provide such traffic controls as required by the contract documents.
    ii. Loading. After removing old concrete and before placing new concrete, restrict loading on bridge decks to approved construction equipment. Limit the wheel and axle loads of construction vehicles to 8000 pounds (35kN) and 16,000 pounds respectively. Any combination of axles spaced closer than 4 feet center-to-center of axles will be considered as one axle. Unless otherwise specified, keep traffic off the finished surface during the specified curing period. Do not perform preparation work in the adjacent lane on areas adjoining new concrete during the specified curing period.

410.05 TESTING — VACANT

410.06 METHOD OF MEASUREMENT

Class A Bridge Deck Repair, Class B Bridge Deck Repair, And Class C Bridge Deck Repair will be computed in square yards from measurements of the areas so repaired. All classes of bridge deck repair will be measured prior to the actual placement of the concrete. Bridge deck overlay will be measured in square yards from measurements of the areas so overlaid.

410.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CLASS A BRIDGE DECK REPAIR	Square Yard
(B) CLASS B BRIDGE DECK REPAIR	Square Yard
(C) CLASS C BRIDGE DECK REPAIR	Square Yard
(D) BRIDGE DECK OVERLAY	Square Yard

Payment will be full compensation for the respective work prescribed in this Section including concrete material, reinforcing steel, sawing, removals, and other incidental items.

SECTION 411 – REINFORCING STEEL

411.01 DESCRIPTION

This section shall cover the furnishing and placing of reinforcing steel in accordance with these specifications and in conformity with the plans.

All reinforcement shall consist of deformed bars or 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. Square twisted bars shall not be used. 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.

411.02 MATERIALS

Materials shall meet the requirements of Section 923.

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 contract unit price.

411.03 EQUIPMENT — VACANT

411.04 CONSTRUCTION METHODS

Reinforcing steel shall be always protected 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.

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 City Engineer. Should the City 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 twelve (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 one-sixth (1/6) of the spacing between bars, and the average over ten (10) spaces shall not vary more than one-twentieth (1/20) of the specified spacing. Perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than one-fourth (1/4) inch in slabs and walls up to and including eight (8) inches in total thickness, the bars shall not vary more than one-half (1/2) inch from plan placement. The placement of deck reinforcement in bridge floors shall not deviate more than one-fourth (1/4) 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 City 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 City Engineer. Splices shall be staggered as far as 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 twelve (12) inches of concrete under the bars shall be lapped as given in the following table for 'top bars':

TABLE 411.1
Required Length of Lap in Inches

Size (No.)	4	5	6	7	8	9	10	11
Top Bar	15	19	24	32	45	54	68	83
Other Bars	12	13	17	23	40	48	59	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 fifty (50) percent. No more than one-half (1/2) 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 City Engineer prior to use.

The minimum spacing center to center of parallel bars shall be two and one-half (2 1/2) times the diameter, but in no case shall the clear distance between the bars be less than one and one-half (1 1/2) 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 two (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 three (3) inches.

411.05 TESTING — VACANT

411.06 METHOD OF MEASUREMENT

Reinforcing steel 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 placed in accordance with these specifications. The weights calculated shall be based upon the following table:

TABLE 411.2 Reinforcing Steel Weights		
Bar Designation Number	Nominal lb/ft	Weight kg/m
¼ 3	0.167	0.249
4	0.376	0.560
5	0.688	0.994
6	1.043	1.552
7	1.502	2.235
8	2.044	3.042
9	2.670	3.973
10	3.400	4.960
11	4.303	6.403
14S	5.313	7.906
18S	7.650	11.384
	13.600	20.239

No allowance will be made for clips, metal spacers, ties, etc., wire or other material used for fastening or holding reinforcement or forms in place, except that wire hoops used in reinforced concrete columns and encased I-beams or similar construction, when included in the bar list shown on the plans, will be classed as reinforcing steel, and will be paid for at the contract unit price per pound for reinforcing steel.

411.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) REINFORCING STEEL	Pounds

Such payment shall be compensation in full for furnishing all materials (including wire mesh), labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

SECTION 412 – PENETRATING SEALER FOR CONCRETE SURFACES

412.01 DESCRIPTION

This section covers the furnishing and placing of a penetrating sealer system in reasonably close conformity with the requirements specified herein and as shown on the plans.

412.02 MATERIALS

The material shall be a penetrating sealer for Portland Cement Concrete. The penetrating sealer shall be as called for in the plans. If the type is not called for, the sealer shall be equal to or better than Chemical Products Corporation's CP-5003.

412.03 EQUIPMENT — VACANT

412.04 CONSTRUCTION METHODS

A) Weather Limitation - The materials shall not be applied when the air or surface temperature is less than forty (40) degrees F or while the surface is wet.

B) Surface Preparation - The surface shall be swept and/or washed to remove laitance, dirt, asphalt, and other foreign materials, exposing a surface of sound concrete. Equipment shall be fitted with suitable traps, filters, drip pans, or other devices to prevent oil or other deleterious matter from being deposited.

C) Application of Penetrating Sealer - The penetrating sealer shall consist of application to be applied at the rate recommended by the manufacturer.

412.05 TESTING — VACANT

412.06 METHOD OF MEASUREMENTS

The penetrating sealer system will be measured by the square yard in place.

412.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) PENETRATING SEALER	Square Yard

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

SECTION 450 – CONSTRUCTION REQUIREMENTS FOR STORM SEWERS

450.01 DESCRIPTION

This section covers general construction requirements of storm sewers and sewer appurtenances as described herein. This section is intended to be used in conjunction with the individual pipe material specifications to form project documents.

450.01.01– REFERENCES

A) ASTM International
   1. ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
   2. ASTM C506, Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
   3. ASTM C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
   4. ASTM C1479, Standard Specification for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations

5. ASTM C1577, Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
6. ASTM C1675, Standard Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
7. ASTM C1840, Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe
8. ASTM D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers & Other Gravity-Flow Applications
9. ASTM F2764, Standard Specification for 30 to 60 in. Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications.
10. ASTM F2881, Standard Specification for 12 to 60 in. Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
11. ASTM A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
12. ASTM A742, Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
13. ASTM A762, Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

B) AASHTO
1. AASHTO LRFD Section 12 Buried Structures and Tunnel Liners

450.01.02 PREQUALIFICATION

As a minimum, all Contractors and Bidders shall meet the prequalification requirements of the City's Prequalification Board and be prequalified to perform work in the "Storm Sewer Construction" Category. Prequalification for additional categories of work, when required may be specified in the Special Provisions.

450.02 MATERIALS

450.02.01– APPROVED PIPE PRODUCTS

Storm water pipe materials will be approved by the City. All materials shall be manufactured, designed, installed, and inspected according to this specification.

The professional engineer responsible for preparation of engineering drawings is also responsible for structural design of storm sewer installations. In all cases, designers shall keep a record of structural design calculations associated with each project in accordance with the appropriate Standard Practice. Design calculations for specific projects shall be provided to the Owner upon request.

A) Reinforced Concrete Pipe
1. Manufacturing Specification – ASTM C76, C506, and C507
2. Design Specification – AASHTO LRFD Section 12
3. Installation Specification – ASTM C1479
4. Post Installation Inspection Specification – ASTM C1840

B) Reinforced Concrete Box
1. Manufacturing Specification – ASTM C1577
2. Design Specification – AASHTO LRFD Section 12
3. Installation Specification – ASTM C1675

4. Post Installation Inspection Specification – Section 451.05 Field Performance and Acceptance Tests

C) Corrugated Metal Pipe
1. Manufacturing Specification – ASTM A760, A742, and A762
2. Design Specification – AASHTO LRFD Section 12
3. Installation Specification – ASTM A798 and A807
4. Post Installation Inspection Specification – Section 451.05 Field Performance and Acceptance Tests

D) Polypropylene Pipe
1. Manufacturing Specification – ASTM F2881 & F2764
2. Design Specification – AASHTO LRFD Section 12
3. Installation Specification – ASTM D2321
4. Post Installation Inspection Specification – Refer to Section 451.05 Field Performance and Acceptance Tests (PP Section PII)

450.02.02– PIPE APPLICATION

Table 450:1
Pipe Application Table

Type of Pipe	Under Paving			Outside Paving	
	Cross Drain	Storm System	Side Drain	Storm System	Side Drain
RCP	Yes	Yes	Yes	Yes	Yes
RCB	Yes	Yes	Yes	Yes	Yes
CMP	No	No	No	No	Yes
Polypropylene	Yes	Yes	Yes	Yes	Yes

A) Definitions
1. Cross Drain – Open ended culvert aligned perpendicular to the direction of traffic.
2. Storm System – A drainage system consisting of a series of at least two interconnecting pipes and two structures (manholes, catch basins etc.) designed to intercept and convey stormwater runoff from specific storm event without surcharge.
3. Side Drain – Open ended culvert aligned parallel to the direction of traffic. (i.e., under a commercial drive entrance would be considered under paving while a rural drive would be considered outside paving)
4. Rejection – Materials that fail to meet the requirements of these specifications shall be rejected by the City or its representative.

450.02.03– PLAN REQUIREMENTS

The design engineer must convey all assumptions used in design calculations such as trench widths, embedment materials and compaction effort, with clear detailed drawings and proper specifications. The design engineer shall not use less than one-foot cover for all pipe products.

Plan and profile drawings must indicate:

- Total length of the pipe run (ft)

- Pipe diameter (inch)
- Strength class (ASTM C76)
- Pipe grade, in percent
- Other special pipe fittings, if applicable
- Flowline

450.02.04- SUBMITTALS

Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted.

450.03 EQUIPMENT — VACANT

450.04 CONSTRUCTION METHODS

Physical properties, compaction characteristics, and gradations of pipe zone materials must meet local material specifications and sourced from approved vendors. At the City's request, the contractor shall be required to perform field density tests to ensure that the pipe installation conforms to the requirements of the contract.

450.04.01– TEMPORARY SEWER AND DRAIN CONNECTIONS

When existing sewers must be taken up or removed, the Contractor at his own expense, shall provide and maintain temporary outlets and connections for all private or public drains, sewers, or sewer inlets. the Contractor shall also take care of all sewage and drainage which will be received from these drains, sewers, and sewer inlets; and for this purpose, the Contractor shall provide and maintain at his own expense, adequate pumping facilities and temporary outlets or diversions. The Contractor shall construct such trough, pipe, or other structures necessary and be always prepared to dispose of drainage and sewage received from these temporary connections until such time as the permanent connections are built and in service. The existing sewers and connections shall be kept in service and maintained under the contract, save where specified or ordered to be abandoned by the City Engineer. All water or sewage shall be disposed of in a satisfactory manner so that no nuisance is created and that the work under construction will be adequately protected.

450.04.02– CLEANUP

After installation of each section of drainage facility, the Contractor shall remove all spills resulting from work, debris, construction materials and equipment from the site of work, grade, smooth over surfaces and leave the right-of-way in a clean, neat, and serviceable condition prior to inspection.

450.05 TESTING

450.05.01 POST INSTALLATION INSPECTION

After all storm lines, manholes and related structures have been cleaned the system must be inspected to ensure that the sewer is free of defects and that the sewer was installed to the line and grade noted on the construction drawings. Pipeline inspection must be carried out for all types of sewer systems and shall include the following:

A) Visual inspection of surface features, manholes, and larger sewers.

B) Image-based video inspection of the smaller sewers (up to and including 36" diameter). Pipe larger than 36" shall be inspected and observations recorded during a walk-through by a Pipeline Assessment & Certification Program (PACP) certified operator or by image-based video inspections where authorized by the City Engineer (subject to obtaining acceptable data quality).

C) Initial and final deflection tests for all flexible pipe (CMP and all approved thermoplastics).

All gravity pipes will be visually (or CCTV) inspected no sooner than 30 days following final backfill. The inspection will be completed only by a certified third-party inspector as outlined in this specification. A final inspection at the end of the warranty period shall be performed to verify performance.

450.06 METHOD OF MEASUREMENT

Storm sewer will be measured by the linear foot in accordance with the dimensions shown on the plans or directed by the City Engineer. Storm sewer, complete with all necessary appurtenances as described in this section, shall be measured by the unit complete and in place.

450.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) (TYPE) STORM SEWER (SIZE)	Linear Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

In the absence of pay items for trench excavation, bedding or embedment materials in a contract, the cost of those items shall be considered incidental to the installation of the pipe and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 451 – REINFORCED CONCRETE PIPE (RCP)

NOTE: This Section is for Storm Sewer only.

451.01 DESCRIPTION

This section covers the requirements for reinforced concrete pipe and fittings intended for non-pressure storm sewers, storm culverts, and fittings.

451.01.01– REFERENCES

A) American Concrete Pipe Association
   1. ACPA Quality Cast (QCast) Plant Certification Manual
   2. ACPA Concrete Pipe and Box Culvert Installation Manual

3. ACPA Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe

B) ASTM International

1. ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
2. ASTM C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
3. ASTM C506, Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
4. ASTM C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
5. ASTM C655, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
6. ASTM C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manholes, Structures, Pipes and Laterals
7. ASTM C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
8. ASTM C1417, Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design
9. ASTM C1479, Standard Specification for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
10. ASTM C1840, Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe
11. AASHTO
12. AASHTO R73, Standard Practice for Evaluation of Precast Drainage Products
13. AASHTO LRFD Bridge Design Specifications, Section 12
14. American Society of Civil Engineers
15. ASCE 15, Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)

451.02 MATERIALS

451.02.01– PLAN REQUIREMENTS

The design engineer must convey all assumptions used in design calculations such as trench widths, embedment materials and compaction effort, with clear detailed drawings and proper specifications. The design engineer shall not use less than one-foot cover for all pipe products.

- Plan and profile drawings must indicate:
- Total length of the pipe run (ft)
- Pipe diameter (inch)
- Strength class (ASTM C76)
- Pipe grade, in percent
- Other special pipe fittings, if applicable
- Flowline
- Other markings as specified by the Owner

451.02.02– SUBMITTALS

Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted. The drawings and data shall include, but shall not be limited, to the following for each size of pipe.

- Strength Class
- Details of joints
- Details of gasket
- Details of fittings and specials
- Test reports

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.

451.02.03– QUALITY ASSURANCE

Pipe size, type, and strength class shall be consistent throughout a pipe run. All concrete pipe and fittings shall be supplied from a manufacturer that is prequalified by an independent third-party certification agency to produce products according to applicable ASTM manufacturing standards.

All pipe products shall be marked with a certification body's logo confirming that the production of the pipe is in accordance with the quality and requirements of an acceptance standard. Quality assurance programs recognized specifically for manufactures of concrete pipe and precast drainage products in Oklahoma are:

All manufacturers will have two years from the effective date of this specification to become QCast or NPCA certified.

A) Quality Cast Plant Certification Program (QCast)

B) NPCA – National Precast Concrete Association

451.02.04– PIPE MATERIALS

A) Manufacturing Standard Designation
   1. Reinforced circular pipe and fittings shall be manufactured in accordance with ASTM C76, ASTM C655, and ASTM C1417.

2. Arched pipe shall be manufactured in accordance with ASTM C506.
3. Elliptical pipe shall be manufactured in accordance with ASTM C507.
4. Under the roadway - all circular reinforced concrete pipe shall have water resistant joints using elastomeric gaskets in accordance with ASTM C443.
5. Outside the roadway - all circular reinforced concrete pipe shall have soil tight joints using Omni-flex or ConSeal gaskets in accordance with ASTM C990.

B) Concrete Pipe Strength Classifications (ASTM C76)

1. Reinforced concrete pipe manufactured to ASTM C76 shall be of three classes: Class III, Class IV, and Class V.

C) Markings

1. The following information must be clearly marked on each section of pipe:
2. Nominal pipe size (inch).
3. Pipe strength classification.
4. Manufacturer's name or trademark.
5. Plant identification, if applicable.
6. Manufacturing standard designation.
7. Date of Manufacture.
8. Quality certification program logo.

451.02.05– PIPE DESIGN

A) Flow Capacity

Pipe capacities shall be calculated using Manning's formula with a roughness coefficient (n) of 0.013 for all smooth-walled pipe materials. Final design shall be in accordance with the latest revisions of the city drainage ordinance and drainage criteria manual.

B) Structural Design

1. The design engineer responsible for the preparation of engineering drawings is also responsible for the structural design of storm sewer installations. In all cases, engineers shall keep a record of structural design calculations for pipe associated with each project. Design calculations for specific projects shall be provided to the City upon request.
2. All minimum and maximum fill height tables are only intended to provide answers to general cover height questions and shall not be used for project design.
3. Depth of cover for concrete pipe is measured from the ultimate finished ground elevation to the outside top of the pipe.
4. Reinforced concrete pipe designed using the indirect design method shall be in accordance with the AASHTO LRFD Bridge Design Specifications, Section 12. *
5. Reinforced concrete pipe designed using the direct design method shall be in accordance with ASCE 15.
6. *PipePac (indirect design) software is available for free at www.pipepac.com.

451.02.06 JOINTS

Joint classification for concrete pipe shall follow ASTM C1840.

A) Soil Tight Joint – A joint that is resistant to infiltration of particles larger than those retained on a No. 200 sieve. Soil tight joints shall be in accordance with ASTM C990.

B) Silt Tight Joint – A joint that is resistant to infiltration of particles smaller than those retained on the No. 200 sieve. Silt tight joints shall be in accordance with ASTM C443.

C) Leak Resistant Joint – A joint that limits water leakage at a maximum rate of 200 gallons/inch of internal diameter/mile of pipeline/24hrs. Leak resistant joints shall be in accordance with ASTM C443.

Table 451:1
Joint Application Table

Under Paving	Outside Paving
O-Ring / Profile Joint (ASTM C443)	Tongue & Groove Joint (ASTM C990)

451.03 EQUIPMENT — VACANT

451.04 CONSTRUCTION METHODS

451.04.01– GENERAL

Industry recommendations for the installation of concrete pipe are provided in the ACPA Concrete Pipe Installation Manual.

A) The contractor must achieve all the design assumptions in the field. Conditions that arise during construction that fails to meet any design assumptions, such as trench widths, must be reviewed to confirm whether the design is still valid.

B) Pipe shall be laid within the alignment and grade tolerances specified in the contract documents. Begin at the downstream end of the pipe run with bell end of the pipe facing upstream.

451.04.02– DELIVERY AND PRE-INSTALLATION INSPECTION

All product RCP deliveries shall be inspected for damages and defects according to AASHTO R73 prior to unloading. Any pipe, fitting, or gaskets that are unsound or damaged shall be rejected. The contractor shall confirm the quantity, class, and joint treatment options match the project documents.

451.04.03– INSTALLATION

Physical properties, compaction characteristics, and gradations of pipe zone materials must meet local material specifications and sourced from approved vendors. At the City's request, the contractor shall be required to perform field density tests to ensure that the pipe installation conforms to the requirements of the contract.

A) The pipe embedment zone consists of the foundation, bedding, and haunch, and initial backfill as detailed in the applicable City Standard Details for pipe installation.

B) Materials for use as foundation, embedment, and backfill for pipe include natural, manufactured, and processed aggregates and the soil types classified according

to ASTM C1479.

C) Reinforced concrete pipe installations consist of Type 1, Type 2, Type 3, or Type 4 embedment and detailed in ASTM C1479 or the applicable City Standard Details for pipe installation.

451.04.04– MOVABLE SUPPORT SYSTEMS

Unless sheathing is to be left in place, it shall be pulled out in vertical increments to permit placement and compaction of fill material for the full width of the trench.

When trench shields or boxes are moved, the previously placed pipe shall not be disturbed. It may be necessary to restrain the installed pipe by use of deadman anchors or other means. Voids that are created by movement of a shield or box shall be filled and compacted per the contract documents.

451.04.05– MINIMUM COVER FOR CONSTRUCTION LOADS

If the passage of construction equipment over an installed pipeline is necessary during project construction, compacted overfill in the form of a ramp shall be constructed to a minimum elevation of 3 ft over the top of the pipe or to a height such that the equipment loads on the pipe do not exceed the pipe design strength.

451.05 TESTING

451.05.01– CLEANING AND FLUSHING

All reinforced concrete shall be cleaned and flushed immediately prior to inspection and acceptance.

451.05.02– POST INSTALLATION INSPECTION

All reinforced concrete pipe will be visually, or CCTV inspected in accordance with ASTM C1840.

The Initial Inspection shall take place no sooner than 30 days following final backfill. A Final Inspection at the end of the warranty period shall be performed to verify performance. All inspection will be completed by City of Oklahoma City Staff.

Inspection of reinforced concrete pipe shall include the following:

A) Visual inspection of surface features, manholes, and larger sewers.
B) Image-based video inspection of the smaller sewers (up to and including 36” diameter). Pipe larger than 36” shall be inspected and observations recorded during a walk-through by a City of Oklahoma City Staff and an image-based video inspection where authorized by the City Engineer.
C) Evaluation of cracks, joints, and infiltration as per ASTM C1840.

451.05.03 – CRACK EVALUATION

The evaluation of crack width will take place during the Initial and Final Inspections.

The contractor will be responsible for the performance of the installed pipeline. Longitudinal cracks greater than the limits listed in the following table will be the

responsibility of the contractor to repair or replace.

Table 451:2 Rigid Pipe Crack Evaluation Table	
Longitudinal Crack Width (inches)	Evaluation
0.00 to 0.05	Accepted
0.05 to 0.10	Accepted[1] or Remediate or Replace at contractor's expense [2]
Greater than 0.10	Remediate or Replace at contractor's expense [2]

(1) Pipe located in areas where soil and or runoff Ph is 5.5 or greater shall not require remediation if cracking is less than or equal to 0.1".
(2) Provide the City in writing a method for repairing the observed cracking. Do not begin work until the method has been approved. Cracks > 0.10" will be given consideration by the City to replace the pipe or allow for site specific repair. Refer to Site Specific Repairs at the end of this specification.

451.05.04– SITE SPECIFIC REPAIRS

Site specific repairs will be sealed by a Professional Engineer and submitted to the City by the contractor for evaluation and approval. Examples of major repairs for reinforced concrete pipe can be found in the ACPA "Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe" Manual.

Any repairs made to the installed pipe must be certified by the contractor and the repair contractor. This certification will state that all repairs will have the same service life as newly installed pipe.

451.06 METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

451.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) REINFORCED CONCRETE PIPE (SIZE)	Linear Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

In the absence of pay items for trench excavation, bedding or embedment materials in a contract, the cost of those items shall be considered incidental to the installation of the pipe and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 452 – POLYPROPYLENE PIPE (PP)

NOTE: This Section is for Storm Sewer only.

452.01 DESCRIPTION

This section covers the requirements for polypropylene pipe intended for non-pressure storm sewers and storm culverts.

452.01.01– REFERENCES

A) ASTM International
   1. ASTM C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
   2. ASTM D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers & Other Gravity-Flow Applications
   3. ASTM D2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
   4. ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   5. ASTM F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
   6. ASTM F2881, Standard Specification for 12 to 60 in. Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

B) AASHTO
   1. AASHTO LRFD Bridge Construction Specifications, Section 30
   2. AASHTO LRFD Bridge Design Specifications, Section 12
   3. R 82-17 Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains

C) OSHA (Occupational Safety and Health Standards)
   1. 29 CFR Part 1926, OSHA Standards for the Construction Industry

452.02 MATERIALS

452.02.01– PLAN REQUIREMENTS

The design engineer must convey all assumptions used in design calculations such as trench widths, embedment materials and compaction effort, with clear detailed drawings and proper specifications. The design engineer shall not use less than one-foot cover for all pipe products.

Plan and profile drawings must indicate:

- Total length of the pipe run (ft)
- Pipe diameter (inch)
- Pipe material type
- Maximum fill height
- Pipe grade, in percent
- Other special pipe fittings, if applicable
- Flowline
- Other markings as specified by the owner

452.02.02– SUBMITTALS

Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted. The drawings and data shall include, but shall not be limited, to the following for each size of pipe.

- Details of joints
- Details of gasket
- Details of fittings and specials
- Test reports

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.

452.02.03– QUALITY ASSURANCE

Pipe size and type shall be consistent throughout a pipe run. All pipe and fittings shall be supplied from a manufacture that is prequalified according to this specification.

All pipe products shall be marked with a certification body's logo confirming that the production of the pipe is in accordance with National Transportation Product Evaluation Program (NTPEP).

452.02.04– PIPE MATERIALS

All thermoplastic pipe shall meet the following requirements.

A) Manufacturing Standard Designation

1. Dual-wall PP pipe (12– 60in) shall be used for storm sewer applications only.
2. Dual-wall PP pipe and fittings shall be manufactured in accordance with ASTM F2881.
3. All PP pipe shall have water resistant joints using elastomeric gaskets in accordance with ASTM F477.
4. PP pipe shall be installed within two years from the production date indicated on the pipe.
5. PP pipe shall have a maximum of 5% deflection

B) Markings

The following information must be clearly marked on each section of pipe:

- Nominal pipe size (inch).
- Manufacturer's name or trademark.
- Plant identification, if applicable.
- Manufacturing standard designation (ASTM)
- Date of Manufacture.
- Cell classification of materials.
- Quality certification program logo.

452.02.05– PIPE DESIGN

A) Flow Capacity

Pipe capacities shall be calculated using Manning's formula with a roughness coefficient (n) of 0.013 for all smooth-walled pipe materials (concrete and polypropylene). Final design shall be in accordance with the latest revisions of the city drainage ordinance and drainage criteria manual.

B) Structural Design

1. The design engineer responsible for the preparation of engineering drawings is also responsible for the structural design of sewer installations. In all cases, engineers shall keep a record of structural design calculations for pipe associated with each project. Design calculations for specific projects shall be provided to the Owner upon request.
2. All minimum and maximum fill height tables are only intended to provide answers to general cover height questions and shall not be used for project design.
3. Depth of cover for PP pipe shall be a minimum of 2 feet unless specifically called out by the design engineer.
4. Use of PP pipe may be approved under paved areas, when specifically designed for this application and approved by the design engineer.
5. Depth of cover for PP pipe is measured from the ultimate finished ground elevation to the outside top of the pipe.
6. Strength limit states calculations shall be completed per AASHTO LRFD Bridge Design Specifications, Section 12.
    i. Thrust
    ii. Buckling
    iii. Combined Strain
7. Buoyancy of PP pipe should be considered, and flotation of pipes should be prevented with appropriate construction where high groundwater conditions are anticipated.
8. A design check for deflection shall be completed per AASHTO LRFD Bridge Design Specifications, Section 12.

452.02.06– JOINTS

Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of ASTM F2881 and ASTM F2764.

A) Soil/Silt Tight Joint – Shall conform to ASTM F477

B) Leak Resistant Joint – Shall conform to ASTM D3212

452.03 EQUIPMENT — VACANT

452.04 CONSTRUCTION METHODS

452.04.01– GENERAL

All flexible pipes are to be installed per ASTM D2321.

A) The contractor must achieve all the design assumptions in the field. Conditions that arise during construction that fails to meet any design assumptions, such as

trench widths, must be reviewed to confirm whether the design is still valid.

B) Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. Begin at downstream end of pipe run with bell end of the pipe facing upstream.

452.04.02– PRE-INSTALLATION INSPECTION

All product deliveries shall be inspected for damages and defects prior to unloading. Any pipe, fitting, or gaskets that are unsound or damaged shall be rejected. The contractor shall confirm that the quantity, diameter, sheet thickness, and connecting band options match the project documents.

452.04.03– INSTALLATION

Physical properties, compaction characteristics, and gradations of pipe zone materials must meet local material specifications and be sourced from approved vendors. At the City's request, the contractor shall be required to perform field density tests to ensure that the pipe installation conforms to the requirements of the contract.

A) The pipe embedment zone consists of the foundation, bedding, and haunch, and initial backfill as detailed in ASTM D2321 and applicable City Standard Details for flexible pipe installation.

B) Materials for use as foundation, embedment, and backfill for PP pipe are classified in Table 1 and Table 2 in ASTM D2321. They include natural, manufactured, and processed aggregates and the soil types according to ASTM D2487 and applicable City Standard Details for flexible pipe installation.

1. Class I, Class II, and Class III materials are suitable to use as foundation material and in the embedment zone subject to the limitations noted in Table 3 of ASTM D2321.
2. Class IV-A materials should only be used in the embedment zone in special design cases, as they would not normally be construed as a desirable embedment material for thermoplastic pipe.
3. Class IV-B and Class V Soils are not permitted in the embedment zone and should be excluded from the final backfill except where specifically allowed by project specifications.

C) Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. Begin at downstream end of pipe run with bell end of the pipe facing upstream.

452.04.04– MOVABLE SUPPORT SYSTEMS

Movable support systems (trench boxes or cages) shall be used in accordance with applicable Occupational Health and Safety requirements. Movable support systems with PP pipe must be used in accordance with ASTM D2321. When using movable support systems with PP pipe, the pipe location, jointing, and its embedment shall not be disturbed. This can be accomplished by limiting the use of standard movable trench boxes that are more than 2.5 pipe diameters on either side of the pipe to below the top of the pipe, or to a shelf above the top of the pipe. When advancing trench boxes or shields, longitudinal pipe movement or disjointing shall not be allowed.

452.04.05– MINIMUM COVER FOR CONSTRUCTION LOADS

If the passage of construction equipment over an installed pipeline is necessary during project construction, compacted overfill in the form of a ramp shall be constructed to a minimum elevation of 3 ft over the top of the pipe or to a height such that the equipment loads on the pipe do not exceed the pipe design strength.

452.05 TESTING

452.05.01– CLEANING AND FLUSHING

All storm sewer pipe shall be cleaned and flushed immediately prior to inspection and acceptance.

452.05.02– POST INSTALLATION INSPECTION

All Polypropylene Pipe will be visually inspected and tested for deflection.

The Initial Inspection shall take place no sooner than 30 days following final backfill. A Final Inspection at the end of the warranty period shall be performed to verify performance. All inspection will be completed by City of Oklahoma City Staff.

Inspection of Polypropylene Pipe shall include the following:

A) Visual inspection of surface features, manholes, and larger sewers.
B) Image-based video inspection of the smaller sewers (up to and including 36” diameter). Pipe larger than 36” shall be inspected and observations recorded during a walk-through by City of Oklahoma City Staff and an image-based video inspection where authorized by the City Engineer
C) A deflection test by mandrel, where authorized by the City Engineer. The deflection limit of the initial inspection is 5%.

452.05.03– DEFLECTION TESTING

Mandrel deflection testing shall be performed on all pipe sewers or culverts constructed using PP pipe. The allowable deflected pipe diameter is calculated as a percentage of the base inside diameter of the pipe. The initial inspection will be limited to 5%, and final inspection will be limited to 7.5%.

The following procedure outlines the mandrel test:

A) A suitably designed device as defined below shall be pulled through the pipe sewer to demonstrate that the pipe deflection does not exceed the allowable deflected pipe diameter.
B) For the Initial Inspection, the device shall be pulled manually through the pipe not sooner than 30 Days after the completion of backfilling and installation of service connections.
C) The suitably designed device shall be a mandrel, cylindrical in shape, and constructed with an odd number of evenly spaced arms or prongs, minimum 9 in number. The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the allowable deflected pipe diameter ± 0.04 in.

D) The mandrel shall be checked with a go-no-go proving ring. The proving ring shall have a diameter equal to the allowable deflected pipe diameter ± 0.04 in. An acceptable mandrel shall not pass through the proving ring. The proving ring shall be fabricated from steel a minimum of ¼ in thick.

E) Any section of pipe that does not allow the mandrel to pass shall be considered to have failed the deflection test.

F) All sections of pipe that fail the deflection test shall be repaired or replaced, then retested.

452.05.04– DEFLECTION EVALUATION

The evaluation of deflection will take place during the initial and final inspections.

The contractor will be responsible for the performance of the installed pipeline. Deflection greater than the limits listed in the following table will be the responsibility of the contractor to repair or replace.

Table 452:1
Initial Inspection - Deflection Evaluation Table

Deflection	Evaluation
0 to 5%	Accepted
Greater than 5%	Remediate or replace at contractor's expense

Table 452:2
Final Inspection - Deflection Evaluation Table

Deflection	Evaluation
0 to 7.5%	Accepted
Greater than 7.5%	Remediate or replace at contractor's expense

452.06 METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

452.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) POLYPROPYLENE PIPE (SIZE)	Linear Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

In the absence of pay items for trench excavation, bedding or embedment materials in a contract,

the cost of those items shall be considered incidental to the installation of the pipe and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 453 – CORRUGATED STEEL PIPE (CSP)

NOTE: This Section is for Storm Sewer only.

453.01 DESCRIPTION

This section covers the requirements for corrugated steel pipe and fittings intended for non-pressure storm sewers, storm culverts, and fittings.

453.01.01– REFERENCES

A) ASTM International
1. ASTM A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
2. ASTM A742, Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
3. ASTM A762, Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
4. ASTM A796, Standard Practice for Structural Design of Corrugated Steel Pipe, Pipe Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications
5. ASTM A798, Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
6. ASTM A807, Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications

B) AASHTO
1. AASHTO M36, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
2. AASHTO M218, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized), for Corrugated Steel Pipe
3. AASHTO M246, Standard Specification for Steel Sheet, Metallic-Coated and Polymer- Precoated, for Corrugated Steel Pipe
4. AASHTO M274, Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe
5. AASHTO M245, Standard Specification for Corrugated Steel Pipe, Polymer-Precoated, for Sewers and Drains

453.02 MATERIALS

453.02.01– PLAN REQUIREMENTS

The design engineer must convey all assumptions used in design calculations such as trench widths, embedment materials and compaction effort, with clear detailed drawings and proper specifications. The design engineer shall not use less than one-foot cover for all pipe products.

Plan and profile drawings must indicate:

- Total length of the pipe run (ft)
- Pipe size, diameter (in.) of circular pipe, or span and rise (in. x in.) of pipe-arch section
- Maximum fill height
- Pipe grade, in percent
- Other special pipe fittings, if applicable
- Flowline
- Other markings as specified by the owner.

453.02.02– SUBMITTALS

Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted. The drawings and data shall include, but shall not be limited, to the following for each size of pipe.

- Details of joints
- Details of gasket
- Details of fittings and specials
- Test reports

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.

453.02.03– QUALITY ASSURANCE

A) Pipe diameter, corrugation size, and sheet thickness shall be consistent throughout a pipe run.
   1. Pipe Ends

B) Pipe ends shall have a minimum of two reformed annular corrugations to accommodate connecting bands.

C) Connecting Bands
   1. Connecting bands shall be of the dimpled type and shall be designed to accommodate flexible rubber gaskets when required.
   2. Connecting bands shall be of the same material as the pipe; and shall be not more than three nominal sheet thicknesses lighter than the connecting pipe.
   3. Connecting bands shall meet the performance criteria set for in Section 23 of AASHTO Standard Specifications for Highway Bridges.

453.02.04– PIPE MATERIALS

A) Manufacturing Standard Designation
   1. Corrugated circular and arch pipe and fittings shall be manufactured in accordance with AASHTO M36.

B) Acceptable Types

   The following types of CSP shall be acceptable based on appropriate hydraulic and durability considerations:
   1. Galvanized (AASHTO M218)
   2. Aluminized (AASHTO M274)
   3. Polymeric coated (AASHTO M245)

C) Markings

The following information must be clearly marked on each section of pipe:

1. Heat number
2. Sheet thickness
3. Manufacturer's name or trademark.
4. Mill identification
5. Manufacturing standard designation.

453.02.05– PIPE DESIGN

A) Flow Capacity

Pipe capacities shall be calculated using Manning's formula with a roughness coefficient of 0.024. Final design shall be in accordance with the latest revisions of the city drainage ordinance and drainage criteria manual.

B) Structural Design

1. The design engineer responsible for the preparation of engineering drawings is also responsible for the structural design of sewer installations. In all cases, designers shall keep a record of structural design calculations for pipe associated with each project. Design calculations for specific projects shall be provided to the Owner upon request.
2. All minimum and maximum fill height tables are only intended to provide answers to general cover height questions and shall not be used for project design.
3. Depth of cover for corrugated steel pipe is measured from the ultimate finished ground elevation to the outside top of the pipe.

453.03 EQUIPMENT — VACANT

453.04 CONSTRUCTION METHODS

453.04.01– GENERAL

Corrugated steel pipe to be installed per ASTM A798.

The contractor must achieve all the design assumptions in the field. Conditions that arise during construction that fails to meet any design assumptions, such as trench widths, must be reviewed to confirm whether the design is still valid.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. Begin at downstream end of the pipe run with the inside seam laps pointing downstream.

The installation of CSP is not allowed in any storm sewer system that will be dedicated to the city for maintenance. See table 450.02.02.

453.04.02– DELIVERY

Use slings for handling CSP. The pipe should be lifted and placed into the location for storage; the pipe should never be dumped from a truck bed or dragged into position to protect the coating from damage.

453.04.03– PRE-INSTALLATION INSPECTION

All product deliveries shall be inspected for damages and defects prior to unloading. Any pipe, fitting, or gaskets that are unsound or damaged shall be rejected. The contractor shall confirm that the quantity, diameter, sheet thickness, and connecting band options match the project documents.

453.04.04– INSTALLATION

Physical properties, compaction characteristics, and gradations of pipe zone materials must meet local material specifications and sourced from approved vendors. At the City's request, the contractor shall be required to perform field density tests to ensure that the pipe installation conforms to the requirements of the contract.

The pipe embedment zone consists of the foundation, bedding, and haunch, and initial backfill as detailed in the applicable City Standard Details for pipe installation.

Materials for use as foundation, embedment, and backfill for pipe include natural, manufactured, and processed aggregates and the soil types classified according to the applicable City Standard Details for pipe installation.

453.04.05– MOVABLE SUPPORT SYSTEMS

Unless sheathing is to be left in place, it shall be pulled out in vertical increments to permit placement and compaction of fill material for the full width of the trench.

When trench shields or boxes are moved, the previously placed pipe shall not be disturbed. It may be necessary to restrain the installed pipe by use of deadman anchors or other means. Voids that are created by movement of a shield or box shall be filled and compacted per the contract documents.

453.04.06– MINIMUM COVER FOR CONSTRUCTION LOADS

If the passage of construction equipment over an installed pipeline is necessary during project construction, compacted overfill in the form of a ramp shall be constructed to a minimum elevation of 3 ft over the top of the pipe or to a height such that the equipment loads on the pipe do not exceed the pipe design strength.

453.05 TESTING

453.05.01 – CLEANING AND FLUSHING

All storm sewer pipe shall be cleaned and flushed immediately prior to inspection and acceptance.

453.05.02– DEFLECTION

The maximum allowable deflection is five percent (5%), which must be based on the nominal diameter. When deflection exceeds 5%, the pipe will be replaced with a new pipe. The pipe is required to be tested, at the contractor's expense, not less than 30 days after installation and again during the final inspection to ensure that the pipe has not exceeded 5% deflection.

453.06 METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

453.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) CORRUGATED METAL PIPE (SIZE)	Linear Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

In the absence of pay items for trench excavation, bedding or embedment materials in a contract, the cost of those items shall be considered incidental to the installation of the pipe and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 454 – PRECAST REINFORCED CONCRETE BOX CULVERT (RCB)

NOTE: This Section is for Storm Sewer only.

454.01 DESCRIPTION

This section covers the requirements for precast reinforced concrete box culvert and fittings intended for non-pressure storm sewers, storm culverts, and fittings.

454.01.01– REFERENCES

A) American Concrete Pipe Association
   1. ACPA Quality Cast (QCast) Plant Certification Manual
   2. ACPA Concrete Pipe and Box Culvert Installation Manual
   3. ACPA Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe

B) ASTM International
   1. ASTM C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manholes, Structures, Pipes and Laterals
   2. ASTM C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
   3. ASTM C1479, Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
   4. ASTM C 1577 (C 1577M): Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
   5. ASTM C1675, Standard Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culvert, Storm Drains, and Sewers
   6. ASTM C1840, Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe

C) AASHTO
   1. AASHTO R73, Standard Practice for Evaluation of Precast Drainage Products
   2. AASHTO LRFD Bridge Design Specifications, Section 12

D) American Society of Civil Engineers
   1. ASCE 26-97: Standard Practice for Direct Design of Buried Precast Concrete Box Sections

454.02 MATERIALS

454.02.01– PLAN REQUIREMENTS

The design engineer must convey all assumptions used in design calculations such as trench widths, embedment materials and compaction effort, with clear detailed drawings and proper specifications. The design engineer shall not use less than one-foot cover for all pipe products.

Plan and profile drawings must indicate:

- Total length of the box culvert run (ft)
- Box culvert width (ft) and height (ft)
- Design Standard – Section 12 AASHTO LRFD
- Live Load (HS-20)
- RCB grade, in percent
- Flowline
- Other markings as specified by the owner.

454.02.02– SUBMITTALS

Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted. The drawings and data shall include, but shall not be limited, to the following for each size of pipe.

- Concrete strength
- Fill heights
- Details of joints
- Details of gasket
- Details of fittings and specials

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.

454.02.03– QUALITY ASSURANCE

All RCB and fittings shall be supplied from a manufacture that is prequalified by an independent third- party certification agency to produce products according to applicable ASTM manufacturing standards.

All RCB products shall be marked with a certification body's logo confirming that the production of the RCB is in accordance with the quality and requirements of an acceptance standard. Quality assurance programs recognized specifically for manufactures of concrete pipe and precast drainage products in Oklahoma are:

All manufacturers will have two years from the effective date of this specification to become QCast or NPCA certified.

A) Quality Cast Plant Certification Program (QCast)

B) National Precast Concrete Association (NPCA)

454.02.04 – PRECAST REINFORCED CONCRETE BOX CULVERT MATERIALS

A) Manufacturing Standard Designation
   1. Precast reinforced concrete box culvert and fittings shall be manufactured in accordance with ASTM C1577 (LRFD).
   2. All precast reinforced concrete box culvert shall have soil tight joints using Omni-flex gaskets in accordance with ASTM C990.

B) Markings

The following information must be clearly marked on each section of precast reinforced concrete box culvert:

- Manufacturer's name or trademark
- Plant location/identification
- Manufacturing standard designation
- Minimum and maximum bury depth (fill heights)
- Box size - span (ft), rise (ft)
- Date of Manufacture.
- Quality certification program logo.
- Other markings as specified by the Owner.

C) Service Connections

Service connections to the main storm lines shall be made using factory made tees, or other approved methods. Resilient connectors conforming to ASTM C923 shall be used for flexible connections.

454.02.05– BOX CULVERT DESIGN

A) Flow Capacity

Box culvert capacities shall be calculated using Manning's formula with a roughness coefficient (n) of 0.013. Final design shall be in accordance with the latest revisions of the city drainage ordinance and drainage criteria manual.

B) Structural Design
   1. The design engineer responsible for the preparation of engineering drawings is also responsible for the structural design of storm sewer installations. In all cases, designers shall keep a record of structural design calculations for pipe associated with each project. Design calculations for specific projects shall be provided to the City upon request.
   2. All minimum and maximum fill height tables are only intended to provide answers to general cover height questions and shall not be used for project

design.

3. Depth of cover for precast reinforced concrete box culvert is measured from the ultimate finished ground elevation to the outside top of the box culvert.
4. Precast Reinforced concrete Box Culverts shall be designed in accordance with AASHTO LRFD Bridge Design Specifications.

454.02.06– FITTINGS

All bends, tees, closure pieces, wall fittings, and other fittings which are indicated on the drawings or required to complete the work shall be furnished. Except as modified or otherwise provided herein, the design and manufacture of fittings shall be governed by the same requirements as the connecting piping.

454.03 EQUIPMENT — VACANT

454.04 CONSTRUCTION METHODS

454.04.01– GENERAL

Industry recommendations for the installation of precast reinforced concrete box culverts are provided in the ACPA Concrete Pipe and Box Culvert Installation Manual.

A) The contractor must achieve all the design assumptions in the field. Conditions that arise during construction that fails to meet any design assumptions, such as trench widths, must be reviewed to confirm whether the design is still valid.

B) Precast reinforced concrete box culvert shall be laid within the alignment and grade tolerances specified in the Contract Documents. Begin at downstream end of box culvert run with bell end of the box culvert facing upstream.

454.04.02– DELIVERY AND PRE-INSTALLATION INSPECTION

All product Precast Reinforced Concrete Box Culvert deliveries shall be inspected for damages and defects according to AASHTO R73 prior to unloading. The contractor shall confirm the quantity, design and joint treatment options match the project documents.

454.04.03– INSTALLATION

Physical properties, compaction characteristics, and gradations of precast reinforced concrete box culvert zone materials must meet local material specifications and sourced from approved vendors. At the Owners request, the contractor shall be required to perform field density tests to ensure that the installation conforms to the requirements of the contract.

A) The embedment zone consists of the foundation, bedding, and initial backfill as detailed in ASTM C1675 and applicable City Standard Details for RCB installation.

B) Materials for use as foundation, embedment, and backfill for RCB include natural, manufactured, and processed aggregates and the soil types classified according to the applicable City Standard Details for RCB installation.

454.04.04– EXCAVATION, SHAPING, BEDDING AND BACKFILL

Excavate, shape, bed, and backfill in accordance with ASTM C1675.

Take precautions in placing and compacting the backfill to avoid any movement of the

boxes or damage to the joints. Remove and replace boxes damaged by the Contractor at no expense to the Public Works Department.

When multiple barrel structures are specified, place the barrels a minimum of 2 inches apart. Place the material between culvert barrels in accordance with the Plans and the City Standard Details. When not specified in the Plans, use flowable fill or continuous concrete for gap material. Provide a minimum 6-inch cast-in-place concrete plug along the length of the barrels at the exposed ends of the barrel to prevent erosion of the gap material.

454.04.05– PLACEMENT OF BOXES

Place the box sections in conformance with the plans or as directed when precast boxes are used to form multiple barrel structures. Place material to be used between barrels as shown on the plans or as directed. Start the laying of boxes on the bedding at the outlet end and proceed toward the inlet end with the abutting sections properly matched unless otherwise authorized. Fit, match, and lay the boxes to form a smooth, uniform conduit true to the established lines and grades. Lower the box sections into the trench, for trench installations, without damaging the box or disturbing the bedding and the sides of the trench. Carefully clean the ends of the box before it is placed. Prevent the earth or bedding material from entering the box as it is laid. Remove and re-lay, without extra compensation, boxes that are not in alignment or show excessive settlement after laying.

454.04.06– MOVABLE SUPPORT SYSTEMS

Unless sheathing is to be left in place, it shall be pulled out in vertical increments to permit placement and compaction of fill material for the full width of the trench.

When trench shields or boxes are moved, the previously placed pipe shall not be disturbed. It may be necessary to restrain the installed pipe by use of deadman anchors or other means. Voids that are created by movement of a shield or box shall be filled and compacted per the contract documents.

454.04.07– MINIMUM COVER FOR CONSTRUCTION LOADS

If the passage of construction equipment over an installed pipeline is necessary during project construction, compacted overfill in the form of a ramp shall be constructed to a minimum elevation of 3 ft over the top of the pipe or to a height such that the equipment loads on the pipe do not exceed the pipe design strength. Above all, the loads applied to the box section should not exceed those specified by the designer.

454.04.07– STORAGE

Store precast sections on a level surface.

454.05 TESTING

454.05.01– CLEANING AND FLUSHING

All precast reinforced concrete box culvert shall be cleaned and flushed immediately prior to inspection and acceptance.

454.05.02– POST INSTALLATION INSPECTION

All precast reinforced concrete box culvert will be visually, or CCTV inspected in by a

certified PACP inspector.

454.05.03– SITE SPECIFIC REPAIRS

Site specific repairs will be sealed by a Professional Engineer and submitted to the City by the contractor for evaluation and approval.

454.06 METHOD OF MEASUREMENT

Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

454.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:
(A) PRECAST REINFORCED BOX CULVERTS (SIZE)	Linear Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

In the absence of pay items for excavation, bedding or embedment materials in a contract, the cost of those items shall be considered incidental to the installation of the precast structure and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 455 – STORM SEWER MANHOLES

455.01 DESCRIPTION

This section covers construction of manholes. Manholes used in Storm Sewer construction shall be Precast or Cast-in-place Reinforced Concrete.

455.01.01– REFERENCES

A) ASTM International
   1. ASTM C478, Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
   2. ASTM C913 Standard Specification for Precast Concrete Water and Wastewater Structures
   3. ASTM C890 Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
   4. ASTM C1821 Standard Practice for Installation of Underground Circular Precast Concrete Manhole Sections
   5. ASTM C479, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
   6. ASTM C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
   7. ASTM C990 Standard Specification for Joints for Concrete Pipe, Manholes,

and Precast Box Sections Using Preformed Flexible Joint Sealants
8. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
9. ASTM A48, Standard Specifications for Gray Iron Castings

455.02 MATERIALS

455.02.01– GENERAL

All materials for construction of round manholes shall be in accordance with ASTM C478.

All materials for construction of square or rectangular manholes shall be in accordance with ASTM C913.

This specification covers construction of precast reinforced concrete manhole base sections, riser sections (walls) and appurtenances in accordance with ASTM C478 Standard Specification for “Precast Reinforced Concrete Manhole Sections” or ASTM C913 Standard Specification for “Precast Concrete Water and Wastewater Structures”, and as modified herein.

455.02.02– SUBMITTALS

When requested be the City Engineer, the Contractor shall submit the following, but not limited to, for review and approval.

A) Concrete cylinder compressive test results as per the applicable specification
B) Amount and detail layout of steel reinforcement as per the applicable specification
C) Affidavit of compliance with these specifications.

455.02.03– SIZES

Standard diameters for round manhole sections shall be from 4’ to 8’ diameter in 1’ increments. Wall lengths for flat walled manhole sections shall be 4’ to 8’ length in 1’ increments. Manholes shall be sized according to the connecting pipe diameters and per the pipe connector gasket manufacturers recommendations where applicable.

455.02.04– MANHOLES, STEPS, AND LADDERS

Steps and ladders shall not be constructed unless otherwise directed by the City Engineer. If called for, they shall conform to Section 16 of ASTM C-478.

455.02.05– HANDLING

Lifting holes shall not be allowed. Design of embedded lifting devices shall conform to requirements as specified in 8.4 under Special Loading Considerations of Practice C890.

455.02.06– ACCEPTANCE

Acceptance of manhole structure shall be based on the conformance and performance of materials required in the applicable specification, and the City Engineer’s inspection of the installed product. The assessment shall include, but not be limited to, the City Engineer’s random plant inspections during production, the quantity and the placement of reinforcement, surface fractures and roughness, and the test results of compressive strength performed on cores and cured cylinders in accordance with Section 7 of ASTM C-497.

455.02.07– MANHOLE INVERT AND BENCH

When required, inverts shall be formed in the field after pipe pipes have been properly connected. All loose materials shall be removed prior to shaping the invert. The invert shall be smooth, U-shaped, have a minimum depth of on half (1/2) pipe diameter and be channeled across the floor of the manhole using the materials specified herein to obtain the proper form and shape.

455.02.08– MANHOLE RING AND COVER

Cast iron rings, tops, covers, gratings, and all cast iron fittings shall be sound, true to form and thickness and neatly finished and shall fit together in a satisfactory manner. Castings shall be clean, uniform, and whole, and without blow or sand holes, dorosit, hardspots, shrinkage, distortion or any other surface defects which would impair serviceability. Casting surfaces shall be smooth and well cleaned by shot blasting or other approved cleaning method. Plugging or filling of holes or other defects shall not be permitted.

Parting fins and pouring gates shall be removed. Sharp edges resulting from fabrication shall be dulled by any acceptable method to ensure safety in handling. Casting shall conform to the requirements of the Standard Specifications for Grey Iron Fittings ASTM A-48, Class “30 B” for rings and “35 B” for covers and the applicable City Standard Details for manholes.

All rings and covers shall be accurately and carefully placed. All rings shall be bedded in a substantial layer of mortar, or a flexible ring seal, shall have a full bearing, and shall be set to the exact grade. Unless otherwise shown, the top of covers shall be flush with, or slightly above, the surrounding surface. When each cover is placed in any position on the ring, the side play shall not exceed one-eighth inch (1/8”) in any direction. Wording and markings on covers shall be in accordance with the City Standard Details.

455.04 EQUIPMENT — VACANT

455.04 CONSTRUCTION METHODS

455.04.01– FOUNDATION

Manholes shall be constructed in a dry excavation. A crushed rock foundation mat shall be constructed under the manhole. The mat shall be a minimum of six inches (6”) thick. Placement of material and material properties shall comply with Section 212.04.04 and in accordance with the plans and the City Standard Details.

455.04.02– BACKFILLING

Backfilling for all manholes shall conform to the requirements of section 212.

455.04.03– MANHOLE TO PIPE CONNECTION AT INVERTS

Manhole to pipe connections shall be made pursuant to manufacturer’s recommendations and the applicable City Standard Details for manhole connections. Grouted connections may be acceptable when connecting like materials such as concrete to concrete. Grouted connections should be made with a pre-packaged non- shrink or expansive grout, properly placed and cure prior to backfill as per grout Manufacturer’s recommendations. When connecting flexible pipes to rigid concrete structures, flexible connectors per ASTM C-923 shall be used. Follow gasket manufacturer’s requirements for installation and pipe

clamping procedures. For manholes built over existing lines or for special conditions, horseshoe shaped openings may be accepted. The City Engineer prior to construction shall approve the method and materials used for grouting any remaining annular space. Flexible pipe seals may be accepted based on Type “D” Certification and a sample, provided that all applicable requirements are met, and that visual inspection 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, head number, or other appropriate identification which can be readily recognized and checked against the certification.

455.04.04– FINISHING MANHOLE TO GRADE

The manhole ring and cover shall be adjusted to grade with concrete grade rings.

Mortar shall be Class D, to which has been added an approved admixture unless otherwise shown on the plans or provided in the special provisions. All work shall be completed and finished in a careful, workmanlike manner.

455.05 TESTING

455.05.01– MANHOLE INSPECTION

After manholes construction has been completed, the manhole shall be visually inspected by the City Engineer for acceptability. Visual inspection shall be done to check for leaks, thin spots, honeycombs, voids, pinholes and conformance with these specifications.

455.05.02– MANHOLE TESTING

Unlike sanitary sewer manholes, it may be acceptable for storm manholes to experience some level of infiltration, therefore no infiltration or vacuum testing is required for manholes used in storm sewer applications.

455.06 METHOD OF MEASUREMENT

Payment for Storm Sewer Manhole shall be made at the unit price bid per each size for a depth of zero (0’) to six feet (6’). The price established shall be full compensation for excavation, backfill, crushed rock foundation, inverts and benches, walls and cones, manhole inserts when specified, ring and cover, removal of existing manhole when necessary or specified or called for on the plans, precast grade ring and all labor, materials, tools, equipment, and incidentals necessary to complete this item of work.

Payment for Extra Depth Manhole Wall shall be made at the unit price bid per vertical foot for each size. The price established shall be full compensation for excavation, backfill, removal of existing manhole, and all labor, materials, tools, equipment, and incidentals necessary to complete this item of work.

Extra depth shall be measured from the invert to within six feet (6’) below top of cover.

455.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	Pay Unit:

(A) (DIAMETER) STORM SEWER MANHOLE (0'-6')	Each
(B) EXTRA DEPTH MANHOLE WALL	Vertical Foot

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with these specifications.

In the absence of pay items for excavation, bedding or embedment materials in a contract, the cost of those items shall be considered incidental to the installation of the manhole structure and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 456 – ADJUSTMENT OF EXISTING MANHOLE

456.01 DESCRIPTION

This section covers various adjustments to existing manholes when called for on the plans or specified. This work may consist of abandoning and plugging, removing, raising, lowering, resetting ring & cover, or setting a new ring & cover on existing manholes.

456.02 MATERIALS

Manhole riser ring skirting and linkage shall be of stainless or galvanized steel and designed for use in storm sewer applications. Skirting shall be formed to produce a radial tension against the sides of the manhole frame when expanded and linkage shall be designed to produce no built-in moments in ring. Ring shall contract and expand without twisting, bending, or binding. Riser ring shall be removable and reusable with no protruding parts that hinder entry into manhole or limit use of equipment. Expandable manhole riser ring shall be as manufactured by American Highway Prod's of Bolivar, Ohio, or an approved equal.

456.03 EQUIPMENT — VACANT

456.04 CONSTRUCTION METHODS

The manhole ring and cover must be adjusted to grade with concrete grade rings or steel risers and installed per manufactures instructions unless the manhole is being abandoned or removed. Steel risers can be expandable and sloped to meet finished grade. The manhole ring and cover must be adjusted to grade with concrete grade rings or course(s) of brick masonry. All brick masonry must meet the requirements of the Material Specifications. Mortar must be Class D, to which has been added an approved admixture unless otherwise shown on the plans or provided in the bidding documents. All brick must be laid in a full bed of mortar and all joints must be shoved joints completely filled with mortar. The joints on the inside face or exposed face of the masonry must be rubbed full and cut as the brickwork is built up. The masonry must be built up in level courses, true to line, grade and dimension. Bats must be used only when necessary to close joints. All brick must be thoroughly wet down immediately before being placed unless otherwise permitted by the City Engineer. All work must be completed and finished in a careful, professional manner. Old brick masonry must be thoroughly cleaned and wetted before joining new masonry thereto. Where a mortar coating is required, it must have the minimum thickness shown on the plans, must be troweled and re-troweled until a uniform, smooth and impervious surface is obtained.

All rings and covers must be accurately and carefully placed. All rings must be bedded in a substantial layer of mortar, or a flexible ring seal, must have a full bearing, and must be set to the exact grade. Unless otherwise shown, the top of covers must be flush with, or slightly above, the surrounding surface. When each cover is placed in any position on the ring, the side play must not exceed one eighth inch (0.125-in) in any direction. All new rings and covers including the wording and markings must be in accordance with the applicable City Standard Details.

A) Abandoning Manhole - This work shall be accomplished in accordance with the applicable City Standard Detail for abandoning manholes. The manhole shall be broken down to a point two (2) feet below proposed or existing grade.

   Manhole shall be filled with sand backfill and shall be compacted to remove all voids in material.

B) Removing Manhole - This work shall be accomplished in accordance with the applicable City Standard Detail for abandoning manholes except the manhole shall be broken down to a point two (2) feet below any proposed construction or totally removed when directed by the City Engineer.

   Any portion of the remaining manhole authorized to remain in place or the void created from the manhole removal, shall be filled with sand backfill and shall be compacted to remove all voids in material.

C) Raising Manhole: Type I - less than or equal to one (1) foot - When called for on the plans or directed by the City Engineer, the manhole shall be raised by using pre-cast concrete grade rings or courses of brick masonry. In no case, however, shall the chimney be greater than one (1) foot in height.

   Once the appropriate raising has been accomplished the existing ring and cover shall be reset to the new grade.

D) Raising Manhole: Type II - greater than one (1) foot - When called for on the plans or directed by the City Engineer, the manhole shall be raised by initially removing the existing corbel or cone. Pre-cast manhole shall then be rebuilt in conformity with the size and shape of requirements for new manholes. Brick or cast-in-place manholes shall then be rebuilt in conformity with the applicable City Standard Detail for rebuilding manholes".

   Once the appropriate raising has been accomplished the existing ring and cover shall be reset to the new grade.

E) Lowering Manhole: Type I - Manhole shall be lowered by removing pre-cast grade rings or courses of brick masonry, such that the frame maintains a minimum of two (2) inches of seat support.

   Once the appropriate lowering has been accomplished the existing ring and cover shall be reset to the new grade.

F) Lowering Manhole: Type II - When the minimum seat support is not available, the corbel, cone, or wall shall be removed to an elevation which will accommodate installation of a pre-cast cone, grade rings, or brick masonry and the ring and cover. The manhole shall be rebuilt in conformance with the applicable City Standard Detail for rebuilding manholes.

   Once the appropriate lowering has been accomplished the existing ring and cover shall be reset to the new grade.

G) Resetting Existing Ring and Cover - Once the appropriate adjustment (raising or lowering) has been accomplished the existing ring and cover shall be reset to the new grade.

The existing ring and cover shall be reset to the desired grade (elevation) by using pre-cast concrete grade rings or brick masonry as further specified in Section 456.04.

H) Setting New Existing Ring and Cover - Once the appropriate lowering has been accomplished the existing ring and cover shall be reset to the new grade.

When existing cast iron fittings are unsound or misshapen or when called for on the plans or directed by the City Engineer, a new ring and cover shall be set to the existing elevation (grade) by use of pre-cast concrete grade rings or brick masonry as further specified in Section 456.04.

I) Raising Manhole Lid - Existing manhole frame and cover must be in good condition and have a minimum one and one quarter (1-1/4) inch deck to accommodate riser ring. Loose rust and debris shall be removed with a wire brush from existing frame prior to installation. Manhole riser shall be installed as directed by the manufacturer as further specified in Section 456.04. Verify proper height and adjustment has been obtained.

In locations where an asphalt surface is not to be placed around the ring, a bead of bituminous or epoxy sealant shall be placed around the exterior circumference where the ring meets the frame before completing surface restoration.

456.05 TESTING — VACANT

456.06 METHOD OF MEASUREMENT

Measurement for Abandoning Manhole shall be made at the unit bid price per each when specified as an item of work. Measurement for Removing Manhole shall be made at the unit price bid per each when specified as an item of work.

Measurement for Raising Manhole (Type I) shall be made at the unit bid price per each when specified as an item of work. Measurement for payment for Raising Manhole (Type II) shall be made from the finish grade to the limit of plan removal unless otherwise directed by the City Engineer.

Measurement for Lowering Manhole (Type I) shall be made at the unit bid price per each when specified as an item of work. Measurement for payment for Lowering Manhole (Type II) shall be made from the finish grade to the limit of plan removal unless otherwise directed by the City Engineer.

Measurement for Resetting Existing Manhole Ring and Cover shall be made at the unit price bid per each when specified as an item of work.

Measurement for Setting New Manhole Ring and Cover shall be made at the unit price bid per each when specified as an item of work.

Measurement for Raising Manhole Lid shall be made at the unit price bid per each ring when specified as an item of work.

456.07 BASIS OF PAYMENT

The City or Awarding Public Agency will pay for each pay item at the contract unit price per the specified pay unit as follows:

Pay Item:	**Pay Unit:**
(A) ABANDONDING MANHOLE (SIZE)	Each

(B) REMOVING MANHOLE (SIZE)	Each
(C) RAISING MANHOLE (TYPE I)	Each
(D) RAISING MANHOLE (TYPE II)	Vertical Foot
(E) LOWERING MANHOLE (TYPE I)	Each
(F) LOWERING MANHOLE (TYPE II)	Vertical Foot
(G) RESETTING EXISTING MANHOLE RING AND COVER	Each
(H) SETTING NEW MANHOLE RING AND COVER	Each
(I) RAISING MANHOLE LID	Each

Payment for Abandoning Manhole shall be made at the unit bid price per each. The price established shall be full compensation for all materials including sand backfill, labor, tools, equipment, and incidentals necessary to complete this item of work. The price established for Removing Manhole shall be full compensation for all materials including sand backfill, labor, tools, equipment, and incidentals necessary to complete this item of work. In the absence of the bid item, the price shall be included in the cost of Storm Sewer Manhole construction.

The price established for all other adjustment pay items shall be full compensation for all materials including excavation, backfill, resurfacing, tools, materials, labor, equipment, and incidentals necessary to complete this item of work.

TABLE OF CONTENTS

SECTION 500 – WATER

SECTION 500 – GENERAL REQUIREMENTS

500.01 – DESCRIPTION

This section applies to the construction, installation, repair, and/or replacement of any water facilities and/or appurtenances on any public property which facilities and/or appurtenances are connected or to be connected, directly or indirectly, to the Oklahoma City water system.

500.01.01 – DEFINITION of TERMS

Additional definitions of terms can be found in section 100.01, “General Provisions, Definition of Terms”

A. adapter – A fitting used to connect pipe, tubing, or other fittings with differing characteristics such as sizes, diameters, or material type.
B. air combination valve - air valve that performs the functions of an air vacuum and air release valve.
C. air vacuum valve – valves that allow air to be exhausted from or admitted into a pipeline as it is being filled or drained.
D. appurtenances – the different devices required for controlling the flow of water, for preventing leakages and for other purposes in water supply system.
E. Awarding Public Agency – The awarding public agency, as defined by the Oklahoma Competitive Bidding Act, entering a public construction contract for a public improvement.
F. Bidding Documents – The documents published by Awarding Public Agency for receipt of bids for a public improvement project, whether or not required to be bid. Bidding Documents also include and incorporate the Standard Specifications, Standard Details, and the project related Notice to Bidders, instructions to bidders, special provisions, plans and specifications.
G. butterfly valve – valves that when operated only allows fluid to flow in one direction through a mechanism with rotating disk set on an axis.
H. chamfer – A bevel made on the end of a thread to facilitate thread engagement, a shaft to help alignment, or the edge of an object to make it not be sharp.
I. check valve - valves that when operated only allows fluid to flow in one direction accomplished by utilizing the weight of the check mechanism, back pressure, spring or a combination of these means
J. City – The City of Oklahoma City.
K. City Engineer – The City Engineer for the City of Oklahoma City or the City employee specifically authorized and designated by the City Engineer.

L. corporation valve (corp stop) – A valve attached to the water line to start a service connection, which is used to interrupt flow during installation or maintenance of the service line.
M. coupling – A fitting for connecting two pipes or tubing sections together.
N. curb valve – A valve installed in the water service line and accessible for operation from the surface of the ground for routinely interrupting flow through the service line normally installed.
O. DIP – Ductile Iron Pipe
P. double detector check – an assembly of two independently operating spring-loaded check valves with a water meter (protected by another check valve or a reduced pressure backflow prevention device, depending upon degree of hazard) connected across the check valves, and with tightly closing shut-off valves on each side of the check valves, plus properly located test cocks for testing each part of the assembly.
Q. driving thread – A thread installed on the outlet end of corporation valves (Corp Stop) and used to hold the valve during installation.
R. dry seal – A type of pipe thread covered by ANSI/ASME B1.20.3. Dry seal pipe threads are based on the USA (American) pipe thread although they differ from the USA (American) pipe thread in that they are designed to seal pressure-tight joints without the need for sealing compounds.
S. Engineer – a professional engineer licensed to practice in the State of Oklahoma contracted to perform services for the person or entity contracting for the design and/or administration of the project.
T. facilities - any building, structure, property, park, open space, water line, storm sewer line or sanitary sewer line leased or operated by the City, its agents, agencies, departments or franchisees.
U. fire hydrants – a outlet valve mechanism that allows tap in an emergency, all fire hydrants referenced in the following specifications are dry barrel hydrants.
V. fitting – A part used to connect piping or tubing.
W. incidental – any work or item, though required, that is not separately called out in the contract for direct payment. The bidder or contractor will not be separately paid for incidental work or items and those costs and expenses will be deemed included and reimbursed through other bid items or lump sum items. The deletion or reduction of a bid item or lump sum item will not give rise to a claim for payment by a contractor alleging the cost or expense of the incidental work or item was included in the deleted or reduced work or item.
X. inlet – The opening in a valve or fitting through which flow from the water line enters the valve or fitting.
Y. meter box and tile – a box and/or structure that protects the water meter and lid/cover (tile) for the meter box and/or structure.
Z. N.P.T. – National Pipe Thread as specified in ANSI/ASME B1.20.1.
AA. OCWUT – Oklahoma City Water Utility Trust
BB. outlet – The opening in a valve or fitting through which flow from the water line leaves the valve or fitting.

CC. Owner – Oklahoma City Water Utility Trust and/or the City of Oklahoma City
DD. PCCP – Pre-Stressed Concrete Cylinder Pipe
EE. PVC – Polyvinyl Chloride
FF. Public Construction Contract – The public construction contract entered by an Awarding Public Agency and a successful bidder/contractor for construction of a public improvement project.
GG. retainer gland – is a gland ring designed to hold the gasket in place at the joint, does not provide thrust restraint.
HH. service line check valve (backflow preventers) – A check valve used to minimize backflow and reduce the potential for contamination of water in the water line if pressure in the water line is reduced, or the customer service pressure is increased.
II. Standard Specifications – The City of Oklahoma City Standard Specifications for Construction of Public Improvements.
JJ. Standard Details – The Standard Details established by the Department of the City of Oklahoma City with responsibility for the system to which the improvement, facilities or structure will be attached or connected.
KK. tapping saddle – A fitting that attaches circumferentially to a pipe to provide for attachment of a corporation valve.
FF. top of curb valve (stop) – the top of the curb valve is the operating nut that can be reached by a curb key or valve key.

500.02 – PREQUALIFICATION

Contractors must be pre-qualified to perform all water construction work as required by the most recent ordinance passed by the Council of the City of Oklahoma City. The Contractor must obtain all permits required by the City of Oklahoma City, State and Federal regulations and laws.

Specific pre-qualification requirements pertain to Section 502, “Water Service Line Connections” and Section 503, “Water Service Lines”.

500.03 – CONSTRUCTION OUTSIDE CITY LIMITS

The Contractor performing work outside the corporate limits of Oklahoma City will comply with all ordinances, regulations, and policies of the county and city wherein the work is located. The Contractor must obtain any permits, provide barricades and lights, and make repairs as required by the responsible authorities. When performing work on any Oklahoma City assets, Contractors must meet all requirements in Section 500, "General Requirements".

500.04 – TEST HOLES

Test hole information, when shown on the project plans or included in the project specifications, must only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole. Each bidder and contractor must make their

own interpretation of the character and condition of the materials that will be encountered between test hole locations. Each bidder and each contractor may, at its own expense, make additional surveys and investigations as deemed necessary to determine conditions which may affect performance of the work.

500.05 – ORDER OF CONSTRUCTION

The contractor must start at enough different locations to complete the entire project within the time limit specified within the contract. Appurtenances must be constructed as soon as the water line that they serve is constructed in accordance with the Project plans. Postponing the construction of appurtenances until the water line has been completed or the building of appurtenances in advance of the construction of the water line will not be permitted.

A. The construction of water lines for more than six hundred feet (600-ft) in advance of appurtenances, which are incomplete or the construction of which has not been started, will not be permitted.

B. Unless otherwise directed by the City Engineer, the contractor must leave no more than three hundred feet (300-ft) between backfilling operations and the complete restoration of paving, paving cut and permanent repairs, driveway permanent repairs, fencing, sodding, etc.

C. When temporary surfacing is provided for within the contract documents and project plans, the contractor must complete temporary surfacing repair immediately before backfilling is completed.

D. Temporary surfacing must be done in accordance with Section 824.02 “Temporary Surfacing – Materials”. Temporary Surfacing with asphalt must be done in accordance with Section 824.02 Part A “Temporary Surfacing – Materials – Asphalt”.

E. All water lines that are to be abandoned in place must be cut to the nearest connection and either capped or plugged as required to provide a watertight connection. Water lines must not be abandoned until all related improvements, connections, and services have been completed, tested, and approved. For Public Construction Contracts, caps or plugs along with any associated joint restraints are incidental and the cost is deemed incidental.

F. Cutting and dewatering of the water lines are considered incidental and costs of these items are deemed incidental. Contractor is responsible for providing the appropriate plug or cap for the work. When an existing valve is abandoned in a grassy area, the box is to be pulled and the top nut removed from the valve and the void from the box filled with soil and compacted level with the surrounding ground surface. When an existing valve is abandoned in a paved area, the valve box is to be filled with concrete.

All materials, labor, tools, and equipment for valve abandonment are considered incidental and costs are included by contractor in other unit bid item prices.

500.06 – DELIVERY OF MATERIALS

Construction materials must not be delivered to the site of the work more than three (3) days in advance of their anticipated use nor can the quantity of pipe or other materials on hand at the site of the work at any time be in excess of the amount required to complete six hundred feet (600-ft) of Water line unless with special permission of the City Engineer.

500.07 – SURFACE DRAINAGE STRUCTURES

When not called for on the plans or specified as a separate bid item, all surface drainage structures and appurtenances must be removed and replaced in a condition equal to or better than the original installation when required. The cost of this work is considered incidental to other items of work.

500.08 – CONCRETE AND STEEL REINFORCEMENT

Unless otherwise specified, all concrete used in the construction of Water lines and appurtenances must be High Early Strength Concrete and have a minimum three (3) day compressive strength of three thousand five hundred pounds per square inch (3,500-psi) and must conform to the applicable requirements of Section 932 “Portland Cement Concrete”. All steel reinforcement used will be grade sixty (60) with a minimum yield strength of sixty thousand pounds per square inch (60,000-psi) and meet the applicable material requirements of Section 900 “Materials”.

500.09 – DEPTH OF COVER

Where not otherwise indicated on plans, the pipe must be laid at an elevation that will provide, after completion, a minimum depth of cover over the top of pipe of four feet (4-ft).

500.10 – STANDARD DESIGN CONDITIONS

A. Standard Design Pressures – Unless otherwise specified, all pipes and fittings must be designed for the following minimum pressure conditions:

Pipe Nominal Size	Minimum Internal Pressure (psi)		
	Working	Surge	Design
≤48	150	100	250
>48	200	200	400

B. Live Loading – Unless otherwise specified or called for on the plans, minimum pipe design corresponding to the specified design pressure must be for highway live loading conditions and where the water line is crossing or running parallel to a railroad, corresponding minimum pipe design for railroad live loading condition must govern (with or without casing).

C. Section Line Pipes – Unless otherwise specified all water lines along section line roads must be greater than twelve inches (>12-in) in diameter.

D. All Pipes – Pipe materials with allowable sizes must be in accordance with the following table.

Pipe Material	Size (Inches)
Pre-Stressed Concrete Embedded Cylinder Pipe (PCCP)	≥48
Polyvinyl Chloride (PVC) Pipe	≤16
Steel Pipe (SP)	≥48
Ductile Iron Pipe (DIP)	≤64

500.11 – CLEAN-UP

A. Water line installation procedures require clean-up operations to follow excavation and construction a distance not to exceed three hundred feet (300-ft).

B. Sodding, seeding, sprigging, and fertilizing operations must be accomplished following completion of water line installation. Sod will be preserved and replaced in areas where heavy sod existed prior to construction.

C. Compaction of trench backfill to 90% standard proctor density will be required. Test will be performed to assure density. The cost of this work will be included in the cost per linear foot of the water line construction. Areas to be paved must be compacted to 95% standard proctor density.

500.12 - WARRANTY

In exchange for permission to construct, install, repair, or replace any water line, water service line, water meter, water facilities, and appurtenances, the Contractor warrants the water line and appurtenances are free of all defects and in compliance with Standard Specifications until acceptance by The City of Oklahoma City and for such maintenance period after acceptance provided in Standard Specifications.

The Contractor will perform any required warranty work and maintenance on any water line, water service line, water meters, water facilities and appurtenances they construct, install, repair, or replace to bring said water service lines, water meters, meter facilities

and appurtenances in compliance with Standard Specifications, regardless of cause, until the expiration of the maintenance period following acceptance by The City of Oklahoma City.

A. Warranty and maintenance work includes, but is not limited to the following:

    1. Repair, replace, raise, lower, level, relocate, or re-install any broken, missing, or improperly located water line, water service line, water meter/pit, water facilities and appurtenances regardless of cause.

    2. Repair or replace any other construction, installation, labor, workmanship, or material defects to any water line, water service line, water meter/pit, water facilities and appurtenances regardless of cause.

    3. Any other repair, replacement, re-installation, or relocation necessary for any water line, water service line, water meter/pit, water facilities and appurtenances to comply with Standard Specifications, the Oklahoma City Municipal Code, or standard specifications adopted by The City of Oklahoma City, regardless of cause.

All warranty work will be performed at no cost to the City or the OCWUT.

500.13 - AS-BUILT DRAWINGS

A. As-built drawings must be submitted and received within 45 days after the final inspection for all newly constructed water service lines, water meters, and meter facilities and appurtenances.
B. Prior to the release and installation of any water meter or commencement of water service, as-built drawings must be submitted and received, which is a condition of acceptance by the City of Oklahoma City.

SECTION 501 – PIPE AND FITTINGS INSTALLATION

501.01 – DESCRIPTION

This section covers installation of pipes in open cuts, in conformity with the lines, grades, and dimensions and as provided in applicable sections of Standard Specifications.

501.02 – MATERIALS

501.02.01 – PIPE AND FITTINGS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Flexible	Polyvinyl Chloride (PVC) Pipe	515
	Steel Pipe	517
	Ductile Iron Pipe (DIP)	514

501.02.02 – EMBEDMENT

A. General – Embedment material must meet the requirements of Section 215 “Embedment Material”. Prior to delivery, the Contractor must submit laboratory tests for materials to be used for embedment and backfill. Materials must be approved by the City Engineer prior to placement.

B. Invoices – The Contractor must submit invoices for the purpose of complying with the minimum quantities necessary to complete installation pursuant to the appropriate Standard Details and the minimum dimensions specified.

501.03 – CONSTRUCTION METHODS

501.03.01 – BEDDING AND HAUNCHING.

A. Polyvinyl Chloride (PVC) Pipe – All PVC pipe less than or equal to sixteen inches (16-in) must be embedded in accordance with ASTM D-2774, "Standard Recommended Practice for Underground installation of Thermoplastic Pressure Piping", ATSM F645-18b “Standard Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping” and ASTM F1668-16 “Standard Construction Procedures for Buried Plastic Pipe”, and as shown on the standard detail “Bedding and Trenching Details - PVC Pipe” and meeting the requirements of Section 515 “Polyvinyl Chloride (PVC) Pipe”.

B. Steel Pipe – All steel pipes must be embedded as shown on the Standard Details and meeting the requirements of Section 517 “Steel Pipe”.

C. Ductile Iron Pipe (DIP) – All ductile iron pipe less than or equal to twelve inches (≤12-in) in diameter must be embedded in accordance with the requirements of Section 514 “Ductile Iron Pipe (DIP)” and as shown on the Standard Details.

   All ductile iron pipes greater than twelve inches (≥12-in) in diameter must be embedded in accordance with AWWA C-150, “Thickness Design of Ductile-Iron Pipe”, Type 4 or Type 5 Laying Condition as modified in the Standard Details and meet the requirements of Section 514 “Ductile Iron Pipe (DIP)”.

501.03.02 – INSTALLATION REQUIREMENTS

A. Shipping, Handling and Storage – Pipe must be transported from the plant, where it is manufactured, to the job site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the job site, it must be carefully inspected for any damage that may have occurred in transit. The pipe must be handled at all times with care using padded slings or hooks. The pipe cannot be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe will be rejected. All pipe and accessories must be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe must be stored in a cool location out of direct sunlight in accordance with the manufacturer's recommendations.

B. Pipe Foundation – No water line will be laid unless the foundation is in a condition satisfactory to the City Engineer. Where trenches are excavated in soft, unsuitable, or rock, trench bottom will be stabilized in accordance with Section 215 “Embedment Material”, when directed by the City Engineer.

C. Trench Dewatering – The Contractor must keep stormwater and stream water out of the trench. The Contractor must maintain groundwater level below pipe and rip-rap.

D. Laying Requirements – All pipes, specials, fittings and other appurtenances must be examined carefully for damage and other defects before installation. The City retains the right to reject damaged and defective materials.

   1. The pipe ends must be free of all lumps and blisters and they must be wiped clean of foreign materials such as dirt and sand before installation.

   2. Pipe must be laid with the bell ends facing in the direction of laying unless directed otherwise by the City Engineer. Where pipe is laid on a slope equal to or greater than ten percent (≥10%) laying must start at the bottom and proceed up the slope.

   3. When laying pipe is not in progress, the open ends of the pipe must be closed by watertight plugs. If water is in the trench the plugs must be left in place until the trench is pumped dry.

   4. Bell holes for bell-and-spigot pipe must be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes must be large enough to permit proper installation of pipe. Bell holes cannot be excavated more than ten (10) joints ahead of pipe laying. Filling and ramming earth or other material beneath the pipe to raise it to grade will not be permitted.

5. The Contractor must use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances must be lowered carefully into the trench with suitable equipment to prevent damage to the pipeline materials. In rock trenches, plywood shields or other approved means can be used to prevent the cradled pipe from swinging against the sides of the trench.

6. All joint preparation and joining operations must comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section. Rubber gaskets must be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces must be coated with the lubricant furnished with the pipe.

7. Any damage to the pipe or joint gaskets from any cause during installation of the pipeline will require replacement at the expense of the Contractor.

8. After a section of pipe is properly installed and approved for backfill, the trench must be backfilled and compacted as per Section 212 “Trench Excavation and Backfill”.

9. No building or structure must be within ten-foot (10-ft) from the centerline of water line.

E. Wet Connections - for tie-in to existing water lines. Wet connections consist of isolating sections of water line to be connected with existing valves, draining the isolated sections, and completing the connections. The connections must be either a cross or tee as called for on the plans where tapping is not allowed. The wet connection must begin with isolating the point of tie-in by closing existing valves. The existing water line must then be cut where a wet connection is to be made and the line drained. Wet Connections and all labor, materials, tool, equipment necessary to complete the item of work are incidental, unless otherwise specifically provided by a separate bid item in the Bidding Documents.

501.04 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Water line Pipe" must be made at the unit price bid per linear foot of pipe installed for each size. The price established must be full compensation for all materials including pipe, short pieces and specials, embedment material, labor, tools, equipment, and incidentals necessary to complete this item of work. "Water line Pipe" must be measured along the pipe, through fittings and valves.

For pipes less than or equal to sixteen inches (16-in) in diameter, payment for fitting will be paid for by pounds. For pipes greater than sixteen inches (16-in) payment for fittings

will be made at price bid for each fitting type. The price established must be full compensation for all materials including fittings, embedment material, deadman when necessary, thrust blocks when necessary, labor, tools, equipment, and incidentals necessary to complete this item of work.

501.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) (TYPE) WATER LINE PIPE (JOINT TYPE)(NOM WALL THICK)	L.F.
FITTINGS (SIZE AND TYPE)	LBS.
FITTINGS (SIZE AND TYPE)	EA.

SECTION 502 – WATER SERVICE LINE CONNECTIONS

502.01 – DESCRIPTION

502.01.01 – GENERAL

This section covers water service line connections for use in buried service lines from the main to the meter valve or meter setting appurtenance in accordance with ANSI/AWWA C-800 “Standard for Underground Service Line Valves and Fittings”, or as modified herein. All water service lines will be connected as per City ordinances, Standard Specifications and Standard Details. All new taps for service lines must be a minimum of one inch (1-in).

502.01.02 – PREQUALIFICATION REQUIRMENTS

The installation of meters requires prequalification authorization through the City of Oklahoma City. Contractors must be prequalified by the City to be able to perform main tapping and meter installation work and comply with the most recent ordinance requirements.

A. Service connections cannot be larger than two inches (2-in), and mains cannot exceed twelve inches (12-in) in diameter.

B. Contractors must be prequalified by the City to set meters and tap mains.

C. If the Contractor is not prequalified, contractor must contract with a prequalified subcontractor or prequalified individuals

502.01.03 – TYPES

A short service line is a line not in excess of ten feet (10-in). All services more than ten feet (10-ft) will be considered long service lines. Extra-long services are used for special circumstances and must be noted on the plans. Service lines will be single service unless otherwise directed by the City Engineer. All long service lines of PEX-a material will require a SCH 40 PVC casing pipe under street and/or sidewalks.

502.02 – MATERIALS

A. Castings – Materials in contact with potable water must be made from brass alloy and cannot contain more than 0.25% lead by weight per United States Public Law 111-380. The brass alloy used for all surfaces coming in contact with potable water must meet the requirements of UNS/CDA No. C89833.

B. Component Parts – Component parts such as fasteners, seals, and packing may be of other materials selected for adequate endurance, corrosion resistance, and strength.

C. Service Lines - All service lines must be seamless copper tubing of the designation, "Type K" or Crosslinked Polyethylene “PEX-a” piping. All fittings must be brass or copper. Substitutions such as plastic or PVC fittings will not be accepted. One inch (1-in) service lines meter tailpieces will be "Type K" copper or Crosslinked Polyethylene “PEX-a” in composition and eighteen inches (18-in) in length. A brass male or female union will be required for the last fitting on the City side of the water service. Said union will not include plastic or galvanized materials and must be compression type fitting. No “SharkBite” type fittings are allowed.

1. Copper Tubing

    a) Copper tubing must be “Type K”.

    b) All fittings must be brass or copper.

    c) All Service lines, requires 18-in tailpiece.

    d) A brass male or female union is required for the last fitting on the City side of the water service.

    e) No “SharkBite” type fittings are allowed.

2. PEX-a PIPE

    a) Can only be used for one-inch (1”) and smaller service lines.

    b) Crosslinked polyethylene (PEX-a) municipal water service pipe to be manufactured using high pressure peroxide method of crosslinking.

c) Pipe must be certified to AWWA C-904, “Cross-linked Polyethylene (PEX) Pressure Pipe”, by approved testing agency.

d) Pipe must be certified to standards ASTM F876, CSA B137.5, NSF 14 and NSF 61, by approved testing agencies, with a standard materials designation of 3306 or 5306.

e) Pipe must demonstrate ability to satisfy the performance requirements of section F.7 of PPI TR-3 for PE materials to apply a 0.63 design factor resulting in a temperature/pressure rating of: 200 psi A 73.4°F (1380 kPa @ 23C)

f) Pipe must be rated for:
   i) 160 psi @ 73.4 (1103 kPa @ 23C)
   ii) 100 psi @ 180 (690 kPa @ 82C) per PPI TR-4

g) Pipe must have a co-extruded UV shield made from UV-resistant high-density polyethylene, color Blue.

h) Pipe must have minimum exposure of six (6) months when tested in accordance with ASTM F2657, or as per manufacturer’s recommendations.

i) Pipe must be compatible with cold-expansion compression-sleeve fittings certified to ASTM F2080 for installations as cold as -40F (-40C)

j) Pipe must be approved for use with AWWA C-800 fittings when using manufacturer’s recommended insert or stiffener.

k) Pipe must be approved by manufacturer and the City Engineer to be repaired using hot air, if kinked in the field.

l) Pipe must have the minimum markings: PEXa 3306 or 5306, CSA B137.5, ASTM F876, F2023 and F2080, NSF-pw-g

m) A brass male or female union must be required for the last fitting on the City side of water service compression type fitting.

n) No “SharkBite” type connections are allowed.

3. Meter Setter

    a) Meter Setters are only required when using PEX-a pipe for service line connection to the water main.

    b) All brass that comes in contact with potable water must conform to AWWA Standard C-800 (ASTM B584, UNS C89833). The product has the letters “NL” cast into the main body for lead-free identification.

    c) Brass components that do not come in contact with potable water conform to AWWA Standard C800 (ASTM B-62 and ASTM B584, UNS C83600, 85-5-5).

    d) Copper conforms to ASTM B75 or B88, UNS C12200.

    e) Saddle nuts hold the meter in place for tightening.

    f) Must include lock wind ground key angle meter stop.

    g) Must have packing joints connections for service lines.

4. Tracer Wire

    a) Tracer to be 12-gauge copper and must have a thermoplastic insulation/nylon sheath to protect against abrasion, heat, moisture, oil, and gasoline.

    b) Tracer Wire to be secured to service line from water main to meter with one and one-half inch (1-1/2 in) polyethylene tapped wrapped around twice with a maximum distance of ten (10) feet between tapped locations. Minimum of two (2) locations is required on all service lines.

    c) Secure tracer wire to meter setter with stainless steel clamp or other approved method by City Engineer.

5. Fittings

    a) All fittings must be brass compression joint fittings which must be manufactured in accordance with AWWA C-800.

    b) b) No crimp or clamp still fittings or valves will be allowed.

    c) No "Sharkbite" type fittings or valves will be allowed.

502.02.01 – DESIGN OF VALVES AND FITTINGS

General – Valves, fittings, and parts thereof will be machined to the sizes and tolerances defined in AWWA C-800 “Underground Service Line Valves and Fittings”. End connections may be threaded, brazed, compression, or flared as appropriate.

Pressure Rating – Service line valves and fittings must be suitable for use with water at one hundred degrees (100º) Fahrenheit and one hundred fifty pounds per square inch (150-psi) pressure.

502.02.02 – DETAILED DESIGN OF VALVES AND FITTINGS

Dimensions of Corporation Valves:

A. General – Corporation valves must be installed with drilling or tapping machines. Unless otherwise specified, the minimum inside diameter of the waterway through a corporation valve must be large enough to accommodate the maximum drill sizes herein. Maximum drill sizes for installation of corporation valves and service clamps or saddles with a driving machine will be as shown below.

Corporation Valve Size (Inches)	Maximum Drill Size	
	Corporation Valve with AWWA Thread Inlet	Corporation Valve with N.P.T Thread Inlet
5/8	9/16	--
3/4	11/16	11/16
1	15/16	7/8
1-1/4	1-3/16	1-1/8
1-1/2	1-7/16	17/16
2	1-7/8	1-3/4

B. Overall Body Dimensions – For corporation valves to be installed by a tapping machine, overall body dimensions must conform to the dimensions listed below.

Corporation Valve Size (inches)	Maximum Radius (inches)	Maximum Length (less nut) (inches)
5/8	1-1/2	4-5/8
¾	1-1/2	4-5/8
1	1-1/2	4-5/8
1-1/4	2-1/2	9-1/16
1-1/2	2-1/2	9-1/16
2	2-1/2	9-1/16

C. Tapping Saddles – Tapping Saddles must conform to the requirements of Section 521, “Tapping Saddles”.

D. Tapping Sleeves - Tapping Sleeves must conform to the requirements of Section 520, "Tapping Sleeves".

E. Service Line Fittings

1. General – The fittings used in service lines must be designed for connection to the service line by threads, brazing compression, and/or flaring. No “Sharkbite” fittings are allowed. Small waterways and abrupt corners causing water turbulence and pressure drop must be minimized.

2. Solder for Service Line Fittings – When solder is used with fittings, it must be "lead free" with a maximum lead content of no more than two-tenths percent (0.2%) as defined in the 1986 amendments to the Safe Drinking Water Act (SDWA).

F. Service Line Check Valve – Check valves may be of an angle design or straight-through design, with good fluid-flow characteristics. The spring must be strong enough to resist opening with a one pound per square inch (1-psi) pressure in the direction of flow. The check valve must be field repairable without removing the valve body from the service line.

510.02.03 – END CONNECTIONS

End connections for must be in conformance with AWWA C-800 “Underground Service Line Valves and Fittings”.

502.03 - NOT USED

502.04 – CONSTRUCTION METHODS

502.04.01 – GENERAL

The following are general connection requirements only. Additionally, Plumbing Code, as adopted by City ordinance, and other requirements may be applicable, which are not included herein.

A. Single taps must be in accordance with the Standard Details. When two (2) or more taps are to be made, they must be a minimum of thirty-six inches (36-in) apart and alternate as shown on the Standard Details.

B. Back/reverse tap will not be allowed unless if directed by the City Engineer.

C. No tap for domestic services will be allowed on fire lines.

D. A minimum of one-inch (1-in) tap and one-inch (1-in) water service line is required whenever a new tap is made for water service; however, existing water service lines may be replaced with the original size water service line if no new tap is required or made.

E. When tapping dedicated fire-lines for irrigation service lines, the tap must be made prior to any meter, valve, and/or the double detector check and will have a separate meter. A gate valve is required on the inlet side of the double detector check on the property line to delineate private and public service

F. Direct taps are allowed in water lines up to twenty inches (20-in) in diameter. Taps into water lines greater than twenty inches (20-in) will require a main extension of a size not less than eight inches (8-in) in diameter.

G. Tapping saddles with "Coated Service Saddle with Double Stainless Steel Straps" may be used for three quarter inch (0.75-in) to two inch (2-in) service line connections on mains two (2-in) to twenty inch (20-in) diameter. Tapping saddle must also conform with the requirement of Section 521 “Tapping Saddles”. All other taps must be accomplished using tapping sleeves in accordance with Section 520 “Tapping Sleeves”.

H. When tapping saddles or sleeves are installed a pressure test must be performed. Saddles must hold a minimum of eighty pounds per square inch (80-psi) of pressure for thirty (30) minutes.

I. When reconnecting to existing three inch (3-in) services, reducing of tapping saddles will only be allowed for a three inch (3-in) service. A four inch (4-in) tap can be allowed with a four inch (4-in) by three inch (3-in) reducer from the tapping saddle. No other reductions of the tapping saddles will be allowed.

J. Service connections two inches (2-in) and smaller must be by corporation valve (stop) of the same size as the water service line and meter to be installed. Corporation valves will be as specified in Section 502 “Water line Service Connections”. Service connections to the main for water service lines larger than two inches (2-in) must be a branch connection and must comply with Standard Specifications.

K. Service connections to all ferrous mains must be electrically insulated by means of an approved insulating fitting. Care must be taken to properly install corporation valves and provide enough slack in water service lines to protect against pullout.

L. Insulated fittings must comply to the requirements of AWWA C-800, “Underground Service Line Valves and Fittings”. The insulated fitting and adjacent pipe must be wrapped with at least three (3) feet in both directions from the insulator to avoid the possibility of stray currents traveling through the soil around the insulator. The wrap material must be eight (8) mils thick polyethylene encasement complying to AWWA C105/ANSI A 21.5, “Polyethylene Encasement for Ductile-Iron Pipe Systems”.

M. Under no circumstances is an asbestos-cement pipe to receive a corporation valve. Machined-over-all (MOA) polyvinyl chloride pipe may receive a corporation valve.

N. Asbestos-cement pipe must be replaced when discovered with pipe of existing size with and approved material as specified in Standard Specifications.

O. When tapping mains where it is necessary to remove part of the polyethylene wrapping, the polyethylene wrap must be repaired or replaced in such a manner as to protect both the pipe and corporation valve. Any bedding material removed during excavation will be replaced in kind and compacted.

P. No tees will be connected to existing water service lines three inches (3-in) and smaller in diameter providing water to a single meter of the same size.

Q. All taps must be performed in the presence of an Oklahoma City Inspector and/or Designee.

R. All water service line and meter facility installations must be inspected and approved before being covered and before water service may be commenced through such water meter and/or water service line.

S. All trenches and excavations must meet applicable federal (including but no limited to OSHA), State of Oklahoma, and these Standard Specifications.

T. The soil in and around trench for the water service line, must be compacted to not permit a crimp in water service line to occur. Must compact the soil by hand and/or machine in a manner that will avoid crimping the water service line when backfilled. Crimped water service lines must be replaced.

U. All necessary easements must be dedicated and accepted by formal action of the City prior to commencement of any public water main tap or the construction, installation, repair, or replacement of any public water service line.

V. Service lines may not be dead ended under or within five-feet (5-ft) of structures, driveways, roads, sidewalks, parking areas, or any area used or to be used for vehicular or pedestrian traffic.

W. Water service lines must be free from crimps and must include a ball valve between the corporation stop and the meter setter. Crimped water service lines must be replaced.

502.04.02 – AFFIDAVIT OF COMPLIANCE

The Contractor must provide an affidavit of compliance that valves, and fittings furnished comply with all provisions of these Standard Specifications.

502.05 – TESTING

Any valves or fittings found defective must be replaced with new valves or fittings at the Contractor's expense.

502.06 – METHOD OF MEASUREMENT – Public Construction Contracts

The price established will be full compensation for all materials including service lines, boring, fittings and when required service line check valve, tapping saddles, connections to meter, labor, tools, equipment, and incidentals necessary to complete this item of work.

502.07 – BASIS OF PAYMENT – Public Construction Contracts

The items as provided above will be paid for at the contract unit price bid: as specified in Section 503, "Water Service Lines"

SECTION 503 – WATER SERVICE LINES

503.01 – DESCRIPTION

503.01.01 – GENERAL

This section covers water service lines intended to be used from the connection to the meter valve for meter setting appurtenance in accordance with AWWA C-800 “Underground Service Line Valves and Fittings”, or as modified herein. All water service lines must be connected as per City ordinances.

503.01.02 – TYPES

A short service line is a line not in excess of ten feet (10-in). All services in excess of ten feet (10-ft) will be considered long service lines. Extra-long services are used for special circumstances and must be noted on the plans. Service lines will be single service unless otherwise directed by the City Engineer. All long service lines will require a SCH 40 PVC casing pipe under street and/or sidewalks for service lines for one inch (1-in) or less.

503.02 – MATERIALS

All service lines must be seamless copper tubing of the designation, "Type K" or Crosslinked Polyethylene “PEX-a” piping. All fittings must be brass or copper. Substitutions such as plastic or PVC fittings will not be accepted. One inch (1-in) service lines meter tailpieces will be "Type K" copper or Crosslinked Polyethylene “PEX-a” in composition and eighteen inches (18-in) in length. A brass male or female union will be required for the last fitting on the City side of the water service. Said union will not include plastic or galvanized materials and must be compression type fitting. No “SharkBite” type fittings are allowed. Refer to Section 502 “Water Service Line Connections”

503.04 – CONSTRUCTION METHODS

The following are general construction requirements only. Additionally, Plumbing Code and other requirements may be applicable, which are not included herein.

A. General – Service lines must be one-inch (1”) and larger for new installations. Existing service lines three-quarters inch (3/4"0 and smaller may be replaced with the original size. Joints in water lines less than one and one-half inch (1.5-in) in diameter must not be soldered. No unnecessary unions must be permitted.

B. Boring / Casing (PEX only)

1. Service lines under street pavement will not be spliced.
2. Street bores must be a minimum of thirty inches (30-in) below the bottom of the street. The bottom of the street is no less than the depth shown on the Standard Details.

3. Bores for service lines must not be larger than the casing pipe
4. All long service with material type PEX-a must be encased under existing or proposed roads and/or sidewalks by trenching or boring with SCH 40 PVC.
5. Copper Service lines do not require PVC casing pipe.
6. Encasement pipe must extend twelve inches (12-in) past curb lines.
7. Service line bores must be level and at the same depth as the main.

CASING SIZE FOR SERVICE LINES				
Service Line Size		Casing Size		
Nominal	O.D.	Nominal	I.D.	O.D.
1”	1.13	1-1/2”	1.59	1.90

C. Service Line Splits - One and one-half inch (1-1/2") in diameter water services lines may only be split as follows:

1. Each one and one-half inch (1-1/2") in diameter water service line may be split to serve three (3) five-eights inch (5/8") water meters or two (2) one-inch (1") water meters.

2. Water meters be of the same size and cannot mix or match sizes.

3. Water service line splits must be identified and pay item(s) match the size of the service line to main.

D. Service Line Splits - Two-inch (2") diameter water service line may only be split as follows:

1. Each two-inch (2") diameter water service lines may be split to serve up to four (4) five-eighths inch (5/8") water meters or three (3) one-inch (1") water meters.

2. Water meters must be of the same size and cannot mix or match sizes.

3. Water service line splits must be identified and pay item(s) match the size of the service line to main.

503.05 – METHOD OF MEASUREMENT – Public Construction Contracts

The price established will be full compensation for all materials including service lines, tracing wire, boring, fittings, meter setter and when required service line check valve, connections to meter, meter box and tile labor, tools, equipment, and incidentals necessary to complete this item of work.

503.06 – BASIS OF PAYMENT – Public Construction Contracts

The items measured as provided above will be paid for at the contract unit price bid:

DOUBLE SERVICE (SIZE)	EA.
SINGLE SHORT SERVICE (SIZE)	EA.
SINGLE LONG SERVICE (SIZE)	EA.
SINGLE EXTRA LONG SERVICE (SIZE)	EA.

SECTION 504 – METERS/ METER RELOCATION

504.01 – DESCRIPTION

This section covers the installation of water meters relocation as called for on the plans and Specifications or as directed by the City Engineer.

504.02 – MATERIALS

A. General

1. The installation of water meters requires a prequalification. Contractor's must be prequalified by the City to perform main tapping and water meter installation work.

2. Water Meters that are three inches (3-in) and larger in diameter must be compound meters. For water meters eight inches (8-in) in diameter and larger, the compound water meter will be a fire service assembly meter.

3. Turbine water meters must be replaced when the condition of the meter is beyond a state that can be corrected with minor repairs or when the meter has reached the end of its useful life.

4. Elbows, tees, and wyes will not be allowed on the City side of meters larger than two-inches (2-in). Wyes and tees will be allowed only for service splits of one and one-half inch (1.5-in) and two inch (2-in) services.

5. Isolation valves must be a minimum of five (5) pipe diameters on the City side of meter, and two (2) pipe diameters on the customer side of meter.

6. Throttling valves, check valves, backflow preventers and pressure-regulating devices must be no closer than twenty (20) pipe diameters outside of the meter on the customer side. Under no circumstance will these valves be allowed in the same pit/vault with the meter.

7. One and one-half inch (1.5-in) and larger meters must be set on blocks a minimum of twelve inches (12-in) above the floor of the pit and must be centered in the pit and must have a minimum of eighteen-inch (18-in) clearance between the outside of the meter and the inside of the pit/vault wall.

8. Water Meter Vaults for meters three inches (3-in) and larger must have a minimum unobstructed pipe length equal to five (5) and two (2) times the diameter of pipe on the City and customer side of meter, respectively.

9. No water meter may be installed until the property to be served has been assigned a permanent address, street signs and house numbers have been established, and the permanent address including street name and house number are visible on site.

10. Water meters, water meter pits/vaults, and water meter tiles must be located in unpaved areas upon the property being served within public right-of-way or Oklahoma City utility easement unless written approval is granted from the Utilities Department.

B. Strainers

1. Two-inch (2-in) compound meters must be set with strainers. All three inch (3-in) and larger meters, whether compound or turbine, must be set with strainers.

2. Strainers on all meters from two inches (2-in) to six inches (6-in) must be bronze. Strainers on all meters eight inches (8-in) or larger will be cast iron or ductile iron.

3. Backflow Preventers

(a) Backflow preventers will be required for all service connections in conjunction with fire or lawn sprinkler systems or swimming pools.

(b) Services supplying water that could be chemically treated in-line within the system will require backflow preventers. Water connection and services with frost-free spigots, require backflow preventers.

(c) Meters will not be installed until a backflow preventer has been installed.

(d) Backflow prevention devices will be installed on the customer's side of the meter.

(e) Backflow prevention devices must meet the standards set forth in the most recent Plumbing Code set forth or incorporated in the Oklahoma City Municipal Code and comply with the requirements of AWWA M-14

"Backflow Prevention and Cross-Connection Control: Recommended Practices".

504.03 – CONSTRUCTION METHODS

The following are general installation requirements only. Additionally, Plumbing Code and other requirements may be applicable, which are not included herein.

A. Water Meters

1. Meters will not be installed unless the foundation of the structure is complete. Meters will not be installed unless the private service line is in place in accordance with the most recent Plumbing Code set forth or incorporated in the Oklahoma City Municipal Code.

2. After the service and the private service line are installed and meter is set, and before service is backfilled, the corporation connection must be turned on to check for leaks in the service line, corporation valve and meter.

3. An approved backflow prevention device must be installed before irrigation meters are set. Irrigation meters must have a service separate from the private line or acceptable service tap on fire lines and separate meter pit or tile. Any meter that services a fire sprinkler, irrigation for landscaping, or directly services a swimming pool is considered an "irrigation meter" and requires the same installation procedures as a domestic meter with the exception that a backflow prevention device must be present between the meter and the sprinkler system before the meter can be set.

4. For three-quarter inch (0.75-in) to one inch (1-in) water service lines, the top of curb valve (stop) must be eighteen inches (18-in) to twenty-four inches (24-in) below inside top of meter box.

5. All water meters and meter pits must be installed on City property, easement, or right-of-way.

6. When water service cannot be interrupted for the purpose of meter relocation, a metered bypass around the meter must be installed.

B. Meter Boxes

1. Meter boxes must be set on firm unpaved surfaces (grassy areas) and away from sidewalks and drives.

2. The top of meter box must be set at grade level. If the ground is not to final grade at the time of the installation of the meter box and tile, then the installing

Contractor must raise or lower the meter box when the final grade is established.

3. In pedestrian and vehicular traffic areas or areas surrounded by pavement or concrete, a poured-in-place meter pit or box with cover will be installed in accordance with the Standard Details. Under no circumstances are corrugated steel meter boxes to be used.

4. A "W" must be cut in the curb on the City side of meter location and painted blue in color.

C. Meter Pits/Vaults

1. Pits/Vaults for meters of three inches (3-in) and larger in diameter must comply with the Standard Detail for meter vaults.

2. The pit/vault wall through which the inlet/outlet pipe passes must be properly sealed with bituminous material.

D. Meter Relocation

1. All labor and materials necessary for a meter relocation includes the removal and reinstallation of the meter box tile, complete with appurtenances, and reconnection to the private service line within the right-of-way or easement.

2. When the existing meter tile or setter is in poor condition, the Contractor will furnish a new meter tile and setter at no additional cost to the City. All work not classified as a unit bid item is considered incidental and the cost must be included in the unit bid item price.

3. If the existing meter is damaged and not functioning properly the City Engineer will be notified and will coordinate with the City to replace or require the contractor replace the water meter.

4. All water service line taps, bores, casings or paving cuts must be included in the cost of the unit bid item price.

504.05 – METHOD OF MEASUREMENT

Payment for "Meter Relocation" will be made at the unit price bid per each, for each size. The price established must be full compensation for all materials including valves, fittings, meter lock, meter pit, labor, tools, equipment, and incidentals necessary to complete this item of work.

Payment for new installation of meters and meter boxes will be included as described in Section 503 - "Water Service Lines ".

504.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

METER RELOCATION (SIZE) EA.

SECTION 505 – TAPPING CONNECTIONS

505.01 – DESCRIPTION

This section covers water line tapping for water main connections for water mains sizes four inch (4-in) to forty-eight inch (48-in) in diameter.

505.02 – MATERIALS

The following materials must be used and meet the requirements of the appropriate Sections listed below.

Tapping Mechanism	Section
Tapping Sleeves	520
Tapping Valves	511

505.03 – CONSTRUCTION METHODS

A. Description – A tap is the cutting of a coupon, utilizing a tapping sleeve or saddle with tapping valve for a connection to the water line.

B. Methods
   1. Direct Taps – Direct taps must be made when the Water line to be tapped is on the same horizontal plane as the branch. The cutting operation is to be done with a sharp shell cutter-tool, which will be lubricated with the manufacturer's recommended cutting tool lubricant.

   2. Swing Ties – Swing ties must be made when the main to be tapped is either above or below the branch when called for on the plans or specifications. A swing tie may consist of:
      a) Water line pipe
      b) Tapping sleeve as necessary
      c) Tapping valve and Box

d) Tap
e) Solid sleeve
f) Ninety-degree (90 degree°) bends

505.04 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Tap" must be made at the unit price bid per each for each size to be installed. Unit price includes all materials, labor, equipment, and incidentals necessary to complete the item. Incidentals include but are not limited to the tapping sleeve, sleeve closure pieces, tapping valve, box, and fittings.

505.05 – BASIS OF PAYMENT – Public Construction Contracts

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) TAP EA.

SECTION 506 – FIRE LINES

506.01 – DESCRIPTION

This section covers construction of fire lines and installation of associated appurtenances, including, but not limited to, fire flow meter vaults, as described herein.

A fire line will be considered a private water line, which exclusively serves fire hydrants, located on private property or which serves fire sprinkler or fire standpipe systems located on private property.

Construction of fire lines and associated appurtenances must comply with the applicable requirements of the most recent Plumbing Code and Fire Code set forth or incorporated in the Oklahoma City Municipal Code.

A double detector check valve of a type and manufacture as described herein must be installed on fire line and will be used to detect the possible leakage or misuse of water and provide a positive separation between the City’s domestic water system and automatic fire sprinkler systems. The double detector check valve with bypass meter, with a check valve in the bypass, will be used as the service inlet to all fire lines.

506.02 – MATERIALS

Double detector check valves must be iron body, bronze seat, or disk ring, designed for a bypass meter, flanged or mechanical joint ends, and must be approved by Underwriter's Laboratories, Inc., or Factory Mutual Laboratories. Double detector check valves must be approved by the American Society of Sanitation City Engineering (ASSE). Upon

request of the City Engineer, the manufacture must furnish a certificate of compliance and acceptance by ASSE.

506.02.01 – FIRE HYDRANTS

Fire hydrants must conform to the requirements of Section 507 “Fire Hydrants” and the appropriate Standard Details.

506.02.02 – BYPASS METER

Double detector check valves serving fire lines, regardless of the type of system they serve, must be equipped with a bypass meter in an approved pit or vault located on private property near the right-of-way or utility easement. The double detector check valve and bypass meter must be installed in the system prior to any other appurtenances, in an accessible location for periodic inspections by the Fire Department. Bypass meters must conform to the latest ASSE Standard #1048 and ASSE Standard #1047.

506.02.03 – ISOLATION VALVE

Isolation valves must be gate valves conforming to the requirements of Section 511 “Water Valves”. Isolation valves must be installed on all fire system lines serving fire sprinkler or fire standpipe systems and must be located on public right-of-way.

506.02.04 – FIRE STANDPIPE

Fire standpipes must be installed pursuant to the requirements of the applicable sections of the Oklahoma City Code for Fire Prevention and Protection.

506.02.05 – METER VAULT

Meter vaults must be constructed to the dimensions shown in the Standard Details.

506.03 – CONSTRUCTION METHODS

Connections for fire hydrants leads must be three feet (3-ft) apart from any other fitting or tap. Construction of fire-lines and appurtenances must conform to the appropriate Standard Detail for Fire-line Construction.

506.04 – BASIS OF PAYMENT – Public Construction Contracts

Payment for Fire-lines must be pursuant to the bid items as established in the Contract Documents and must include compensation in full for furnishing all materials, labor,

equipment, tools, and incidentals, and for performing the work in accordance with Standard Specifications.

SECTION 507 – FIRE HYDRANTS

507.01 – DESCRIPTION

This section covers fire hydrants intended to be used for fire protection when specified or called for on the plans. The hydrant must be located and positioned in such a way as to be accessible and protected from traffic.

507.02 – MATERIALS

507.02.01 – GENERAL

All fire hydrants furnished must conform to AWWA C-502, “Dry-Barrel Fire Hydrants”, as amended, or as modified herein. No hydrant manufacturer will be considered which has not regularly manufactured hydrants continuously for a period of at least ten (10) years. No hydrant model will be considered which has not regularly been in service for a period of at least two (2) years.

507.02.02 – SUBMITTALS

The Contractor must provide a digital copy of all submittals, and if requested by the City Engineer, hardcopies of any submittal must be provided as well. The submittal must clearly identify the make, model, design, and metal characteristics for approval by the City Engineer prior to installation.

Drawings must show principal dimensions, metal thickness, construction details, materials used in all parts of the fire hydrant with ASTM designation and structural properties. Net assembled weight of hydrants must be shown.

Specifications must include comprehensive parts list with sufficient drawings or details to clearly identify parts.

507.02.03 – AFFIDAVIT OF COMPLIANCE

The Contractor must provide an “Affidavit of Compliance” that fire hydrants furnished comply with all provisions of Standard Specifications.

507.02.04 – TYPE OF SHUT-OFF

Type of shut-off must be of the compression type with the flow.

507.02.05 – DELIVERY CLASSIFICATION

All hydrants must be equipped with two (2) hose nozzles and one (1) pumper nozzle. Nozzles must be lead free per safe water drinking act requirement.

507.02.06 – INLET CONNECTION

Unless otherwise specified, the inlet connection will be a mechanical joint hub complete with all joint accessories. All mechanical joint gland bolts must be high strength, low alloy, corrosion resistant material as specified in ASTM A-252/A252M “Standard Specification for Welded and Seamless Steel Pipe Piles” The inlet valve opening must be five and one-quarter inches (5.25-in) net.

507.02.07 – OUTLET CONNECTIONS

The outlet connections must be two (2) hose nozzles, two and one-half inches (2½-in) in nominal I.D. and one (1) pumper nozzle five inches (5-in) in nominal I.D. Nozzle threads must be Oklahoma City Standard, six (6) threads to the inch for two and one-half inch (2.5-in) nozzles, and four (4) threads to the inch for five-inch (5-in) nozzles pursuant to Standard Detail for Fire Hydrant Nozzle Threads. When installed the outlet connections must be a minimum of eighteen inches (18-in) from finish grade.

507.02.08 – HARNESSING LUGS

Harnessing lugs must be furnished when specified or called for on the plans.

507.02.09 – NOZZLE CAP GASKET

Gaskets must be furnished on all nozzle caps. Gaskets must be a neoprene material.

507.02.10 – DRAIN VALVE AND OUTLET

A positive operating drain valve or valves must be provided.

507.02.11 – PAINT

Privately owned fire hydrants must be painted “Canary Yellow” (Sherwin Williams 3060 / #ffef00) and comply with NFPA 24 and NFPA 25 including required testing and permits from the Fire Marshal. Publicly owned fire hydrants must be painted with two (2) coats of high gloss “International Orange” (Sherwin Williams 4082 / #ff4f00) enamel paint. Each coat of paint must have a minimum dry thickness of two (2) mils.

507.02.12 – SHAPE AND SIZE OF OPERATING AND CAP NUTS

The operating and cap nuts must be National Standard Pentagon nuts.

507.02.13 – BREAKABLE TYPE

Breakable type (traffic models) will be furnished. A breakable type hydrant is one that requires no excavation and will break at the design point.

507.02.14 – STANDPIPE, FLANGES, AND EXTENSIONS

Breakable parts of standpipe will be located approximately three inches (3-in) but not more than five inches (5-in) above the ground line. These parts must be of the breakable flange type, breakable coupling, or integral flange with sawed bolts. Breakable flanges screwed to the standpipe will not be accepted. The flange on each end must have at least eight (8) bolts, or other acceptable method to permit proper orientation of nozzles in forty-five degree (45-degree) increments and must be designed so that a wrench can be used on nuts and bolts. Extension of hydrant will be made by adding at the ground line flange a new coupling and stem section equal to the length of the extension. Stem extensions made by adding new section of stem to the threaded section of the stem at the top of the hydrant will not be acceptable.

507.02.15 – STEM

Provisions must be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents.

507.02.16 – COUPLINGS

If breakable or sleeve type couplings are used, they must have sufficient torsional strength such that a torsional failure of the stem will occur at some point other than coupling. Design of the coupling must be such that when the coupling is broken, no parts will come loose and fall into hydrant, and the break will not occur through the pins or bolts holding the coupling to the stem.

507.02.17 – GROUND LINE GASKETS

Gaskets furnished for ground line flanges must be full face, or flange must be recessed.

507.02.18 – MAIN AND VALVE SEATS

Main valve seats on the fire hydrant must be of such design that incorrect positioning is impossible and that the threads must be adequately guided into position. Arrangements must also be made to hold the main valve gasket in place during assembly. The main valve seat must be made of bronze and threaded into a bronze retainer ring or it may be threaded into a heavy bronze bushing in the hydrant base. All bronze parts in constant contact with the water must comply to the requirements of AWWA C-504, “Dry Barrel Fire Hydrants”.

507.02.19 – NOZZLE CAP CHAINS

All fire hydrants must be equipped with nozzle cap chains.

507.02.20 – FLANGES

All flanges must have a minimum thickness of seven-eighths inch (0.875-in). Bolt hole edge distance must be sufficient to provide full support for the bolt heads and nuts.

507.02.21 – OPERATING STEMS

Operating stems must be high grade bronze, wrought iron or steel. Stem nuts must be bronze. Where passing through O-rings, iron or steel stems will have a bronze, stainless steel, or other non-corrodible metal sleeve. Operating threads must be sealed against contact with water regardless of open or closed position of the main valve. An internal lubricant chamber must be provided as a part of the dry top construction. An external access for adding lubricant must be provided.

507.02.22 – O-RINGS

Fire hydrants must be equipped with O-rings in lieu of stem packing.

507.02.23 – CAP NUTS

The fire hydrant must have a cap nut to seal the bottom end of the stem threads against contact with water.

507.03 – CONSTRUCTION METHODS

507.03.01 – BURY LENGTH

Unless otherwise specified, fire hydrants must be furnished with a four-foot six-inch (4.5-ft) depth of bury.

507.03.02 – TAPPING OF DRAIN OPENING

Tapping of drain opening will not be required.

507.03.03 – DIRECTION OF OPENING

The direction of opening will be to the left or Counter-Clockwise. An arrow and the word "OPEN" must be cast in relief to be clearly visible on the top of the hydrant, to designate the direction of opening. A minimum number of turns to open will be ten (10).

507.03.04 – INSTALLATION

The hydrant must be inspected and cleaned prior to installation. The fire hydrant must be placed on a concrete mat not less than four inches (4-in) thick and sixteen inches (16-in) square. The rear side of the fire hydrant, opposite the pipe, must be blocked with concrete between the fire hydrant and a vertical face of undisturbed earth. A minimum of seven cubic feet (7-cf) of crushed rock must be placed around and below the fire hydrant to allow the fire hydrant to properly drain. The fire hydrant must be firmly supported prior to backfill. The height of the openings must be a minimum of eighteen inches (18-in) above finish grade

507.04 – TESTING

Hydrostatic tests outlined in AWWA C-502, “Dry-Barrel Fire Hydrants”, must be complied with.

507.05 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Fire Hydrants" will be made at the unit price bid per each. The price established must be full compensation for furnishing and installing all materials including fire hydrants, extension pipe, riser pipe, and labor, tools, equipment, and incidentals necessary to complete this item of work.

507.06 – BASIS OF PAYMENT – Public Construction Contracts

Payment must be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with Standard Specifications.

The items measured as provided above will be paid for at the contract unit price bid:

FIRE HYDRANT EA.

SECTION 508 – REMOVAL OF FIRE HYDRANTS

508.01 – DESCRIPTION

This section covers removal of fire hydrant when called for on the plans or specified.

508.02 – CONSTRUCTION METHODS

Construction must be in conformance with the Standard Detail for Removal of Fire Hydrants. The Contractor must dispose of salvaged materials, including the fire hydrant.

Fire hydrants removed from an abandoned water line must be capped as required to provide a tight connection.

Fire hydrants removed from a functional water line must be plugged and restrained as required to provide a tight connection.

508.03 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Removal of Fire Hydrant" will be made at the unit price bid per each. The price established must be full compensation for all material including solid sleeves, nipples, removal of existing fire hydrant and its appurtenances, labor, tools, equipment, and incidentals necessary to complete this item of work.

Cap and or plugs necessary for this work must be paid in accordance with Section 501 “Pipe and Fittings Installation”.

508.04 – BASIS OF PAYMENT – Public Construction Contracts

Payment must be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with Standard Specifications.

The items measured as provided above will be paid for at the contract unit price bid:

REMOVAL OF FIRE HYDRANT EA.

SECTION 509 – THRUST RESTRAINTS.

509.01 – DESCRIPTION

This section covers thrust restraints intended to be used to transmit unbalanced thrust forces into undisturbed soil. This section includes Thrust Restraint devices, Thrust Collars, and Thrust Blocks. The use of Thrust blocks and Thrust Collars will only be permitted by the City Engineer’s approval.

509.01.02 DEFINITIONS

The following definitions will apply:

A. Thrust restraints – is a special type of push-on or mechanical joint that is designed to provide longitudinal restraint. Thrust restraints and joint restraints, pipeline restraints are synonymous terminology.

B. Thrust block – prevents separation of joints and pipe movement by transferring the resultant thrust force at a bend to the undisturbed soil behind the thrust block. The bearing strength of the soil is expressed in pounds per square foot.

The area behind the thrust block must engage enough soil area to resist the resultant thrust force at a change in direction.

C. Thrust collar – welded-on thrust collar or other dependable anchorage means on one or both sides of the point requiring restraint and to use concrete poured around the collar for support against undisturbed soil surrounding the pipe adequate to withstand total thrust. A thrust collar here is not a “wall collar” or a “water stop”. Wall Collars and Water Stops do not meet the requirements of a water line thrust collar.

509.02 – MATERIALS

A. Thrust Restraints

1. Thrust restraint must have gland body, wedges and wedge actuating components cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
2. Thrust restraints must be traceable, an identification number consisting of year, day, plant and shift is required.
3. Thrust restraints for pipe sizes three-inch three inch (3-in) through (16-in) must have a working pressure rating of 350 and eighteen (18-in) through fifty-four inch (54-in) must have a working pressure rating of 250 psi. Pressure ratings for water pressure must include a minimum safety factor of two (2) to one (1) in all sizes.
4. Thrust restraints must comply to the following standards ANSI/AWWA C110/A21.10 “Ductile Iron and Gray Iron Fittings”, ANSI/AWWA C111/A21.11 “Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings”, ANSI/AWWA C115/A21.15 “Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flange”.

B. Thrust Collars

1. Thrust collars must be fabricated from steel or manufactured of ductile iron, grade 70-50-05 Ductile Iron.

Pipe Material	Restrictions
Ductile Iron Pipe	• Retainer glands will not be permitted. • Flanged joints must be used for above ground installations.
Steel Pipe	• No restraint will be required for welded joints
PVC pipe	• Retainer glands will not be permitted. • Flanged joints must be used for above ground installations.
Pre-stressed Concrete Cylinder Pipe	• Restrained joints must be welded, clamp type harness, or snap ring type harness.

509.03 – CONSTRUCTION METHODS

A. Thrust restraints – the restrained joints should be fully extended (if applicable) during installation. In certain configurations, fittings may be close enough to one another that adjacent calculated restrained lengths overlap. In situations of this type, one approach is to:

   1. Restrain all pipe between the two fittings.
   2. Assume 1/2 of the restrained pipe length between the two fittings acts to resist the thrust force of each fitting. Using the appropriate equations, calculate the additional restrained length required on the outer legs of the fittings.

   For above ground installations, it is necessary to assure a minimum of lateral and vertical stability at the supports. Deflected pipe joints can result in thrust forces of hydrostatic or hydrodynamic origin, and if not laterally and vertically restrained unbalanced forces may result in additional joint deflection and possible failure of the pipeline.

B. Thrust Blocks – the use of thrust blocks are only permitted with the City Engineer's approval.

C. Thrust Collars – A concrete thrust block must be cast around steel thrust collar after pipe is installed. One method of restraining a pipeline is to provide a welded-on thrust collar or other dependable anchorage means on one or both sides of the point requiring restraint and to use concrete poured around the collar for support against undisturbed soil surrounding the pipe. Should not rely on a mastic to seal. Field wielding of thrust collars must be approved by the City Engineer prior to installation.

509.04 – METHOD OF MEASUREMENT – Public Construction Contracts

Thrust restraints, thrust blocks and thrust collars and all labor, materials, tool, equipment necessary to complete the item of work are incidental and must be paid for with other items of work, unless otherwise noted by the City Engineer

SECTION 510 – BLOW-OFF CONNECTIONS

510.01 – DESCRIPTION

This section covers blow-off connections intended to be used to provide outlets to aid in draining water lines at low points in the profile and upstream of line valves located on a slope.

510.02 – CONSTRUCTION METHODS

Blow-off connections must be constructed of the size, detail and location shown on the plans. Blow-offs must be provided with a shut-off valve. Blow-offs must be manufactured in accordance with AWWA C-208 “Dimensions for Fabricated Steel Water Pipe Fittings”. Blow off connections must be constructed in accordance with Standard Details for construction and installed per manufacturer’s instructions.

510.03 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Blow-Off Connections" must be made at the unit price bid per each for each size. The price established will be full compensation for each installation, all materials, including fittings, labor, tools, equipment, and incidentals necessary to complete this item of work.

510.04 – BASIS OF PAYMENT – Public Construction Contracts

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) BLOW-OFF CONNECTION EA.

SECTION 511 – WATER VALVES

511.01 – DESCRIPTION

This section covers water valves of size and type specified or called for on the plans. Unless otherwise specified, all valves twelve inches (12-in) or smaller in diameter will be gate valves. Valves sixteen inches (16-in) and larger must be butterfly valves. Valves specified must be of the types shown in the following table:

Valve Type	Reference Standard	Size Range (inches)
Gate (Metal Seated)	AWWA C-500 & C-515	3-in – 12-in
Gate (Resilient Seated)	AWWA C-509-15 & C515-15	3-in – 12-in
Tapping	AWWA C-500-09 & C515-15	3-in – 48-in
Butterfly	AWWA C-504-15	16-in – 72-in
Check	AWWA C-506-69	0.5-in – 10-in
Check	AWWA C-508-69	2-in – 24-in
Air		1-in and larger

511.02 – MATERIALS

The Contractor must submit the following for approval prior to installation:

A. Valve make and model
B. Valve detail drawings
C. Type "A" and "B" Certifications, see Section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications.
D. Affidavit of Compliance with specifications
E. Valve Key Extension guide product specification. A Valve Key is required unless otherwise specified by the City Engineer.

511.02.01 – GATE VALVES

A. General – Gate valves must conform to the requirements of AWWA C-500, “Metal-Seated Gate Valves for Water Supply Service”, C-509, Resilient-Seated Gate Valves for Water Supply Service”, or C-515, “Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service”, and must be, bronze mounted, outside screw and yoke, non-rising stem for buried installations and rising stem for unburied installations, open left, double disk (metal seated), or resilient seated, or resilient wedge seated, parallel seat, "O-ring" for non-rising stem, and must have standard operating nut.

B. Pressure Rating – Valves produced conforming to AWWA C-500, “Metal-Seated Gate Valves for Water Supply Service”, C-509, “Resilient-Seated Gate Valves for Water Supply Service”, and C-515, “Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service”, must have a design working pressure of two hundred pounds per square inch (200-psi).

511.02.02 – TAPPING VALVES

A. General – Valves to be used with tapping sleeves must have connecting flanges (Standard Class 125) with centering lip on the valve flange to fit recess or counterbore on the outlet tapping sleeve flange. The outlet end of the valve must have a combination mechanical joint end and tapping machine flange.

B. Tapping Valves 4-in to 12-in – Tapping valves must conform to AWWA C-509, "Resilient-Seated Gate Valves for Water Supply Service", or C-515, "Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service", except as modified for passage and clearance of tapping machine cutters. The opening through the valve must be at least one-quarter inch (0.25-in) larger than nominal valve diameter. The outlet end of the valve must have the desired joint connection for the intended pipe. Tapping valves must allow full size cutters to be used. Seating of the disc gate will not require any sliding or wedging to achieve a zero leakage. A maximum of three (3) internal moving parts must be required for operation of the valve. The stem collar must be protected from outside grit, sand, etc., by dual O-rings above stem collar. There must be an O-ring below stem collar sealing off lubrication chamber from line fluid. Pressure energized O-rings may be used in place of flat gaskets on flanged joints in valve body/bonnet. All interior and exterior ferrous surfaces must be protected against corrosion by fusion-bonded epoxy coating. Coating must be applied prior to assembly to ensure coverage of all exposed areas, including bolt holes.

C. Taping Valves 16-in and less than 24-in – Tapping valves must conform to AWWA C-500, "Metal-Seated Gate Valves for Water Supply Service", covering gate valves except as modified for passage and clearance of tapping machines. The outlet end of the valve must have the desired joint connection for the intended pipe. Valves must be of the fully revolving, double disc, parallel seat design and have independent wedging action designed to spread the two discs against the seats in the valve body. Seats in the body must be replaceable without removing valve from pipeline. The two discs must be interchangeable and field replaceable without removing valve from pipeline. Either disc must be able to seat against line pressure. Wedging surface must be protected by bronze, stainless steel, or other suitable material for corrosion purposes. Valves twenty-four inches (24-in) and larger, to be installed with stem in horizontal position, must be equipped with tracts and scrapers. Enclosed bevel gearing with two inch (2-in) square wrench nuts to be provided on sixteen inch (16-in) and larger horizontal stem valves. By-pass valves for equalization of line pressures on both sides of discs to be required for twenty-four inch (24-in) and larger valves. All internal and external ferrous surfaces must be coated with asphaltic varnish per Federal Specification TT-V-51, Military Specification MIL C-450, or equal.

D. Pressure Rating – Tapping valves manufactured conforming to AWWA C-500, "Metal-Seated Gate Valves for Water Supply Service", and C-509, "Resilient-Seated Gate Valves for Water Supply Service", must have the following pressure ratings:

Size (inches)	Working Pressure (psig)
≤ 12	200
≥16	150

E. Construction Notes – Tapping valves must be installed in accordance with the recommendations of the pipe manufacturer being tapped.

511.02.03 – BUTTERFLY VALVES

A. General – Butterfly valves must be manufactured to all applicable sections of AWWA C-504, “Rubber-Seated Butterfly Valves, 3 In. (75 mm) through 72 In. (1,800 mm)”, with modifications to permit a non-shock pressure rating of two hundred-fifty pounds per square inch (250 psi). Unless otherwise shown on the plans, valves twenty inches (20-in) or smaller in diameter must be Class 150-B. All valves twenty-four inches (24-in) and larger must be equal to or better than specified below. Technical data must be submitted to the City Engineer for approval prior to installation.

B. Bodies – Bodies must be cast-iron ASTM A-126, “Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings”, Class B “, or ductile iron ASTM A-536, “Standard Specification for Ductile Iron Castings”, grade 65-45-12, heat-treated. Wall thickness must be in accordance with AWWA C-504, “Rubber Seated Butterfly Valves, 3 In. (75 mm) through 72 In. (1,800 mm)”, Table 1, Class 150B. Flanges must be ANSI B16.1, “Cast Iron Flanged Fittings – Class 125/250 Class 250”.

C. Shafts – Shafts must be stub or through shaft type of stainless-steel conforming to ASTM A-564, “Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless-Steel Bars and Shapes”, Type 630, with one thousand one hundred fifty degrees Fahrenheit (1,150-degrees F) aging, and must have diameters in accordance with Table 4 “Mechanical Rest Requirements for each type”, Class 150-B. If shafts are made of ASTM A-276 “Standard Specification for Stainless Steel Bars and Shapes”, stainless steel, the diameter must be increased by fifteen percent (15%) over Table 4, Class 150-B. The torsional shear stress must not exceed fifty percent (50%) of the yield strength of the shaft material used at the maximum torque for the application.

D. Discs – Discs must be of the double offset design so that the shaft centerline is offset both vertically and horizontally. The disc material must be ductile iron ASTM A-536, “Standard Specification for Ductile Iron Castings”, Grade 65-45-12, heat treated or stainless-steel ASTM A-743, “Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application”, Grade CF8M, or cast-iron ASTM A-48, “Standard Specification for Gray Iron Castings”, or Ductile Iron Flow through or truss type disc will not be acceptable.

E. Seats – Seats must be synthetic rubber attached to the disc and held in place by retaining shoulders on both sides of the rubber seat ring and conform to ASTM A-276, “Standard Specification for Stainless Steel Bards and Shapes”, Type 316 stainless steel retainer ring screws passing through the seat and retainer ring. The

rubber seat ring must seal against an ASTM A-276, “Standard Specification for Stainless Steel Bars and Shapes”, Type 316 stainless steel body ring rolled and mechanically locked into the valve body. Valves twenty inches (20-in) and smaller must have bonded seats. Bonded seats must be simultaneously molded in, vulcanized, and bonded to the body. Seat bond must withstand seventy-five pounds (75-lbs) pull when tested in accordance with Valve seats on twenty-four inch (24-in) diameter valves and larger must be field adjustable and replaceable without dismantling operator, disc, or shaft. Seats must be retained in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream. The valve disc edge must have a Type 316 stainless steel edge for mating with the rubber seat. Butterfly valves with rubber seats located on the disc will not be allowed.

F. Bearings – The shaft must be supported on both sides of the disc in sleeve type bearings with an area such as not to exceed one-fifth (20-percent) of the compressive strength of the bearing or shaft material or the published design load for the bearing material with three hundred fifty pounds (350-psi) per square inch differential pressure across the disc.

G. Actuators – Actuators must be of the traveling nut or link and lever type with mechanical stops in the open and closed position that are field adjustable and will withstand four hundred fifty foot pounds (450-ft-lbs) of input torque against the open and shut stops without damage to the actuator.

H. Production Testing – Production testing must be in accordance with Section 5.2 of AWWA C-504, “Rubber-Seated Butterfly Valves, 3 In. (75 mm) through 72 In. (1,800 mm)”, for the seat leakage test in both directions using three hundred fifty pounds per square inch (350-psi) hydrostatic and Section 5.2.3 of AWWA C-504, “Rubber-Seated Butterfly Valves, 3 In. (75 mm) through 72 In. (1,800 mm)”, for shell testing using five hundred pounds per square inch (500-psi) hydrostatic pressure. Each valve must be shop operated with the actuator in place for three (3) open-close cycles under no flow conditions as specified in Section 5.2 of AWWA C-214, “Tape Coatings for Steel Water Pipe”.

I. Proof-of-Design-Tests – Valve designs must be tested in accordance with Section 5.2.4 of AWWA C-504, “Rubber-Seated Butterfly Valves, 3 In. (75 mm) through 72 In. (1,800 mm)”, with five hundred pounds per square inch (500-psi) used for disc testing and three hundred fifty pounds per square inch (350-psi) used for cyclic testing.

511.02.04 – CHECK VALVES

A. General – Check valves must conform to the requirement of AWWA C-506, “Standard for Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types”, or AWWA C-508, “Standard for Swing-Check Valves for Waterworks Service, two inches (2-in) through twenty-four inches (24-in) NPS”.

1. Must be coated with Fusion Bonded Epoxy on interior and exterior for corrosion resistance
2. Must be certified to ANSI/NSF 61 for drinking water system components.
3. An adjustable spring tension to control opening and closing of clapper, lever and spring can be installed on either side of valve

B. Pressure Ratings – Check valves conforming to AWWA C-506, "Standard for Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types", must have a working pressure rating of one hundred fifty pounds per square inch (150-psi). Valves conforming to AWWA C-508, "Standard for Swing-Check Valves for Waterworks Service, two inches (2-in) through twenty-four inches (24-in) NPS". must have the following pressure ratings:

Size (inches)	Working Pressure (psig)
2-in to 12-in	175
16-in to 24-in	150

C. Construction Notes – Check valves must be set horizontally.

511.02.05 – AIR VALVES

A. General – Two (2) types of air valves of size and type may be used to admit or vent air when specified or called for on the plans. The air valve may be as follows:
1. Air release valve
2. Air valve release and air vacuum combination

B. Materials – Unless otherwise specified or called for on the plans, air valves must have a cast iron minimum pressure of three hundred pounds per square inch (300-psi) without damage, and must be consistent with the following specification:

Component	Material	Standard
Body and Cover	Cast Iron	ASTM A-48, Class 35
Float	Stainless Steel	ASTM A-240
Seat	Buna-N or Equal	.....
Retaining Screws	Stainless Steel	ASTM A-276
Guide Bushings	Stainless Steel	SAE 30303

511.03 – CONSTRUCTION METHODS

At the site of the work and just prior to installing the valve, the valve must be fully opened and closed and a record of the number of turns required for full operation must be furnished to the City Engineer. The inside of the valve must be thoroughly cleaned before installation.

The valve must be set on a firm base. Valves in PVC pipelines must be supported by independently of the pipe. The valve and the valve box must be firmly supported and centered prior to backfill. Installation of valves must also comply with the appropriate standard detail. Must be installed in accordance with manufacturer requirements and standards.

511.04 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for valves, valve boxes and valve vaults must be made at the unit price bid per each for each type and size of valve. The price established must be full compensation for all material including valve, valve boxes, valve vaults, installation, labor, tools, equipment, and incidentals necessary to complete this item of work.

511.05 – BASIS OF PAYMENT – Public Construction Contracts

Unless otherwise called out on plans, the item measured as provided above will be paid for at the contract unit price bid:

(SIZE) (TYPE)(DEPTH RANGE) VALVE AND VALVE BOX	EA.
(SIZE) (TYPE)(DEPTH RANGE) VALVE AND VAULT	EA.
(SIZE)(TYPE)(DEPTH RANGE) VAULT	EA.

SECTION 512 – VALVE BOXES AND VAULTS

512.01 – DESCRIPTION

This section covers valve boxes and vaults intended to provide means to operate the valve.

512.02 – MATERIALS

A. Valve Boxes – All valve boxes must be three (3) piece cast iron of the extension type suitable for a depth of cover over the pipeline as required by the backfill requirements at each valve. Each valve box must be provided with a suitable cast iron base and cover. Each valve box must have a valve key extension guide unless otherwise specified by the City Engineer. All parts of valve boxes, bases, and covers must be coated by dipping in hot bituminous base material.

B. Valve Vaults – Valve vaults must be reinforced concrete structures constructed to size and dimensions shown on the appropriate Standard Details for valve vaults.

512.03 – BASIS OF PAYMENT – Public Construction Contracts

Payment for valve boxes and vaults will be paid for as per Section 511, “Water Valves”.

SECTION 513 – HYDROSTATIC PRESSURE TESTING AND DISINFECTION

513.01 – DESCRIPTION

This section covers hydrostatic pressure testing of installed water line in accordance with the requirements specified herein. Hydrostatic Pressure testing of all pipes must be accomplished pursuant to Section 4 of AWWA C-600, “Installation of Ductile-Iron Mains and Their Appurtenances”. The test pressure must be the greater of one and one-quarter (1.25) times the working pressure and the testing pressures at the highest point along the test section. The allowable leakage in gallon per hour (gph) per one thousand feet (1,000-ft) of pipe must not exceed the values shown in the table. The allowable leakage for welded steel pipes must be zero (0).

At a minimum, all pipes must be tested at 150-psi working pressure. The test pressure must be maintained for a minimum of two (2) hours. If any section of pipeline including specials, fitting and appurtenances are discovered to be damaged after the hydrostatic test, they must be repaired or replaced with sound material and the test must be repeated to the satisfaction of the City Engineer. If any test of pipe installed indicates leakage greater than the allowable leakage, the Contractor must, at his own expense, locate and repair the source of leak in the pipeline until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the amount of leakage.

The water main must be disinfected by the Contractor in accordance with the requirements of AWWA C651 latest edition.

513.01.01 – GENERAL

A. Water lines – All new water lines and appurtenances must be cleaned and disinfected before they are placed in service. All water lines taken out of service for inspecting, repairing, or other activity that might lead to contamination of water must be cleaned and disinfected before they are returned to service. All work must comply with AWWA C-651, “Disinfecting Water Mains”. Raw water lines do not need to be disinfected.

B. Water Storage Facilities – All new storage facilities must be disinfected before they are placed in service. All storage facilities taken out of service for inspecting, repairing, painting, cleaning, or other activity that might lead to contamination of water must be disinfected before they are returned to service. All work must comply with AWWA C-652, “Disinfection of Water Storage Facilities”.

C. Water Treatment Plants – All new treatment facilities to be disinfected must be cleaned and disinfected before they are placed in service. All treatment facilities taken out of service for inspecting, repairing, painting, cleaning, or other activity that might lead to contamination of water must be cleaned and disinfected before

they are returned to service. All units that are downstream from the first point of application of disinfectant in the treatment process must be disinfected. All work must comply with AWWA C-653, “Disinfection of Water Treatment Plants”.

D. Water Wells – Disinfection and bacteriological testing of water wells must be done prior to placing in domestic service, any well or any existing well that has received servicing or maintenance that might have caused foreign material or contamination to be introduced into the well. All work must comply with AWWA C-654, “Disinfection of Wells”. The OWRB does not conduct testing of water supply wells unless that well is part of an existing water quality monitoring program, such as GMAP. However, the disinfection of water wells must comply to all applicable section of the Oklahoma Administrative Code, Title 785 - Oklahoma Water Resources Board.

513.02 - CONSTRUCTION METHODS

513.02.01 – FLUSHING

The Contractor must perform preliminary flushing with potable water in accordance to AWWA C651, “Disinfecting Water Mains”. Flushing chlorinated water must not be discharged into lakes, streams, storm drains or other bodies of water. All flushing water must be dechlorinated in accordance with AWWA C-651, “Disinfecting Water Mains”, Section 4.5, prior to disposal. The site for flushing must be selected with the approval of the City Engineer and must have adequate provision for drainage and that does not discharge onto private property without authorization and approval.

513.02.02 – DISINFECTION

The Contractor must perform the disinfection of the pipeline and the bacteriologic and chemical tests must be performed by the City. The Contractor must furnish the necessary equipment and materials for disinfection and the City will provide the necessary testing. The Contractor must furnish labor to make the necessary connections and must provide any temporary drainage measures for disposal of the water.

513.03 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Hydrostatic Pressure Testing and Disinfection" must be made at the unit price bid lump sum. The price established will be full compensation for all material, labor, tools, equipment, and incidentals necessary to complete this item of work.

513.04 – BASIS OF PAYMENT – Public Construction Contracts

Payment for valve boxes and vaults "Hydrostatic Pressure Testing and Disinfection" will be paid for at the contract unit price as lump sum.

SECTION 514 – DUCTILE IRON PIPE (DIP)

514.01 – DESCRIPTION

This section covers ductile iron pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes three inches (3-in) through sixty-four inches (64-in). All Ductile Iron Pipe must be polyethylene encased as per Section 514 “Ductile Iron Pipe (DIP”.

514.02 – MATERIALS

514.02.01 – GENERAL

All ductile iron pipe and fittings must conform to the requirements of the following standards listed below or as modified herein.

A. ANSI/AWWA C-150/A 21.50, Thickness design of Ductile Iron Pipe

B. ANSI/AWWA C-151/A 21.51, Ductile Iron Pipe, Centrifugally Cast in Meal Molds or Sand-Lined Molds, for Water or Other Liquids

C. ANSI/AWWA C-111/A 21.11, Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings

D. ANSI/AWWA C-104/A 21.4, Cement Mortar Lining for Ductile Iron Pipe for Water

E. ANSI/AWWA C-105/A 21.5, Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids

F. ANSI/AWWA C-600, Installation of Ductile Iron Water Mains and Their Appurtenances

G. ANSI/AWWA C-115/A 21.15, Flanged Ductile Iron Pipe with Threaded Flanges

H. ANSI/AWWA C-116/A 21.16, Protective Fusion-Bonded Epoxy Coatings for Interior and Exterior surface of Ductile Iron and Gray Iron Fitting

I. ANSI/AWWA C-153/A 21.53, Ductile Iron Compact Fittings

514.02.02 – SUBMITTALS

No pipe, special sections and fittings will be manufactured until shop drawings have been reviewed and approved by the City Engineer. Review and approval of the Contractor

submittals, by the City Engineer, will not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing ductile iron pipe and fittings as described herein. When requested, the Contractor must submit the following items.

A. General – Detail drawings of pipes, specials, fittings, and joints

B. Laying Schedule – Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials and fittings.

C. Certification – Type "A" and "D" certification, see Section 109.17.02 “Control of the Work and Materials - Materials Certifications – Types of Certifications”, for pipe, specials, fittings, gaskets, and lining material pursuant to, but not limited to, applicable standards in Section 514 “Ductile Iron Pipe (DIP)”. The affidavits of compliance and test reports must be certified by a Professional City Engineer licensed in the State of Oklahoma.

D. Guides – The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual will be required.

E. Copies – The Contractor must provide a digital copy of all submittals, and if requested by the City Engineer, hardcopies of any submittal must be provided as well.

514.02.03 – DESIGN BASIS

A. General – All ductile iron pipes are designed in accordance with AWWA C-150/ANSI 21.50, “Thickness Design of Ductile-Iron Pipe”. The designs are based on prism load of ordinary clay backfill with a unit weight of one hundred twenty pound per cubic feet (120-pcf), maximum horizontal ring deflection of three percent (3%), design factor safety of two (2), and for AASHTO HS-20 truck highway (HWY) or Cooper axle E-80 railroad (RR) live loading conditions.

B. Depth of Cover – The minimum design depth of cover must be ten feet (10-ft). See table below. Pipe to be installed inside a casing must be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

Minimum Design Depth of Cover for Ductile Iron Pipe	
Actual Buried Depth (Feet)	Design Depth (Feet)
minimum	10
10-15	15
15-20	20
20-25	25
25-30	30
Greater than 30	30

C. Deflection – The allowable deflection for the specified mortar lining system is three percent (3%). Deflection calculation is in accordance with AWWA C-150 “Thickness Design of Ductile-Iron Pipe”.

D. Bending and Hoop Stresses – The bending and hoop stress requirements are met in accordance with AWWA C-150, “Thickness Design of Ductile-Iron Pipe”.

E. Buckling –

1. Buried Installations – The controlling load for buried pipes is determined from the greater of hydrostatic and earth loads plus vacuum or hydrostatic and earth load plus live load with a factor of safety of two (2.0) as determined in accordance with AWWA M-11 “Steel Pipe Design and Installation”. It is assumed that the groundwater level is equal to natural ground surface and the ground is fully saturated.

2. Unburied Installations – For unburied pipes, the internal collapsing vacuum pressure is used in determining the minimum wall thickness(es) in accordance with equation 4-2 of AWWA M-11, “Steel Pipe Design and Installation”, for a factor of safety of 1.5 against buckling. The Poisson’s ratio is 0.28 and modulus of elasticity is 52×10^6 psi.

3. Vacuum Pressure – For both buried and unburied installations, the internal collapsing vacuum pressure is taken as 14.7 psi.

514.02.04 – MINIMUM PIPE DESIGN FOR DUCTILE IRON PIPE

Unless otherwise specified, ductile iron pipes and fittings for buried and unburied installations, including boring, tunneling, and micro and small diameter tunneling, must have the following minimum nominal thicknesses, in inches, shown below.

For boring, tunneling and micro and small diameter tunneling installations, the minimum pipe design must be equal to or greater than the minimum pipe design on either side of the installation.

Minimum Pipe Design for Ductile Iron Pipe		
Pipe Size (inches)	**Nominal Push on Joint Wall Thickness Class 51 (inches)**	**Flange Joints Class 53 (inches)**
4	0.26	0.32
6	0.28	0.34
8	0.30	0.36
12	0.34	0.40
16	0.37	0.43
18	0.38	0.44
20	0.39	0.45
24	0.41	0.47

30	0.43	0.51
36	0.48	0.58
42	0.53	0.65
48	0.58	0.72
54	0.65	0.81
60	0.68	0.83
64	0.72	0.87

514.02.05 – PIPE JOINTS AND FITTINGS

A. General – All specials and fittings may be used with push-on, mechanical, or flanged joints conforming to the requirements of AWWA/ANSI C-110/A 21.16 “Ductile-Iron and Gray-Iron Fittings”, for Full body, MJ fittings must comply to AWWA/ANSI C-153. Mechanical joints must be adequately protected against unbalanced forces. Fittings with flanged joints must be used with above ground installations. Unless otherwise specified all fittings must be restrained joint type. All joints must have the same pressure rating as the pipe of which they are a part and must meet the requirements of AWWA/ANSI C-111/A 21.11, “Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings”.

B. Push-on Joints – Push-on joints are a rubber gasket compression type joint meeting the requirements of AWWA C-111, “Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings”. Push-on joints must have a deflection capability of three degrees (3-degrees).

C. Mechanical Joints – A mechanical joint is a bolted joint of the stuffing-box type. Each joint must consist of a bell that is cast integrally with the pipe or fitting and provided with an exterior flange having bolt holes or slots, and a socket with annular recesses for the sealing gasket and the plain end of the pipe or fitting, a pipe or fitting plain end, a sealing gasket, a follower gland with bolt holes, and T-head and hexagonal nuts.

D. Flanged Joints – The flanged joints for ductile iron pipe must be in accordance with AWWA C-111, “Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings”. Bolts, gaskets, and installation must meet the requirements of AWWA C-115, “AWWA Standard for Flanged Ductile-Iron Pipe With Threaded Flanges”, Appendix A. The flanged joints for specials and fittings must meet the requirements of AWWA C-110, ““Ductile-Iron and Gray-Iron Fittings”.

The flanges must be rated for two hundred fifty pounds per square inch (250-psi) working pressure with bolt-hole drillings as for Class 125 flanges for service at temperatures ranging from twenty degrees Fahrenheit (20-degrees F) to one hundred fifty degrees Fahrenheit (150-degrees F) are pressure temperature rated for one hundred fifty pounds per square inch (150-psi) to two hundred pounds per square inch (200-psi) as shown in ANSI B 16.1. All flanged joints must be made with single piece, red rubber gaskets one-eighth inch (0.125-in) thick. Gaskets

must be full face for exposed installations and ring type or full faced for buried service meeting AWWA C-110, “Ductile-Iron and Gray-Iron Fittings”, Appendix A requirements. As directed by the City Engineer or shown on plans, flange joints meeting the requirements of ASME/ANSI B-16.1 may be used.

E. Restrained Joints – Retainer glands will not be permitted. A retainer gland assembly is used to hold pipe joints together. Retainer glands alone cannot restrain against unbalanced forces; however, the mechanism of a retainer gland is incorporated into some retrained joint assemblies.

F. Sleeve Couplings – All sleeve couplings, except as noted on the plans or otherwise specified, must be restrained with tie rods, and must be designed for the pipe design pressure and maximum allowable stress not to exceed sixty-five percent (65%) of minimum yield strength of steel used. Sleeve couplings for pipes three inch (3-in) to sixteen inches (16-in) must be compact fittings meeting the requirements of AWWA C-153, “Ductile-Iron Compact Fittings”.

514.02.06 – COATING AND LINING

A. Exterior Coating – The exterior of ductile-iron pipe, specials and fittings must be coated with the asphalt coating in accordance with AWWA C-151, “Ductile Iron Pipe Centrifugally Cast”. Also, for Ductile Iron fittings Protective Fusion Bonded Epoxy coatings in accordance with AWWA C-116-09 “Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior surfaces of Ductile Iron and Gray Iron Fittings” will be permitted. The coating must have a minimum thickness of one mil (1-mil). The finished coating must be smooth, continuous, and strongly adherent to the pipe. Any damage to the outside coating during shipping, storage, handling and installation must be field repaired with a fresh coating in accordance with the manufacturer's recommendations.

B. Interior Lining – Unless otherwise called for on the plans or specified, the interior of ductile-iron pipe, specials and fittings must be cement mortar lined in the shop, with centrifugally spun lining in accordance with AWWA C-104, “Cement-Mortar Lining for Ductile-Iron Pipe and Fittings”. The Portland cement for cement mortar lining must be in accordance with the requirements of ASTM C-150, “Standard Specification for Portland Cement”, Type I cement. Field repair of lining must be made in accordance with AWWA C-104, “Cement-Mortar Lining for Ductile-Iron Pipe and Fittings”, Section 4-7.2.

The thickness of cement mortar lining must be in accordance with the following table:

Nominal Pipe Size (inches)	Minimum Lining Thickness (inches)
6 - 12	1/16
14 - 24	3/32
30 - 64	1/8

514.02.07 – CORROSION PROTECTION

When specified or called for on the plans, all ductile-iron pipe, specials, fittings, and other appurtenances must be polyethylene encased in accordance with AWWA C-105/ANSI A 21.5, “Polyethylene Encasement for Ductile-Iron Pipe Systems”. Exposure to sunlight of polyethylene wrapped pipe must be kept to a minimum to prevent deterioration of polyethylene. Damage to polyethylene wrapping must be prevented during backfilling operations. The minimum thickness for polyethylene encasement is eight mils (8-mil).

514.03 – TESTING (MANUFACTURER TESTING)

514.03.01 – SOURCE QUALITY CONTROL

A. Hydrostatic Testing – Hydrostatic Testing must be completed in accordance with AWWA C-600, “Installation of Ductile-Iron Mains and their Appurtenances”. Each length of pipe must be shop tested hydrostatically to a pressure equal to two (2) times design pressure, but not less than five hundred pounds per square inch (500-psi). The pipe must be under the full test pressure for a minimum of ten seconds. The test must be made before the application of cement mortar lining to the pipe. Any pipe that leaks or does not withstand the test pressure will be rejected.

B. Pinhole Leak Testing – Pinhole leak testing of the ductile-iron pipe must be done during the hydrostatic test as follows:

1. During the day's production of pipe, the first (5) five sections of pipe and subsequently (1) one in every (10) ten sections must be tested for pinhole leaks.

2. After testing the section of pipe hydrostatically to the pressure specified above in Part “1” above “Hydrostatic Testing”, the same section of pipe must be tested hydrostatically to the working pressure and the pipe physically inspected for any pinhole leaks.

3. Any pipe found to have pinhole leaks during the working pressure hydrostatic test will be rejected, and the entire production for the day, must be tested for leakage.

C. Joint Testing – Joints must be tested and meet the performance requirements established in AWWA C-111/ANSI A 21.11, “Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings”, Section 11-9 and as modified herein. The working pressure rating of the joint must be established by subjecting the joints to three percent (3%) of the pipe produced to hydrostatic pressure of twice the

rated working pressure, but in no event less than twice the minimum working pressure rating shown below. At least two (2) joints must be hydrostatically tested at a deflected angle of three (3) degrees at the specified pressure rating below.

The minimum working pressure ratings for joints must be as follows:

Joint Size (inches)	Pressure Rating (psi)
≤ 18	350
20	300
24	250
30 - 64	200

D. Test Reports – Test reports for the hydrostatic testing of ductile-iron pipe including the pinhole leak tests must be submitted to the City Engineer on a weekly basis during production.

E. Quality Control Tests – All quality control tests conducted by the Manufacturer for each production run of pipe must be submitted to the City Engineer on a weekly basis during production.

F. Charpy Impact Test – Charpy impact test must be performed in accordance with AWWA C-151. The absorbed energy requirements will be 7-ft-lbs at 70-degrees F ± 10-degrees F.

G. Mill Test Reports – Mill test reports of ductile iron used in the manufacture of pipe, specials, fittings, and appurtenances must be submitted to the City Engineer.

H. Welding – All welding must be done by qualified welders. Certificate of qualifications issued by ASME. The ductile-iron pipe manufacturer will be responsible for quality control and testing of all welding done in the plant during fabrication of special fittings. Pipe Supplier must submit welder qualifications to the City Engineer.

I. Inspection – The City retains the right to inspect the pipe, specials and fittings, all work performed, and materials furnished, at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials, and fittings. Such inspection will not relieve the Contractor or the manufacturer of their responsibilities to furnish material and perform work in accordance with Standard Specifications.

514.04 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment must be made pursuant to Section 501 “Pipe and Fittings Installation”. Polyethylene Encasement must be measured along the pipe and fittings including all

materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with Standard Specifications.

514.05 – BASIS OF PAYMENT – Public Construction Contracts

The price for polyethylene encasement must be included in the price of the Ductile Iron Pipe. See Section 514 “Ductile Iron Pipe”

SECTION 515 – POLYVINYL CHLORIDE (PVC) PIPE

515.01 – DESCRIPTION

This section covers polyvinyl chloride (PVC) pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes six-inch (6-in) through thirty-six inch (36-in) diameter.

515.02 – MATERIALS

PVC pipe and fittings must be produced by extrusion from Class 12454-A or 12454-B PVC compound providing a hydrostatic design basis (HDB) of four thousand pounds per square inch (4,000-psi). Tracer Wire or Detectable Tape is required for all buried PVC pipe.

A. Tracer Wire Requirements
   1. Material Requirements –
      (a) Tracer wire must be 12 gauge (American Wire Gauge Measurement) copper clad (steel), high strength with a minimum of 450 lb. break load.

      (b) Wire coating must be High Molecular Weight Polyethylene (HMWPE) and color must be blue for potable water.

   2. Direction Bore of Jacked installation
      (a) Tracer wire must have a break load of 1,150 lbs. for this application.

   3. Termination and Access
      (a) All tracer wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the tracer wire connection and the terminal for the ground rod wire connection.

   4. Grounding
      (a) Tracer wire must be properly grounded at all dead ends/stubs.

      (b) Where ground rod wire will be connected to a tracer wire access box, a minimum of two foot (2 ft.) of excess/slack wire is required after meeting final elevation.

5. A minimum thirty (30) mil HDPE insulation thickness is required.

6. Testing requirements
   (a) UL 83," Standard for Thermoplastic-Insulated Wires and Cables."
   (b) UL 1581, "Standard for Electrical Wires, Cables, and Flexible Cords."

B. Detectable Tape
   1. Material Requirements –
      (a) Core material must be no less than fifty (50) gauge solid aluminum foil core.

      (b) The core must be encased in 100% virgin polyethylene film and a clear protective film that clearly shows the labeling.

      (c) Overall thickness of the tape must be five (5) mils.

      (d) Must have minimum tensile strength of twenty-eight pounds per square inch (28 psi).

   2. Depth of bury
      (a) Locate 12-in below ground surface above pipe.

      (b) Must comply to the manufacture's installation procedures.

   3. Appearance and Markings
      (a) For water utilities the tape must be blue in color and be labeled with the follow "CATION BURIED WATER LINE BELOW."

      (b) The solid foil core must be visible from both sides.

      (c) No inks or printing extended to the edges of the tape; this printing must also be encased to avoid ink run-off.

      (d) The ink must be heat set Mylar.

   4. Standards
      (a) Must comply to applicable requirements of ASTM D-2103, "Standard Specification for Polyethylene Film and Sheeting".

515.02.01 – GENERAL

All PVC pipe must conform to the requirements of the following standards listed below or as modified herein.

A. AWWA C-900-PVC – pressure pipe, 4-in through 60-in for Water Distribution.

B. AWWA M-23-PVC – Pipe Design and Installation.

C. ASTM D-2774 – Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.

D. ASTM D-2827 – Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

E. ASTM D-3139 – Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

F. ASTM F-477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

G. NSF 14 – Plastic Piping System Components and Related Materials.

H. PPI TR3 – Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

515.02.02 – SUBMITTALS

No pipe, special sections and fittings will be manufactured until shop drawings have been reviewed and approved by the City Engineer.

Review and approval of the Contractor submittals, by the City Engineer, will not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing PVC pipe and fittings as described herein. When requested, the Contractor must submit the following. :

A. General – Detail drawings of pipes, specials, fittings, and joints. Submittals must also include design calculations for fittings and specials.

B. Laying Schedule – Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials, and fittings.

C. Certification – Type "A" and "D" certification for pipe, specials, fittings, gaskets, and lining material. The affidavits of compliance and test reports must be certified by a professional City Engineer licensed in the State of Oklahoma..

D. Guides – The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E. Mill Test Reports – Mill test reports of materials used in the fabrication of pipe, specials, fittings, and appurtenances.

F. Tracer Wire - The Contractor must furnish and install a conductive tracer wire with all buried PVC water mains, services, and appurtenances in accordance with Standard Specifications, Standard Details, and approved drawings. It must be secured to the pipe as required to ensure that the wire remains adjacent to the pipe. The tracer wire must be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it must be accessible at all tracer wire access points.

G. Copies – The Contractor must provide a digital copy of all submittals, and if requested by the City Engineer, hardcopies of any submittal must be provided as well.

515.02.03 – DESIGN BASIS

A. General – The PVC pipe is designed in accordance with AWWA M23, “PVC Pipe - Design and Installation”, or as modified herein, and must conform to minimum DR in Section 515 - "PVC Pipe “.

B. Depth of Cover – The minimum design depth of cover must be ten feet (10-ft). The assumed depth of cover for design purposes must be fifteen feet (15-ft) for burial depths of ten to (10-ft) fifteen feet (15-ft), twenty feet (20-ft) for burial depths of fifteen feet (15-ft) to twenty feet (20-ft), twenty-five feet (25-ft) for depth of twenty feet (20-ft) to twenty-five feet (25-ft), thirty feet (30-ft) for depth of twenty-five feet (25-ft) to thirty feet (30-ft), and the actual cover for depths over thirty feet (30-ft). Pipe to be installed inside a casing must be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

Minimum Depth of Cover for PVC Pipe	
Actual Buried Depth (Feet)	Design Depth (Feet)
minimum	10
10-15	15
15-20	20
20-25	25
25-30	30
Greater than 30	30

C. Allowable Stresses – For pipes six inches (6-in) through twelve inches (12-in), the allowable design stress is sixteen hundred pounds per square inch (1,600-psi) and pipes sixteen-inch (16-in) through thirty-six inch (36-in), the allowable design stress is two thousand pounds per square inch (2,000-psi), as established per AWWA C-900, “Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 60 in. (100 mm Through 1,500 mm), for Water Transmission and Distribution”.

D. Dimension Ratio (DR) - Minimum pipe DR is determined in accordance with equation A.4 or equation 2 of AWWA C-900, “Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 15,000 mm), for Water Transmission and Distribution”.

E. Deflection – The allowable deflection is five (5%) percent of the nominal diameter. Deflections are determined based on the following:

1. Deflection lag factor = 1.0

2. Bedding Constant = 0.10

3. Modulus of soil reaction, E' = 1,000-psi

4. Earth load considered is the prism load of ordinary clay backfill with a unit weight of one hundred and twenty pounds per cubic foot (120-pcf), compacted to 90% density (ASTM D-698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”).

5. A highway live loading of AASHTO HS-20 truck or railroad live loading of Cooper Axle E-80.

515.02.04 – MINIMUM DIMENSION RATIO (DR)

Unless otherwise specified, PVC pipe and fittings for buried installations including boring, tunneling, and micro and small diameter tunneling, must have the following minimum dimension ratios (DR).

For boring, tunneling, and micro and small diameter tunneling installations, the minimum dimension ratio must be equal to or greater than the minimum dimension ratio on either side of the installation.

Pipe Nominal Size (inches)	Dimensions Ratio (DR)
≤12	14
≥16	18

515.02.05 – DIMENSIONS

All PVC pipes must have Cast-Iron-Pipe equivalent (C.I.) outside diameter (O.D.) dimensions.

515.02.06 – PIPE JOINTS AND FITTINGS

Unless otherwise specified, fittings for use with PVC pipe must conform to provisions of AWWA C- 110/A21.10, “Ductile-Iron and Gray-Iron Fittings” and must be full-bodied style and AWWA C-153, “Ductile-Iron Compact Fittings”, for short-bodied style. Fittings must

be mechanical joint type. Pressure rating must conform to these requirements of Section 514 “Ductile Iron Pipe (DIP)”. The outside coating for fittings must conform to the requirements of Section 514 “Ductile Iron Pipe (DIP)”. Flange nuts and bolts must be of stainless steel and must meet the requirements of ASTM A-193, “Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications”, Grade B7. Fittings must be restrained joint unless otherwise specified.

515.03 – CONSTRUCTION METHODS

The City and Awarding Public Agency retain the right to inspect the pipe, specials and fittings, all work performed, and materials furnished at the manufacturer’s plant and at the project site and to independently monitor the fabrication of the pipe, specials, and fittings. Such inspection must not relieve the Contractor or the Manufacturer of their responsibilities to furnish material and perform the work in accordance with Standard Specifications.

515.04 – TESTING

Hydrostatic Pressure Testing and Disinfection must be accomplished in accordance with Section 513 “Hydrostatic Pressure Testing and Disinfection”.

515.05 – BASIS OF PAYMENT – Public Construction Contracts

Payment will be made pursuant and incidental to Section 501 “Pipe and Fittings Installation”.

SECTION 516 – PRE-STRESSED CONCRETE CYLINDER PIPE (PCCP)

516.01 – DESCRIPTION

This section covers pre-stressed concrete cylinder pipe and fittings may be used for conveyance of raw or potable water in sizes forty-eight (48-in) inches and larger when specifically called out on the plans or in the Bidding Documents.

516.02 – MATERIALS

516.02.01 – GENERAL

Except as herein modified, all PCCP and fittings must be embedded steel cylinder type and must conform to the requirements of AWWA C-301, and C-304, “Design of prestressed concrete cylinder pipe”.

516.02.02 – SUBMITTALS

Review and approval of the Contractor submittals, by the City Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing steel pipe and fittings as described herein. No pipe, special sections and fittings must be manufactured until shop drawings have been reviewed and approved by the City Engineer. The Contractor must submit the following:

A. General – All City Engineering data for review and approval prior to pipe manufacture must be submitted. Submittals must include pipe design data, design curves, design computations, joint details, special pipe and fittings, and shop drawings. All pipe drawings must show weld symbols and indicate manufacturing dimensions and tolerances.

Review and approval of the Contractor submittals, by the City Engineer, will not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing PCCP and fittings as described herein.

B. Laying Schedule – Pipe laying schedules corresponding to the numbers or identification markings on the pipe, specials and fittings are required.

C. Samples – Representative samples of the steel cylinders, pre-stress wires, aggregate and cement to be used in the fabrication:

1. Steel Cylinders – two (2) samples, approximately two feet (2-ft) square, one to include a sample of the cylinder weld

2. Pre-stressing wires – two (2) samples, twenty-four inches (24-in) long

3. Coarse aggregate – one hundred pounds (100-lbs)

4. Fine aggregate – fifty pounds (50-lbs)

5. Cement – fifty pounds (50-lbs) in a sealed container

D. Test Reports – Quality control and assurance test reports for pipes, specials, and fittings for each production run, including production welds, mill test reports, all steel plates, sheets and other materials used are required.

E. Concrete and Mortar Mix Designs – Proportions of materials for the mixtures must be established on the basis of laboratory trial batches using the proposed materials and curing procedures. The following properties must be measured and reported in accordance with the respective method.

Property	Method

Slump	ASTM C-153
Compressive Strength	ASTM C-39

The water-cement ratio will be on the basis of aggregate in a saturated-surface dry condition. Proportions must be established to obtain the required average compressive strength by the methods of ACI 214-77 at a slump of three to four inches (3-in to 4-in).

F. Materials Certification – Type "A" and "D" certification, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications. Prior to City Engineer's approval the manufacturer must submit certified material test reports for the following materials: aggregates, cement, admixtures, wire mesh, reinforcing rod, pre-stress wire, steel sheet, plate and shapes, joint rings, bolts, lugs and gaskets. Water for mortar and concrete mix must be certified to be clear, clean and to have met the requirements of ASTM C-94, “Standard Specification for Ready-Mixed Concrete”. Certified reports must show the actual results of all required chemical analyses, physical tests, examinations and heat treatments, including times and temperatures. The expense of performing all tests and for providing certified test reports required must be borne by the Contractor.

G. Proof of Design and Cylinder Hydrostatic Test Reports – Test reports in accordance with this section are required.

H. Welders’ Qualification Certificates – Certificate of qualifications issued by ASME. Welders must meet the general requirements of Section 4.6 of AWWA C-301“Design of prestressed concrete cylinder pipe”.

I. Affidavits of Compliance – Affidavits of compliance from the manufacturer for the following:

1. Pre-stressed concrete cylinder pipes as required by AWWA C-301“Design of prestressed concrete cylinder pipe” and as modified herein.
2. Specials and fittings as required by AWWA M-11, “M11 Steel Pipe: a guide for design and installation”, and as modified herein.
3. The affidavits of compliance must be certified by a professional City Engineer licensed in the State of Oklahoma.

J. Guides – The manufacturer's pipe installation guide, standard pipe material repair guide and written quality control manual are required.

K. Copies – The Contractor must provide a digital copy of all submittals, and if requested by the City Engineer, hardcopies of any submittal must be provided as well.

516.02.03 – DESIGN BASIS

A. General – All pre-stressed concrete cylinder pipe must be designed for the combination of internal pressure and external load outlined in the referenced AWWA standard (AWWA C-304) referred to in AWWA C-301“Design of prestressed concrete cylinder pipe”., or as modified herein.

B. Depth of Cover – The minimum design depth of cover must be ten (10') feet. The assumed depth of cover for design purposes must be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') feet to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') feet to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing must be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

Minimum Depth of Cover for PCCP	
Actual Buried Depth (Feet)	Design Depth (Feet)
minimum	10
10-15	15
15-20	20
20-25	25
25-30	30
Greater than 30	30

C. Soil Unit Weight – Unless otherwise specified, the soil unit weight must be taken as one hundred twenty pounds per cubic foot (120-pcf).

D. Earth Load – Earth load must be calculated based on a trench at the transition width using Marston equations.

E. Live Load – Unless otherwise specified, all pipes and fittings must be designed for AASHTO HS-20 truck load or E-80 Cooper axle railroad conditions.

F. Bedding – The design bedding angle must be taken as ninety (90°) degrees, pursuant to the Standard Detail for installation of Rigid Pipes. Bedding must be installed as per Section 501 “Pipe and Fittings Installation”.

G. Core Concrete – The twenty-eight (28) day compressive strength must be assumed to be no greater than five thousand pounds per square inch (5,000-psi) and no greater than six thousand pounds per square inch (6,000-psi) for vertically cast cores, and centrifugal or radial compaction, respectively.

H. Elastic Limit Pressure – The elastic limit pressure must be not less than 1.4 times the design pressure.

I. Burst Pressure – The burst pressure must be at least three (3) times the working pressure.

J. Trenchless Installations – For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design must be equal to or greater than the minimum pipe design on either side of the installation.

516.02.04 – MODIFICATIONS TO AWWA C-301

The following sections of AWWA C-301 are modified as follows:

A. Marking – The manufacturer's control number or work order number pertaining to any given section of pipe must be stamped legibly and indelibly on the interior of the spigot joint ring following curing. All inspection reports must show the work control number. Piece designation corresponding to laying position in lay schedule must be marked on the outside of the pipe.

Each piece of straight and special pipe and each fitting must be indelibly stenciled on the inside concrete surface at the pipe end with the following information: inside diameter, class, unique control number, cast date, wrapping date, wire diameter, wire class, wire spacing.

B. Inspection and Testing by Purchaser – The City Engineer will have the right to inspect and review all materials, processes, procedures, and records related to the manufacture and repair of pipe. The manufacturer must provide the City Engineer with copies of all written quality control procedures and tests and reports as may be employed by the manufacturer during the production of the pipe. Such information must be kept confidential when so requested by the manufacturer.

C. Cement – Cement used for the core, slurry, mortar coating, and authorized repairs must conform to the requirements of ASTM C-150 "Specifications for Portland Cement" Type II. No cement replacement materials or mineral admixtures must be used without prior approval from the City Engineer.

D. Fine Aggregate and Coarse Aggregate – Acceptance of coarse and fine aggregate failing to meet the requirements for grading and quality as defined in ASTM C-33 "Standard Specification for Concrete Aggregates" must be based on comparative laboratory test data demonstrating at least equal performance with respect to compressive strength and shrinkage for both concrete and mortar. The coarse aggregate must be sampled in accordance with ASTM D-4791, “Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate”, for thin or elongated pieces, the maximum dimension of

which exceeds five times the minimum, cannot be more than ten percent (10%) of the coarse aggregate by weight.

E. Water – Clear, clean water in compliance with ASTM C-94 must be used in all concrete and mortar. The use of recycled or wash water must not be permitted.

F. Admixtures – No admixture must be used without prior approval of the City Engineer. Test data and compositional analysis of admixtures must be submitted for acceptance prior to use.

G. Steel for Cylinders and Fittings, Steel sheets and coils – Steel sheets and coils for cylinders must be hot rolled Grade C conforming to the requirements of AWWA C-301.

H. Steel Reinforcement, Pre-stressed Wire – The pre-stressing wire for circumferential reinforcement must conform to ASTM A 648 "Specification for Steel Wire Hard-Drawn for Pre-stressing Concrete Pipe" except that the following must be added under the specification paragraphs as noted below:

I. Section Numbers referred to are those in ASTM-A648

1. Physical Requirements (Section 7).
   a) Section 7.1.5 - Reduction of area must conform to thirty-five (35%) percent minimum for size one-quarter (0.250) inch and larger wire. Torsion Test (Section 7.2) Torsion Test
   b) Section 7.2.2 - One (1) test specimen suitable for a twelve (12") inch (12-in) span must be taken for each coil.

2. Inspection (Section 10) - The wire supplier's certification that the wire was manufactured and tested in accordance with the specifications, as herein modified, together with a report of the test result must be furnished to the City Engineer prior to acceptance of the finished pipe. Such reports must clearly reference the lot or heat involved and the reference number, code or other designation must be identifiable on each coil as delivered.

3. The pipe design must be based on the minimum tensile strengths of the wire class used. Wire other than Class I, II, or III must not be used.

4. General Requirements for Core and Coating Tolerances – The minimum thickness of the core for embedded cylinder pipe must be as shown in the following table.

Diameter (inches)	Core Thickness (inches)
48	4
54	4

Diameter (inches)	Core Thickness (inches)
60	4½
66	5
72	5½
78	6
84	6½
90	6½
96	6½
102	6½
120	8
126	8½

For embedded cylinder pipe, the thickness of the inner concrete lining must not vary from the nominal dimension by more than the values shown in the table below:

Diameter (inches)	Inner Concrete Lining Thickness Variance (inches)
48	⅛
54 – 72	3/16
> 72	¼

The thickness of the mortar coating must be such as to provide a minimum clear cover of four (4) times the nominal wire diameter over the exterior portion of the wire but cannot exceed one and one-quarter inches (1.25-in).

J. Design of Pipe Reinforcement – The pre-stress wire cannot be smaller than one quarter inch (0.25-in) diameter. Adjacent wires must not touch at any point. End wraps cannot be placed more than one and one-half inches (1.5-in) or less than one inch (1-in) from the edge of the core to be coated with the full depth of the mortar coating. Splices in the pre-stress wire cannot be closer than three feet (3-ft) from each splice as measured along the longitudinal axis of the pipe.

K. Concrete for Pipe Core Mixing – The temperature of the mix must not exceed ninety degrees F (90-degrees F) at the time of placement. The measured slump of the concrete used in embedded-cylinder pipe must not vary more than one inch (1-in) from the approved mix design, as measured at the mixer discharge. Pipe made with a concrete slump exceeding this limit must be rejected.

L. Curing of Pipe General – Cores must be cured by the accelerated curing method only. The total continuous cure including the delay period, but excluding the time required to remove the forms or end rings, must be a minimum of twenty-four hours (24-hrs). Forms or rings must not be removed until after a minimum of twelve hours (12-hrs) of accelerated curing, including the required four hour (4-hr) delay period.

M. Accelerated Curing – The delay period before temperature is increased during accelerated curing must not be less than four (4) hours for any pipe core or coating, during which period temperature must not be raised above one hundred (100°) degrees F and the humidity must be maintained as specified in AWWA C-301, Placing of Wire Reinforcement.

N. Placing of Wire Reinforcement General – The temperature of the cores must be at least forty degrees F (40-degrees F) and the cores must be in a surface dry condition at the time of pre-stressing. Air pockets, honey combing, holes or voids three-eighths inch (0.375-in) depth and/or diameter or greater and offsets as defined in Section 516.02.04.V - "Modifications to AWWA C-301 “Repair of Core and Coating” and deeper must be filled and patched at the time the form is removed. Patches must be adequately cured prior to pre-stress and finished in such a manner as to prevent bridging or gaps under the pre-stress wire.

O. Portland Cement Slurry – A retarding admixture must be used in the mix. The point of application must be eight inches (8-in) to twelve inches (12-in) ahead of the leading wire or between the lead wraps and final wraps of the lead wrap machines. The rate of application must not be less than one gallon per ninety square feet (90-gpsf). Cores must not be pre-stressed prior to ninety-six hours (96-hrs) following the completion of casting.

P. Pipe Coating General – The coating must be applied within sixteen hours (16-hrs) after pre-stressing. The temperature of the pipe must be at least forty degrees F (40-degrees F) at the time of coating.

Q. Mortar Coating – Cement mortar coating must not contain any rebound and must consist of a cement-to-fine aggregate ratio between 1:2 and 1:2.75 by weight on the pipe. Batched fine aggregate weights must be compensated for moisture in the fine aggregate. The moisture content of the coating as applied must not be less than six percent (6%) of the total saturated surface dry weight of the sand and cement. Ambient accelerated curing temperatures of the coating must not exceed one hundred and ten degrees F (110-degrees F). The cured coating must be free of holes, hollows, delamination, and cracks.

R. Curing of Coating (Accelerated Curing) – All cement mortar coating must be cured by the accelerated method only and must be continuous for a minimum of twelve hours (12-hrs), including the four hours (4-hr) delay period.

S. Repair of Core and Coating – Repairs must not be made without prior approval of the detailed written repair and testing procedures. The following procedures must be employed where applicable.

> “Cylinders” through “Finished Pipe” are created herein, to define what may be repaired and what is not acceptable to be repaired. For

Cylinders, all oil, grease, soap, mud, ice, snow, etc., must be removed. Bumps and dents must be taken out of cylinders before they are used. To remove bumps or dents, use only a rubber, rawhide, or fiber mallet. For a core that has been rejected, when the concrete is knocked out of the cores, the cylinder must be hydrostatically retested before being reused.

Exceptions must be submitted to the City Engineer for approval.

T. Cores

1. Embedded Cylinder – Cores with indentations which cause bridging of the wire and/or gate offsets in the outer concrete surface exceeding one-eighth inch (0.125-in) will not be pre-stressed without repair.

   Depth of depression and offset must be determined by an outside template placed on the core surface. Cores having air pockets in the outer envelope three-eighths inch (0.375-in) deep and/or one quarter inch (0.25-in) wide must be repaired. Surface skin must be removed. Elongated pockets of equivalent surface area must be repaired. Sand streaks, honeycombs, casing leaks, or soft and rotten concrete in the inner and outer envelopes must be removed and patched. So that patches may cure with the pipe, all core repairs must be done in the bays after the casings are removed and the core temperature is below ninety degrees F (90-degrees F). The patching mix must be at the same temperature as the core.

2. Embedded Cylinder Core Cracks Prior to Pre-stress – Pipe must be patched as soon as possible and prior to pre-stressing. Inside longitudinal cracks due to handling, plastic shrinkage, sags or tears must be patched or the concrete broken out and recast or the core rejected.

   Lining circumferential or helical slump cracks of less than fifteen hundredths' inches (0.015") (0.15-in) in width need not be patched. Circumferential cracks in excess of fifteen thousandths inches (0.015-in) width, but less than three-thousandths inches (0.030") (0.003-in) may be repaired. Cracks that exceed thirty-thousandths inches (0.030-in) width and twelve inches (12-in) in length must not be repaired and the core must be rejected.

   Cores with external longitudinal cracks of any width are not acceptable and the core must not be pre-stressed, except for cracks less than five thousandths' inches (0.005-in) width within one foot (1-ft) of bell end or spigot end.

U. Brush Coating

1. Application Faults – Defects appearing in mortar coating, such as blisters, hollow spots, falloffs, or slippage cracks during or immediately after

application, must be removed and repaired before the pipe is placed in the bay for curing.

Defective areas greater than fifty square inches (50-sin) or extending more then ninety degrees (90-degrees) circumferentially or exposing pre-stress wire must be repaired on the machine, not by hand. Defective areas smaller than fifty square inches (50-sin) that are not over the pre-stress wire may be hand patched. Pipe to be hand repaired must be positioned in a revolving machine so that area to be patched is on top when in curing bins.

2. Other Conditions – Holes caused by the depth gauge, used to measure the coating thickness, must be fully pressed closed immediately after removing gauge. Stone holes in the mortar must be filled and repaired in the curing bins, preferable prior to curing, otherwise prior to yarding. Drip holes must be repaired prior to yarding pipe.

V. Finished Pipe

1. Interior of Pipe – Core cracks must not be slurried, painted over or otherwise dressed to improve appearance. Holes larger than three-eighths inch (0.375-in) diameter and/or one-fourth inch (0.25-in) deep must be repaired. Pre-stressed pipe with shrinkage cracks, either circumferential or helical, must not be shipped if cracks exceed fifteen thousandths inches (0.015-in) in width at any point.

   Inner lining longitudinal cracks exceeding two thousandths inch (0.002-in) width, after pre-stress or with an offset, are cause for rejection except for cracks less than one hundredth inches (0.01-in) maximum width in the not pre-stressed area between the spigot face and joint ring weld. Circumferential spigot cracks wider than thirty thousandths inches (0.030-in) at any point, resulting from pre-stressing, must be filled by epoxy injection prior to shipment.

2. Exterior of Pipe – Cracks in coating of pipe may be cause for rejection. This does not apply to surface craze cracks whose width cannot be measured or where cracks occur over saddles which may be repaired.

3. Ends of Pipe (Over Joint Rings) - All visible coating cracks must be repaired.

W. Fittings Design – All fittings must meet the minimum thickness requirement shown below. Fittings must be mortar coated on the interior and exterior surfaces. Fittings employing supplemental external reinforcement cages must not be used.

Pipe Inside Diameter (inch)	Steel Cylinder Thickness

	(inch)
48	1/2
54	9/16
60	5/8
≥ 72	3/4

X. Steel Fabrication

1. General – Remove all scale and other foreign matter accumulating on the plate during rolling and forming operation by an air blast so that it will not be rolled or pressed into the surface of the plate. Complete all rolling and forming prior to making butt welds. Do not heat or hammer for the necessary forming of angles.

2. Fit up – Prior to welding using fillet welds, fit the plates to be welded closely; and during welding hold them firmly together.

   Tack weld the edges of the butt joints or clamp in place in proper alignment and so hold throughout the welding process. Do not use dogs, clips, lugs or equivalent devices welded to the steel plate for the purpose of forcing it into position.

3. Cleaning – Prior to welding, clean the surfaces of all plates and members to be welded of all scale and rust for a distance of not less than one inch (1-in) and of all oil or grease for a distance of not less than three inches (3-in) from the welding edge on both sides of the plates in the case of butt joints.

   Remove grease or oil with gasoline, lye or other approved means. Do not use kerosene or any heavier petroleum solvent. When it is necessary to deposit metal over a previously welded surface, remove scale, slag or welding flux by a roughing tool, chisel, air chipping hammer, or other means.

4. Aligning – Where butt-welded joints are used, align edges to be jointed to ensure complete penetration and fusion at the bottom of the joint. Limit the offset in abutting edges to one-sixteenth inch (0.0625-in) at circumferential seams and to one thirty-second inch (0.03125-in) at longitudinal seams.

5. Quality of Welds – Butt welds must not be made prior to the completion of the rolling and forming. All butt welds for both hand and automatic welding must be grounded out or back-gouged to sound metal before welding reverse side.

   Longitudinal seams must be welded before girth seams. All welds must be full strength, ductile, and must be made to ensure uniform distribution of load throughout the welded section. All welded joints must be of a type that

will produce complete fusion of the plates and must be free from unsound metal, pinholes, and cracks.

The finish of welded joints must be uniform, smooth, and free from grooves, depressions, burrs and other irregularities. There must be no valley or undercut in the center or edges of any weld.

Flanges must be flat faced. The gasket surfaces must have a V-serrated finish of approximately thirty-two (32) serrations per inch, approximately one sixty-fourth inch (0.015625-in) deep. Serrations may be either concentric or spiral.

Welded-type outlets must have a mounting diameter the same as that of the surface upon which they are to be mounted, except that where the mounting surface is curved to a diameter of thirty-six inches (36-in) or more, the outlet bottom may be flat. Welded-type outlets must be forged steel.

Steel plate fittings must be designed in accordance with AWWA M-11. Steel plate must conform to ASTM A-36 or an approved equal. The fittings, specials and appurtenances must be hydrostatically tested to a pressure not less than that for the pipe. Non-destructive testing in accordance with AWWA C-200, Section 4.3 can be substituted for the hydrostatic test. Lining and Coating - All fittings must be cement mortar coated and lined.

Y. Curves, Bends and Closures – Where restrained joints are called for on the plans, they must be made by fully welding the spigot contact ring to the bell mating surface to produce a watertight joint without the use of a rubber gasket. The spigot ring must be prepared for welding during manufacture of the pipe by cutting off the spigot groove. The fillet weld size must be equal to the thickness of the bell joint ring.

Z. Outlets and Connections on Pipe – Openings for manholes and connections for air valves, blowoffs, and other branches must be built into the walls of the concrete pipe and must be designed in accordance with AWWA M-11.

In all cases, the primary steel reinforcement must not be in the form of a collar. In the case where a collar is sufficient reinforcement according to AWWA M-11, a three hundred sixty degree (360-degree) wrapper can be substituted. If secondary reinforcement is required by the AWWA M-11 procedure, a collar may be used. The steel plate must conform to ASTM A-36 or an approved equal. The wrapper thickness must be no greater than four times the thickness of the cylinder in the concrete pipe section. The wrapper must be welded to the exterior of the cylinder of the pipe section and the portion of the cylinder between the circumferential welds removed. The welds must be penetrant dye tested for their entire circumference.

The flanges for specials and fittings must be in accordance with AWWA C-207 Class E with bolt-hole drillings as for Class 125 cast iron flanges. All flanged joints must be made with single-piece, red rubber gaskets one-eighth inch (0.125-in) thick. Gaskets must be full face for exposed installation and ring type or full faced for buried service meeting AWWA C-207 requirements. All nuts and bolts for buried flange joints must be of stainless steel meeting the requirements of ASTM A-193, Grade B7.

516.03 – TESTING (MANUFACTURERS' TESTING)

516.03.01 – PLANT QUALITY CONTROL AND INSPECTION

A. General – Procedures, tests and requirements as set forth herein are in addition to, and for the purpose of monitoring the quality of pre-stressed concrete pipe supplied under AWWA C-301 standard. The inspections and tests required must be performed by the material supplier, pipe manufacturer, or designated laboratory and the results forwarded to the City Engineer. The City Engineer reserves the right to inspect the materials, fabrication process or product at any or all times.

B. Tests and Inspections – Tests and inspections to assure conformance with the specifications are established herein. Inspection to verify the quality of work be performed by persons other than those engaged in the activity being examined. Such persons must not report directly to the production supervisor responsible for the work.

The City Engineer will make an effort to inspect each section of pipe at various stages of production. Accordingly, the manufacturer must provide the City Engineer with a written production schedule to facilitate inspections. Testing must be performed in accordance with the approved procedures. In the absence of established written procedures, the test methods must be documented by the manufacturer and proved by actual demonstration to the satisfaction of the City Engineer.

When approved, the manufacturer must be notified in writing. At least one (1) copy of the procedures to be followed must be available to all appropriate personnel at the testing site for reference and use. All instruments, gauges and other testing and measuring equipment used in activities affecting quality must be of proper range, type, and accuracy to verify conformance with Standard Specifications, and Standard Detail and project specifications and requirements. Procedures must be in effect to assure that they are calibrated and certified at no longer than annual intervals.

Calibration must be against measurement standards that have known relationship to national standards where such exist. Gauges must be calibrated and certified

for the piece of equipment of which they are a part and must remain on the piece of equipment following certification. Materials and items including products previously checked or manufactured with equipment found to be out of calibration or adjustment must be considered unacceptable until it can be determined that all applicable requirements have been met. The manufacturer must maintain records of all required tests and inspections.

These records must include documents such as records of materials, manufacturing, inspection, repairs, and test data taken before and during fabrication. The City Engineer reserves the right to request specific data be included in the report which may not otherwise be included. Whenever tests and inspections are performed on a pipe element or pipe, the appropriate identification number must be shown on the report. Copies of all reports of tests by the manufacturer, including computer printouts of production records, independent laboratory, or material suppliers must be given to the City Engineer in such form as to be appropriate for permanent records.

The City Engineer must have access to all records of tests and inspections related to pipe manufactured and must also have the right to witness any tests being performed by the manufacturer or his suppliers relative to products, materials, or the pipe being produced.

C. Fabrication Testing and Inspection – Testing and inspection of the materials, used in fabrication of the pipe, must be executed in accordance with the procedure and at the frequency listed in the following table. The required testing must be done by either the material supplier, an independent laboratory, or the manufacturer. The test area wherein the tests are performed must be properly certified and such certification must meet with the City Engineer's approval. Where the frequency of testing differs in the following table from that required by the referenced specification or test method, the greater frequency will govern.

MATERIAL	REQUIREMENTS	REFERENCE OR TEST METHOD	FREQUENCY
Cement	Physical and chemical properties	ASTM C-150	Each Shipment
Aggregates	Gradation	ASTM C-136	Weekly
	Moisture content	ASTM C-566	Daily
	Material finer than #200 sieve	ASTM C-117	Weekly
	Organic impurities	ASTM C-40	Test frequency must be on a source basis. The City Engineer reserves the right to call for tests during the manufacture of the
	Flat and elongated particles	CRD-C-119	
	Friable particles	ASTM C-142	

MATERIAL	REQUIREMENTS	REFERENCE OR TEST METHOD	FREQUENCY
Aggregates	Lightweight particles	ASTM C-123	pipe. The tests applied to new sources and the results approved by the City Engineer prior to use.
	Specific gravity and absorption	ASTM C-127 or ASTM C-129	
	Chlorides	ASTM C-1411	
	Potential reactivity	ASTM C-289	
	Soundness	ASTM C-88	
Admixtures	Chemical composition	Infrared spectro-photometry, pH, and solids content in accordance with ASTM C-494	Each Shipment
Concrete	Mixer uniformity	ASTM C-94	Initially and every six months
	Sampling	ASTM C-172	
	Cylinders	ASTM C-31	
	Compressive strength	ASTM C-39	One set of 2 cylinders daily for each test age for each 50 cu. yd. or portion thereof and for each class of concrete
	Slump	ASTM C-143	First batch placed each day and every 50 cu. yd. or portion thereof for each class of concrete
	Temperature		Same as above
	Unit weight/yield	ASTM C-138	Weekly
Casting	Proportions on pipe wash out test		Weekly
Mortar	Hardened mortar absorption	ASTM C-497 Method A	Weekly
Slurry	Proportions	Specific gravity	Daily
	Application rate	Discharge nozzle flow	Initially
Pre-stressing	Tension Test	ASTM A-370 Supplement IV	Tests must be applied to each 10,000-pound lot with samples representing one test for each coil, and not less than every fifty
	Wrapping test	ASTM A-370 Supplement IV	

MATERIAL	REQUIREMENTS	REFERENCE OR TEST METHOD	FREQUENCY
	Torsion test	ASTM E-558	consecutive pipes wrapped. If any sample test indicates defective product, each coil within the lot or heat must be tested. If any additional tests indicate any defective product, the entire heat will be rejected. Same as above Same as above

D. Proof of Design Test – Prior to the start of manufacture, (1) one section of the highest class of each size of pipe must be fabricated in accordance with the approved design and the requirements of these Standard Specification. At age five (5) to seven (7) days after completion, each section must be subjected to a hydrostatic test.

During this test, the pressure must be raised from eighty percent (80%) of the P_o (internal pressure required to overcome all compression in the concrete) to P_o in twenty pounds per square inch (20-psi) increments pausing at least five (5) minutes at each increment. At the P_o pressure, the pressure must be raised in ten (10-psi) pound per square inch increments to the working plus surge pressure, pausing at least five minutes (5-min) at each increment.

At the working plus surge pressure, there must be no coating crack exceeding three thousandths of an inch (0.003-in) at any location nor a coating crack in the barrel exceeding two thousandths of an inch (0.002-in) by one foot (1-ft) long, nor any evidence of delamination. The barrel is defined as the coated portion of pipe exclusive of area six inches (6-in) from the spigot shoulder and twelve inches (12-in) from the bell face. It will be permissible to keep the exterior of the pipe wet for a period not exceeding forty-eight hours (48-hrs) prior to test. Before the test must commence and during the entire period of the testing, the coating must be in a surface dry condition.

During the first week of production, two (2) additional sections of pipe of the highest class of each size can be selected at random by the City Engineer and subjected to the hydrostatic test. Failure to meet the hydrostatic test requirements must be cause for reducing the pressure rating of each pipe class to a class that can be shown to meet the criteria established. If in the judgment of the City Engineer, additional test are warranted because of variations in design, materials, manufacturing or handling/storage methods, they must be conducted as directed in accordance with the above procedures The contractor/manufacturer must provide means or equipment, meeting OSHA requirements, to the City Engineer, to safely inspect the pipe during the hydrostatic testing.

E. Manufacturer’s Plant Inspection

1. Manufacturer's Inspection – In addition to all other hydrostatic tests, the City Engineer can select at random one (1) of the pipe produced each day for hydrostatic testing. When less than ten (10) pipes are produced in a day, one (1) pipe can be selected from each lot of twenty (20) pipes manufactured, for hydrostatic test. The pipe must be tested at age five (5) to seven (7) days to the working plus surge pressure for a period of time sufficient to determine the coating crack behavior. Pipes developing coating cracks must be rejected and further testing required to establish acceptable performance in the opinion of the City Engineer. Prior to final inspection by the City Engineer, the manufacturer must conduct a complete inspection and place an appropriate stamp on the lining indicating the pipe to be complete and ready for shipment.

2. City Engineer's Inspection – In-Process examination by the City Engineer will encompass all phases of manufacturing and testing, and will include but not be limited to the following, for each section of pipe at the indicated stages of pipe production:

3. Cylinder Prior to Casting Concrete

   (a) Number of leaks at first pressure test. Excessive repairs in the opinion of the City Engineer will be cause for rejection

   (b) Dents or indentations

   (c) Surface dirt or contamination

   (d) Advanced corrosion. Pits exceeding ten percent (10%) thickness of the sheet will be cause for rejection.

4. Pipe Cores Prior to Pre-stressing

   (a) Voids and patching

   (b) Offsets and bulges which may cause bridging and gaps under wire

   (c) Damage or cracking in core concrete

5. Pre-stressing Pipe Core Prior to Coating

   (a) Adequacy of slurry coverage

   (b) Clearance between pre-stress wires

   (c) Proper position and number of pre-stress wires

6. After Coating and Curing – All pipe, fittings and specials will be inspected for cracks, delamination and spalls. Inspection in the areas listed above must also be routinely included in the manufacturer's quality control program.

7. The City Engineer's examination must include but not be limited to:

   (a) Joint ring dimensions and roundness`s (manufacturer must provide templates, if necessary)

   (b) Mortar coating defects such as cracks, delamination, spalls, coating thickness, soft areas and foreign matter

   (c) Marking and identification.

F. Field Inspection – After shipment to the job site and prior to installation, the pipe may be re-inspected by the City Engineer for cracks, delamination, spalls or other defects. In addition, the coating may be "sounded", using a ball peen hammer having a head weight of not more than one pound(1-lb), over its entire exterior surface at the spacing of approximately one foot (1-ft) both circumferentially and longitudinally to locate any hollow or drummy areas which may indicate a delamination or void.

516.03.02 – HYDROSTATIC PRESSURE TESTING AND DISINFECTION

Hydrostatic pressure testing and disinfection must be accomplished in accordance with Sections 522.

516.04 – BASIS OF PAYMENT – Public Construction Contracts

Payment must be made pursuant to Section 501.

SECTION 517 – STEEL PIPE

517.01 – DESCRIPTION

This section covers steel pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes forty-eight inches (48-in) and larger unless otherwise specified on plans and specifications.

517.02 – MATERIALS

517.02.01 – GENERAL

All steel pipe and fittings must meet the requirements of ASTM A-572 “Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel”, Grade 52 or ASTM A-139/A-139M, “Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)”, Grade C, and conform to the requirements of the following standards listed below or as modified herein.

A. AWWA M11 – Steel Pipe – A Guide for Design and Installation

B. AWWA C-200 – Steel Water Pipe 6-in and Larger

C. AWWA C-209 – Cold – Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

D. AWWA C-214 – Tape Coating Systems for the Exterior of Steel Water Pipelines

E. AWWA C-206 – Field Welding of Steel Water Pipe

F. AWWA C-602 – Cement - Mortar Lining of Water Pipelines – 4-in and Larger - In Place

G. AWWA C-208 – Dimensions for Fabricated Steel Water Pipe Fittings

H. AWWA C-207 – Steel Pipe Flanges for Waterworks Service - Sizes 4-in through 154-in

I. AWWA C-205 – Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-in and Larger - Shop Applied

J. AWWA C-210 – Liquid Epoxy Coatings Systems for the Interior and Exterior of Steel Water Pipelines

K. AWWA C-213 – Fusion Bonded Epoxy Coating for Interior or Exterior Pipeline Coating

L. ASTM A-193 – Alloy Steel and Stainless Steel - Bolting Materials for High Temperature Service

M. ASTM A-139 – Electric-Fusion (Arc) - Welded Steel Pipe (sizes 4-in and over)

N. ASTM A-370 – Mechanical Testing of Steel Products

O. ASTM A-673 – Sampling Procedure for Impact Testing of Structural Steel

P. ASTM C-150 – Portland Cement

517.02.02 – SUBMITTALS

Review and approval of the Contractor submittals, by the City Engineer, will not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing steel pipe and fittings as described herein. No pipe, special sections and fittings must be manufactured until shop drawings have been reviewed and approved by the City Engineer. The Contractor must submit the following:

A. General – Detail drawings of pipes, specials, fittings, and joints, with design calculations for fittings and specials.

B. Laying Schedule – Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials, and fittings.

C. Certification – Type "A" and "D" certification, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications. for pipe, specials, fittings, gaskets, and lining material pursuant to, but not limited to, applicable standards in Section 517 “Steel Pipe”.

D. Guide – The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E. Mill Test Reports – Mill test reports of steel plates, sheets or coils used in the fabrication of pipe, specials, fittings, and appurtenances.

F. Copies – The Contractor must provide a digital copy of all submittals, and if requested by the City Engineer, hardcopies of any submittal must be provided as well.

517.02.03 – MANUFACTURER

Pipe must be the product of one manufacturer that has had not less than five (5) years successful experience manufacturing pipe of the particular type and size indicated. Pipe manufacturing operations (pipe, fittings, lining, and coatings) must be performed at one (1) location. Pipe Supplier must have, and document, a pipe quality audit program certification from the Steel Pipe Fabricators Association (SPFA) or be certified under International Standards Organization (ISO) quality control standard.

517.02.04 – DESIGN BASIS

A. General – All steel pipe and fittings are designed in accordance with the latest edition of AWWA M-11, “Steel Pipe – A Guide for Design and Installation”, or as modified herein and must conform to minimum wall thickness in Sections 527.02.05 “Steel Pipe – Materials – Minimum Wall Thickness for Buried Installations” and 527.02.06 “ Steel Pipe – Materials – Minimum Wall Thickness for Unburied Installations”. For buried pipes, the design satisfies internal pressure,

deflection, and buckling requirements. Buckling loads are made up of hydrostatic and earth loads plus live load or internal vacuum.

B. Depth of Cover – The minimum design depth of cover must be ten feet (10-ft). The assumed depth of cover for design purposes must be fifteen feet (15-ft) for burial depths of ten to (10-ft) fifteen feet (15-ft), twenty feet (20-ft) for burial depths of fifteen feet (15-ft) to twenty feet (20-ft), twenty-five feet (25-ft) for depth of twenty feet (20-ft) to twenty-five feet (25-ft), thirty feet (30-ft) for depth of twenty-five feet (25-ft) to thirty feet (30-ft), and the actual cover for depths over thirty feet (30-ft). Pipe to be installed inside a casing must be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

Minimum Depth of Cover for Steel Pipe	
Actual Buried Depth (Feet)	Design Depth (Feet)
minimum	10
10-15	15
15-20	20
20-25	25
25-30	30
Greater than 30	30

C. Allowable Stresses – The hoop stress must not exceed fifty percent (50%) of minimum specified yield strength for both working pressure, and combined working pressure plus surge pressure conditions.

D. Deflection – The allowable deflection for the specified mortar lined and flexible coated system, is three percent (3%), for both shop lined and field applied lining and coating system. Deflections are determined based on the following:

1. Deflection lag factor = 1.00

2. Bedding Constant = 0.10

3. Modulus of soil reaction, E' = 1,000-psi

4. Earth load considered is prism of ordinary clay backfill with a unit weight of one hundred and twenty pound per cubic foot (120-pcf), compacted to ninety percent (90%) density (ASTM D-698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”).

5. A highway live loading of AASHTO HS-20 truck, or railroad live loading of Cooper Axle E-80

E. Buckling –

1. Buried Installations – The controlling load for buried pipes is determined from the greater of hydrostatic and earth loads plus vacuum or hydrostatic and earth load plus live load with a factor of safety of 2.5 or 3.0 as determined in accordance with AWWA M-11, “Steel Pipe – A Guide for Design and Installation”. It is assumed that the groundwater level is equal to natural ground surface and the ground is fully saturated.

2. Unburied Installations – For unburied pipes, the internal collapsing vacuum pressure is used in determining the minimum wall thickness in accordance with equation 4-2 of AWWA M-11, “Steel Pipe – A Guide for Design and Installation”, for a factor of safety of 1.5 against buckling. The Poisson’s ratio is 0.30 and modulus of elasticity is $30x10^6$ psi.

3. Vacuum Pressure – For both buried and unburied installations, the internal collapsing vacuum pressure is taken as 14.7-psi.

517.02.05 – MINIMUM WALL THICKNESS FOR BURIED INSTALLATIONS

Unless otherwise specified, steel pipe and fittings for buried installations, including boring, tunneling and micro and small diameter tunneling must have a minimum thickness of three-eighths inch (0.375 inches) and must be not less than the minimum thickness, in inches, shown in the following tables.

For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design must be equal to or greater than the minimum pipe design on either side of the installation. The minimum design pressure is equal to one hundred fifty pounds per square inch (150-psi) working pressure plus one hundred pounds per square inch (100 psi) surge pressure.

A. Pipe Nominal Size – 42-in

<table>
<tr><th rowspan="2">Design Pressure (psi)</th><th rowspan="2">Live load Condition</th><th colspan="5">Maximum Depth of Cover (ft)</th></tr>
<tr><th>10</th><th>15</th><th>20</th><th>25</th><th>30</th></tr>
<tr><td rowspan="2">250</td><td>HWY</td><td>0.3750</td><td>0.3750</td><td>0.3750</td><td>0.3750</td><td rowspan="6">Per City Engineer’s Approval</td></tr>
<tr><td>RR</td><td>0.3750</td><td>0.3750</td><td>0.3750</td><td rowspan="5">Per City Engineer’s Approval</td></tr>
<tr><td rowspan="2">300</td><td>HWY</td><td>0.3750</td><td>0.3750</td><td>0.3750</td></tr>
<tr><td>RR</td><td rowspan="4">Per City Engineer’s Approval</td><td>0.3750</td><td>0.3750</td></tr>
<tr><td rowspan="2">350</td><td>HWY</td><td rowspan="3">Per City Engineer’s Approval</td><td rowspan="3">Per City Engineer’s Approval</td></tr>
<tr><td>RR</td></tr>
<tr><td rowspan="2">400</td><td>HWY</td></tr>
<tr><td>RR</td></tr>
</table>

B. Pipe Nominal Size – 48-in

Design Pressure (psi)	Live load Condition	Maximum Depth of Cover (ft)				
		10	15	20	25	30
250	HWY	0.3750	0.3750	0.3750	0.3750	0.5000
	RR	0.3750	0.3750	0.3750	0.4375	0.5625
300	HWY	0.3750	0.3750	0.3750	0.3750	0.5000
	RR	0.5375	0.3750	0.3750	0.5375	0.5625
350	HWY	0.5375	0.5375	0.5375	0.5375	0.5000
	RR	0.5375	0.5375	0.5375	0.5375	0.5625
400	HWY	0.5000	0.5000	0.5000	0.5000	0.5000
	RR	0.5000	0.5000	0.5000	0.5000	0.5625

C. Pipe Nominal Size – 54-in

Design Pressure (psi)	Live load Condition	Maximum Depth of Cover (ft)				
		10	15	20	25	30
250	HWY	0.3750	0.3750	0.3750	0.5375	0.5625
	RR	0.5375	0.3750	0.3750	0.5000	0.6250
300	HWY	0.5375	0.5375	0.5375	0.5375	0.5625
	RR	0.5375	0.5375	0.5375	0.5000	0.6250
350	HWY	0.5000	0.5000	0.5000	0.5000	0.5625
	RR	0.5000	0.5000	0.5000	0.5000	0.6250
400	HWY	0.5652	0.5625	0.5625	0.5625	0.5625
	RR	0.5652	0.5625	0.5625	0.5625	0.6250

D. Pipe Nominal Size – 60-in

Design Pressure (psi)	Live load Condition	Maximum Depth of Cover (ft)				
		10	15	20	25	30
250	HWY	0.5375	0.5375	0.5375	0.5375	0.6250
	RR	0.5375	0.5375	0.5375	0.5625	0.6875
300	HWY	0.5000	0.5000	0.5000	0.5000	0.5260
	RR	0.5000	0.5000	0.5000	0.5625	0.6875
350	HWY	0.5625	0.5625	0.5625	0.5625	0.6250
	RR	0.5625	0.5625	0.5625	0.5625	0.6875
400	HWY	0.6250	0.6250	0.6250	0.6250	0.6250
	RR	0.6250	0.6250	0.6250	0.6250	0.6875

E. Pipe Nominal Size – 66-in

Design Pressure (psi)	Live load Condition	Maximum Depth of Cover (ft)				
		10	15	20	25	30
250	HWY	0.5000	0.5000	0.5000	0.5000	0.6875
	RR	0.5000	0.5000	0.5000	0.6250	0.7500
300	HWY	0.5000	0.5000	0.5000	0.5000	0.6875
	RR	0.5000	0.5000	0.5000	0.6250	0.7500
350	HWY	0.6250	0.6250	0.6250	0.6250	0.6875
	RR	0.6250	0.6250	0.6250	0.6250	0.7500
400	HWY	0.6875	0.6875	0.6875	0.6875	0.6875
	RR	0.6875	0.6875	0.6875	0.6875	0.7500

F. Pipe Nominal Size – 72-in

Design Pressure (psi)	Live load Condition	Maximum Depth of Cover (ft)				
		10	15	20	25	30
250	HWY	0.5000	0.5000	0.5000	0.5625	0.7500
	RR	0.5625	0.5625	0.5625	0.6250	0.8125
300	HWY	0.5625	0.5625	0.5625	0.5625	0.7500
	RR	0.5625	0.5625	0.5625	0.6250	0.8125
350	HWY	0.6250	0.6250	0.6250	0.6250	0.7500
	RR	0.6250	0.6250	0.6250	0.6250	0.8125
400	HWY	0.7500	0.7500	0.7500	0.7500	0.7500
	RR	0.7500	0.7500	0.7500	0.7500	0.8125

G. Pipe Nominal Size – 78-in

Design Pressure (psi)	Live load Condition	Maximum Depth of Cover (ft)				
		10	15	20	25	30
250	HWY	0.5625	0.5625	0.5625	0.6250	0.8125
	RR	0.6250	0.5625	0.5625	0.6875	0.8750
300	HWY	0.6250	0.6250	0.6250	0.6250	0.8125
	RR	0.6250	0.6250	0.6250	0.6875	0.8750
350	HWY	0.6875	0.6875	0.6875	0.6875	0.8125
	RR	0.6875	0.6875	0.6875	0.6875	0.8750
400	HWY	0.8125	0.8125	0.8125	0.8125	0.8125
	RR	0.8125	0.8125	0.8125	0.8125	0.8750

H. Pipe Nominal Size – 84-in

Design Pressure (psi)	Live load Condition	Maximum Depth of Cover				
		10	15	20	25	30
250	HWY	0.6250	0.5625	0.5625	0.6250	0.8750
	RR	0.5260	0.5625	0.5625	0.7500	0.9375
300	HWY	0.6250	0.6250	0.6250	0.6250	0.8750
	RR	0.6250	0.6250	0.6250	0.7500	0.9375
350	HWY	0.7500	0.7500	0.7500	0.7500	0.8750
	RR	0.7500	0.7500	0.7500	0.7500	0.9375
400	HWY	0.8750	0.8750	0.8750	0.8750	0.8750
	RR	0.8750	0.8750	0.8750	0.8750	0.9375

517.02.06 – MINIMUM WALL THICKNESS FOR UNBURIED INSTALLATIONS

The design pressure class selected is the minimum pressure class needed. Unless otherwise specified, steel pipe and fittings for unburied installations must have a minimum thickness of three-eighths inch (0.375-in) and must be not less than the thickness, in inches, shown in the following table:

Pipe Nominal Size (inch)	Design Pressure (psi)			
	250	300	350	400
48	0.3750	0.3750	0.5375	0.5000
54	0.5375	0.5375	0.5000	0.5625
60	0.5375	0.5000	0.5626	0.6250
66	0.5000	0.5000	0.6250	0.6875
72	0.5625	0.5625	0.6250	0.7500

78	0.5625	0.6250	0.6875	0.8125
84	0.6250	0.6250	0.7500	0.8750

517.02.07 – SPECIALS AND FITTINGS

The specials and fittings must be fabricated in accordance with AWWA C-200, “Steel Water Pipe, 6 in. (150 mm) and Larger”. Fittings must meet the requirements of AWWA C-208, “Dimensions for Fabricated Steel Water Pipe Fittings”, for dimensions. All tees, laterals and outlets must be designed in accordance with AWWA M-11, “Steel Pipe – A Guide for Design and Installation”. The specials and fittings must be provided in accordance with approved submittals or as shown on the plans.

517.02.08 – JOINTS

A. General – Pipe joints must be made with flanges, sleeve couplings, or lap welded slip joints.

B. Flanges – The flanges for steel pipe, specials and fittings must be in accordance with AWWA C-207, “Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)”, Class E with bolt-hole drillings as for Class 125 cast iron flanges. All flanged joints must be made with single-piece, red rubber gaskets one eighth inch (0.125-in) thick. Gaskets must be full face for exposed installation and ring type or full faced for buried services meeting AWWA C-207, “Steel Pipe Flanges for Waterworks Service—Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm)”, requirements. Flange nuts and bolts must be of stainless steel and must meet the requirements of ASTM A-193, “Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications”, Grade B7.

C. Sleeve Couplings – All sleeve couplings, except as shown on the plans, must be restrained with tie rods, and must be designed for pipe design pressure and maximum allowable stress not to exceed sixty-five percent (65%) of minimum yield strength of steel used. Harnessed joints must be designed in accordance with AWWA M-11, “Steel Pipe – A Guide for Design and Installation”.

D. Lap-Welded Slip Joints – Welding of pipe joints must be done in accordance with the requirements of AWWA C-206, “Field Welding of Steel Water Pipe”. Buried pipe, specials, fittings, and tied joints, except as shown or noted on the plans must have full size, single fillet lap-welded slip joints, welded inside and outside. All welds must be sound and free from embedded scale or slag. The welded joints must have tensile strength across the weld not less than that of the thinner of the connected sections and must be leak free.

The type and use of welding electrodes for the carbon steel must meet the requirements of AWS B2.1, “Specification for Welding Procedure and Performance

Qualification". During welding of pipe sections, coating must be protected to avoid damage to the coating by hot weld splatters. No welding ground must be made on coated part of the pipe. All field welding must be done in accordance with the requirements of AWWA C-206, "Field Welding of Steel Water Pipe".

517.02.09 – EXTERIOR COATING

A. Pipe and Specials – Exterior coatings for steel water pipe must be Tape Coating.

1. Tape Coatings for Steel Water Pipe

   (a) The exterior of steel pipe and specials must be coated and wrapped with prefabricated, multi-layer, cold-applied tapes by mechanical methods and tested in accordance with the requirements of AWWA C-214, "Tape Coatings for Steel Water Pipe".

   (b) The tape coating system must be a minimum of three (3) layers with a total thickness of eighty mils (80-mil). The three layers must consist of a primer, twenty mil (20-mil) thick inner layer and two (2) thirty mil (30-mil) thickness layers outer layers.

   (c) The properties of the entire system must conform to the appropriate values used in Tables 1, 2 and 3 of AWWA C-214, "Tape Coatings for Steel Water Pipe". The field joints must be coated with cold-applied tapes in accordance with the requirements of AWWA C-209, "Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water".

   (d) The bell must provide for a two-inch (2-in) lap with three-fourths inch (0.75-in) allowable pull for a required one inch (1-in) minimum lap. Shop applied exterior coating must be held back four inches (4-in) each end.

B. Connections, and Fittings – The exterior of connections and fittings for steel water pipelines must be primed and wrapped with prefabricated cold-applied tape coating in accordance with the requirements of AWWA C-209, "Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water". The thickness of prefabricated tape coating must be two (2) thirty-five mil (35-mil) layers.

517.02.10 – INTERIOR LINING

The interior of steel pipe, specials and fittings must be cement mortar lined. The thickness of cement mortar lining must be one-half inch (0.5-in).

Field linings must be placed mechanically in accordance with AWWA C-602, “Cement-Mortar Lining of Water Pipelines in Place 4 In. (100 mm) and Larger”. Shop applied lining must be in accordance with AWWA C-205, “Cement–Mortar Protective Lining and Coating for Steel Water Pipe 4 In. (100 mm) and Larger”.

Portland Cement for cement mortar lining must be in accordance with the requirements of ASTM C-150/C-150M, “Standard Specification for Portland Cement”, Type I cement.

Field joints must be made in accordance with the requirements of AWWA C-205, “Cement–Mortar Protective Lining and Coating for Steel Water Pipe 4 In. (100 mm) and Larger”, Appendix A.

The interior of all outlets and connections smaller than six inches (6-in) must be painted with liquid epoxy in accordance with the requirements of AWWA C-210, “Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings”. Shop applied interior coating must be held back four inches (4-in) on both ends.

517.02.11 – CONNECTIONS

A. General – Air valves, blow-offs, manholes, outlets and shut-off line valves must be designed and manufactured to meet the combined working and surge pressures of the pipe.

B. Connection to Other Pipe Materials – When connecting steel pipe to either gray or ductile cast iron pipe, or to steel-reinforced concrete pipe, an electrically insulating joint must be used. The insulating joint can be accomplished with an insulating gasket with sleeves and washers on a flanged connection or with an insulating sleeve-type flexible coupling. Any valves or other ferrous equipment connected to steel pipe must be encapsulated in polyethylene sheeting in accordance with Standard Specifications or coated with a coating compatible with the steel pipe coating. Similar precautions are not necessary when connecting to nonmetallic pipe, such as asbestos-cement or plastic.

C. Flanged Connections – Attachment of flanges must be in accordance with AWWA C-207, “Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)”. Outlet nozzles must be as short as possible.

D. Blow-Off and Air Valve Connections – Connections to the pipe for blow-offs and air valves must be shop welded thread lets, half couplings or flanged nozzle with reinforcing collar in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division I, “Rules for Construction of Pressure Vessels”, Paragraph UG-37 and AWWA M-11, “Steel Pipe – A Guide for Design and Installation”. An outlet less than six inches (6-in) in diameter must be lined with epoxy paint in accordance with the requirements of AWWA C-210, “Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings”.

E. Manhole and Outlet Connections – Manhole and outlet connections must be fabricated and designed in accordance with AWWA M-11, “Steel Pipe – A Guide for Design and Installation”.

F. Air-Release and Air-And-Vacuum Valves – Air-release valves and air-and-vacuum valves, if not installed directly over the pipe, may be located adjacent to the pipeline. A horizontal run of pipe must connect the air valve and the pipeline. The connecting pipe must rise gradually to the air valve to permit flow of the air to the valve for venting.

517.03 – CONSTRUCTION METHODS

The City and/ or City Engineer retains the right to inspect the pipe, specials and fittings, all work performed, and materials furnished at the manufacturer’s plant and at the project site and to independently monitor the fabrication of the pipe, specials, and fittings. Such inspection must not relieve the contractor or the manufacturer of their responsibility to furnish material and perform the work in accordance with Standard Specifications.

517.04 – TESTING

517.04.01– HYDROSTATIC PRESSURE TESTING AND DISINFECTION

Field Testing must be accomplished in accordance with Section 513 “Hydrostatic Pressure Testing and Disinfection”.

517.04.02 – SOURCE QUALITY CONTROL

A. Hydrostatic Test – Each length of pipe must be shop tested hydrostatically to a pressure which will induce a hoop stress equal to at least seventy-five percent (75%) of the minimum yield stress of steel used. The test requirements must be in accordance with AWWA C-200, Section 3.4, “Steel Water Pipe, 6 In. (150 mm) and Larger”.

The fittings, specials and appurtenances must be hydrostatically tested to a pressure not less than that for the steel pipe. Non-destructive testing in accordance with AWWA C-200, “Steel Water Pipe, 6 In. (150 mm) and Larger”, may be substituted for the hydrostatic test when approved by the City Engineer. Test reports of the hydrostatic testing of steel pipe, specials and fittings must be submitted to the City Engineer on a weekly basis during production.

B. Welding – Quality control tests of production welds during the manufacture of steel pipe must be conducted in accordance with the requirements of AWWA C-200, “Steel Water Pipe, 6 In. (150 mm) and Larger”.

C. Field Welding – At the beginning of work, a yield point determination of a welded joint must be made by an independent testing laboratory. When directed by the City Engineer, welded test specimens must be furnished for testing. All costs for laboratory testing must be borne by the Contractor. Use of back up welding strips or rings for shop welds must not be permitted.

D. Welder Qualifications – All welding must be done by ASME qualified welders. Welders must meet the general requirements of Section IX of ASME Boiler, “Welding and Brazing Qualifications”, and Pressure Vessel Code.

E. Holiday Tests – The Contractor must conduct an electrical inspection of all wrapped surfaces. The electrical inspection must be conducted in accordance with the requirements of AWWA C- 209, “Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines”, and C-214, “Tape Coatings for Steel Water Pipe”.

517.05 – BASIS OF PAYMENT – Public Construction Contracts

Payment will be made pursuant and incidental to Section 501 “Pipe and Fittings Installation”.

SECTION 518 – STEEL CASING PIPE

518.01 – DESCRIPTION

This section covers steel pipe intended to be used as a casing pipe for boring and micro and small diameter tunneling installations.

518.02 – MATERIALS

518.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the City Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing steel pipe and fittings as described herein. When requested the Contractor must submit the following, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of material to be satisfactory:

A. Type "A" certification for pipe, See section 109.17.02, “Control of the Work and Materials – Materials Certifications – Types of Certifications”, for types of certifications.

B. Shop drawings of pipe, joints, and seams

C. Documentation of manufacturer's on-going quality control program

518.02.02 – GENERAL

A. General – Steel pipe must conform to ASTM A-139, “Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS, Nominal Pipe size, 4 and Over)”. The steel material must be new, smooth wall, carbon steel, Grade B, with minimum sixty thousand pounds per square inch (60,000-psi) tensile strength, and minimum thirty-five thousand pounds per square inch (35,000-psi) yield strength.

The pipe must be straight seam pipe, seamless pipe, or spiral weld pipe. For spiral weld pipe, the spiral must be one hundred percent (100%) welded, and the weld's height over the outside wall surface must be equal to or less than three-sixteenths inch (0.1875-in).

All steel pipe must be square cut and must have a roundness such that the difference between the major and minor outside diameters cannot exceed one percent (1%) of the specified nominal outside diameter or one-fourth inch (0.25-in), whichever is less. The outside circumference must be within plus or minus (±) one percent (1%) of the nominal circumference or within plus or minus (±) one-half inch (0.5-in), whichever is less. The pipe must have a maximum allowable straightness deviation in any ten-foot (10-ft) length of one-eighth inch (0.125-in).

Steel pipe joints must be continuously welded with an approved butt weld. The welds must attain the full strength of the pipe and result in a fully watertight section. The welded joints must conform to the requirements of AWWA C-206, “Field Welding of Steel Water Pipe”.

B. Boring (Micro and Small Diameter Tunneling) Installations –

1. Casing Pipe Size – Steel casing pipe must have the follow minimum inside diameters:

Pipe Nominal Size (inches)	Casing Pipe Inside Diameter (inches)
4	8 to 10
6	10 to 12
8	14 to 16
10	16 to 18
12	18 to 20
15	20 to 22
18	24 to 26
24	31 to 33
27	33 to 36
30	36 to 42
36	42 to 48
42	54 to 60
48	60 to 66
>48	Subject to City Engineer Approval

2. Casing Pipe Thickness – Steel casing pipe must the following minimum thickness, in inches, for the indicated maximum depth of cover(s), in feet:

Outside Diameter (inches)	Under Highway		Under Railroad	
	Wall Thickness (inches)	Maximum Cover (feet)	Wall Thickness (inches)	Maximum Cover (feet)
≤12	0.188	30	0.250	30
16	0.250	30	0.281	30
18	0.250	30	0.322	30
20	0.250	30	0.344	30
24	0.250	30	0.406	30
30	0.322	30	0.469	30
36	0.375	30	0.531	30
42	0.375	25	0.531	30
48	0.438	25	0.531	25
54	0.438	25	0.531	20
60	0.438	25	0.531	20
66	0.438	20	0.531	20

3. Casing Spacers – Casing spacers must be PVC with stainless steel bands. Use and positioning of spacers must be in accordance with manufacturer's recommendations

518.03 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Steel Casing Pipe" must be made at the unit price bid per linear foot for each carrier pipe size. Installation method will be included in the payment for "Steel Casing Pipe." The price established must be full compensation for furnishing and installing of all materials including, labor, tools, equipment, and incidentals necessary to complete this item of work.

518.04 – BASIS OF PAYMENT – Public Construction Contracts

The items measured as provided above will be paid for at the contract unit price bid:

STEEL CASING PIPE (CARRIER PIPE SIZE)	LF

SECTION 519 – CLOSURE PIECES

519.01 – DESCRIPTION

This section covers pipe closure pieces intended to be used for connecting water lines where a standard connection (joint) cannot be made.

519.02 – MATERIALS

519.02.01 – GENERAL

The pressure rating of closure pieces must be equal to or greater than the pressure rating of the water line.

519.02.02 – TYPES

Unless otherwise specified or called for on the plans the following requirements must be adhered to:

A. Steel Pipe – Closure pieces must be sleeve coupling, double-butt weld, or butt strap joint meeting the requirements of Section 517 “Steel Pipe” and AWWA M-11,“Steel Pipe – A Guide for Design and Installation”.

B. PCCP – Closure pieces must be follower ring or welded. Standard length must be six feet (6-ft) and cannot be less than a minimum of two feet (2-ft). When necessary, double spigot adapter may be used to convert a bell end on a pipe section to a spigot end to facilitate proper alignment and closure of the pipe sections. The spigot ends must not be more than one inch (1-in) out of line or grade. Closure with restrained joints must be used when the pipe has restrained joints.

519.03 – CONSTRUCTION METHODS

The installation must conform to the recommendation of the manufacturer of the pipe being tapped.

519.04 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for "Closure Piece" must be made incidental and included in the cost of solid sleeves. The price established must be full compensation for furnishing and installing of all materials including closure piece assembly, repair kits, labor, tools, equipment, and incidentals necessary to complete this item of work.

519.05 – BASIS OF PAYMENT – Public Construction Contracts

Payment will be made pursuant and incidental to Section 501 “Pipe and Fittings Installation”.

SECTION 520 – TAPPING SLEEVES

520.01 – DESCRIPTION

This section covers tapping sleeves intended to be used for tapping water lines.

520.02 – MATERIALS

Tapping sleeves must be manufactured in accordance with AWWA C-110, “Ductile-Iron and Gray-Iron Fittings” and equipped with gaskets made in accordance with AWWA C-111, “Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings”. Tapping Sleeve must be solid sleeve, Ductile Iron or Steel, and Mechanical Joint.

All Steel Tapping Sleeves must have Fusion-Bonded Epoxy Coating and Type 316 Stainless Steel Bolts and Nuts.

520.03 - NOT USED

520.04 – CONSTRUCTION METHODS

The installation must conform to the recommendation of the manufacturer of the pipe being tapped.

520.05 – BASIS OF PAYMENT – Public Construction Contracts

Payment must be made pursuant to Section 505, “Tapping Connections”.

SECTION 521 – TAPPING SADDLES

521.01 – DESCRIPTION

This section covers tapping saddles used for tapping water lines.

521.02 – MATERIALS

Tapping saddle must be manufactured in accordance with AWWA C-110,“Ductile-Iron and Gray-Iron Fittings” and equipped with gaskets made in accordance with AWWA C-111, “Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings”.

521.03 – CONSTRUCTION METHODS

A. General – Tapping saddles must have a body with a threaded outlet, seal, and suitable means for attachment to the main. The body must be made to conform to the outside configuration of the main. Tapping saddles must be designed to provide a drip-tight connection when used as a service connection to the main. The materials used to produce tapping saddles must comply with Section 502 “Water Service Line Connections”.

B. Three-quarter inch (0.75-in) to one-inch (1-in) services – Tapping saddles must be required when tapping. Saddles must be brass or stainless steel. Saddles may be required on older cast-iron and ductile iron as directed by the City Engineer. Tapping saddles must be the same size as the service line. The reducing of tapping saddles will not be allowed.

C. One and one-half inch (1.5-in) and larger services – One and one-half inch (1.5-in) and larger tapping saddles must be ductile iron, stainless steel or approved equal. Three inch (3-in) and larger taps will require solid back tapping saddles. Four-bolt epoxy-coated alloy bolts will be required. No shop coat bolts will be allowed. No strap tapping saddles will be allowed.

D. Tapping Polyvinyl Chloride (PVC) – Only tapping saddles manufactured specifically for PVC pipe must be used. The service saddle must be designed to provide a drip tight connection. The maximum branch line size is two inch (2-in) in diameter. Wide-range tapping saddles must not be used for PVC. Tapping Saddle must provide full support around the circumference of the pipe. Tapping saddles with lugs that dig into the pipe when saddle is tightened will not be permitted. Tapping Saddles that have U-bolt Type straps will not be permitted. Tapping Saddles for PVC

must comply to the requirements AWWA C-605, “Underground Installation of Polyvinyl Chloride (PVC) and Molecularly oriented polyvinyl chloride (PVCO) pressure pipe and fittings”. Double stainless-steel tapping saddles with stainless steel straps and bolts are required. The tapping saddle must be the same size as the main. The tapping saddle may not be reduced to the size of the water service line.

521.04 – BASIS OF PAYMENT – Public Construction Contracts

Payment must be made pursuant to Section 510, “Water Service Line Connections”.

SECTION 522 – CORROSION MONITORING SYSTEM

522.01 – DESCRIPTION

This section covers corrosion monitoring system intended to provide protection against corrosion for PCCP, and steel water lines, unless otherwise called for on the plans or specifications.

522.01.01 – GENERAL

All installation, and testing must be consistent with sound corrosion City Engineering practice as determined by the City Engineer.

522.01.02 – REQUIREMENTS

A. Steel Cylinder Bonding – For PCCP, bonds must be provided between the steel cylinders of adjacent pipe sections and all non-insulating joints as necessary to assure electrical continuity except where electrical isolation is necessary or required. The joint bonds must be designed with sufficient slack to allow for some joint displacement and rotation.

Two steel bonding clips per joint must be placed at the spring line of the pipe. The increase in electrical resistance due to the joint bonds per one hundred feet (100-ft) of pipe cannot exceed two hundred and fifty percent (250%) when compared to the electrical resistance of one hundred feet (100-ft) of pipe when calculated as follows:

$$I = \left(1 + \frac{R_B}{R_p}\right)100$$

Where:

I = percent increase in electrical resistance

R_B = resistance in ohms of the joint bonds per 100 feet of pipe

R_p = resistance in ohms per 100 feet of pipe when calculated as follows:

W_p = weight of Pipe in pounds per linear foot

$$R_p = \frac{0.2158}{W_p}$$

The effective resistance of parallel circuit, pre-stress wire path and cylinder path, must be used as *Rp* for embedded cylinder pre-stressed concrete pipe.

Bonds must consist of insulated copper or steel cable metallurgically welded or brazed to adjacent cylinders. All bare copper and steel must be insulated by approved means.

B. Pre-stress Wire Bonding – For PCCP, intermediate bonds for pre-stress wire of embedded cylinder must also be provided as required to minimize attenuation. The intermediate bonds must be in the form of steel straps embedded in the outer surface of the concrete core directly upon which the pre-stress wire is tightly wound. The size and number of straps must be designed to provide uniform current distribution to all embedded metallic surfaces of the pipe.

C. Electrical Isolation – Electrical isolation in the form of either flexible or rigid insulating fittings as specified herein must be provided as required to obtain electrical discontinuity at:

1. The beginning and end of all portions of the pipeline to be monitored.

2. Joints where the line-pipe is joined to steel manifolds or steel pipe.

3. Joints where steel or ductile iron or nonferrous metals are joined to structures other than air valves, blow-off valves, and turnouts.

4. All points where ductile iron is joined to PCCP.

D. Flexible Insulating Fittings – Flexible insulating fittings required.

E. Rigid Insulating Fittings – Rigid insulating fittings required must be flanged joints with full-faced neoprene phenolic gaskets, polyethylene sleeves and steel washers backed with insulating washers.

F. Corrosion Test Stations – Corrosion test stations must be installed meeting the following requirements:

1. Locations

   (a) All buried line crossings.

   (b) The beginning and end of the portions of the pipeline to be monitored.

   (c) Both sides of insulated fittings.

   (d) Intermediate locations along the line, such that test stations are no more than 1,200-ft apart.

   (e) Casing and carrier pipe.

   (f) Corrosion stations must be installed on both the carrier pipe and the casing at both ends of the metallic casings.

2. Types

   (a) Two-Wire Type – Test stations may be of the two-wire type with one of the wires being No. 6 AWG or larger such that it can be used for bonding. The other wire, for determining pipe-to-soil potentials, must be No. 12 AWG or larger. Both leads must be continuous (without splices) and laid with sufficient slack to prevent stress. The leads must be insulated with 600-volt rated solution suitable for direct burial. Prior to backfilling, the insulation must be inspected for defects. All defects must be repaired by approved methods.

   (b) Flush Type – Test stations may be of the flush type (terminals below grade) or above-surface type, protected as required for permanency. The flush type must be installed in developed, urban areas (streets, alleys, sidewalks, etc.) and above surface type (mounted on a post) must be installed in undeveloped open areas; where possible, test stations must be located at or closely adjacent to clearly identifiable topographical features (fences, line, road, intersection, section line, etc.) of the pipeline right-of-way.

G. Testing – The Contractor must perform tests as required to determine the following, and to correct corrosion monitoring system to comply with Standard Specifications.

1. Pipeline electrical continuity
2. Effectiveness of insulating joints
3. Test station integrity
4. Static pipe-to-soil potentials at each test station
5. Soil resistivity at each test station

522.02 – METHOD OF MEASUREMENT – Public Construction Contracts

Payment for Corrosion Monitoring System will be made at the unit price per lump sum. Such payment will be compensation in full for furnishing all materials, labor, equipment, tools, and incidentals, and for performing the work in accordance with Standard Specifications.

522.03 – BASIS OF PAYMENT – Public Construction Contracts

The items measured as provided above will be paid for at the contract unit price bid:

CORROSION MONITORING SYSTEM	L.S.

SECTION 523 - WATER CONSTRUCTION STANDARD BID ITEMS

523.01 – DESCRIPTION

This section covers standard bid items used in the Contract Documents for the construction of water lines and their appurtenances. Additional bid items may be called out in the Bidding Documents, other sections of the Standard Specifications, or as directed by the City Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
501	(SIZE) (TYPE) WATER LINE PIPE (JOINT TYPE) (NOM WALL THICK)	L.F.
501	FITTINGS (SIZE AND TYPE)	LBS.
501	FITTINGS (SIZE AND TYPE)	EA.
503	DOUBLE SERVICE (SIZE)	EA.
503	SINGLE SHORT SERVICE (SIZE)	EA.
503	SINGLE LONG SERVICE (SIZE)	EA.
503	SINGLE EXTRA LONG SERVICE (SIZE)	EA.
504	METER RELOCATION (SIZE)	EA.
505	(SIZE) TAP	EA.
507	FIRE HYDRANT	EA.
508	REMOVAL OF FIRE HYDRANT	EA.
510	(SIZE) BLOW-OFF CONNECTION	EA.
511	(SIZE) (TYPE)(DEPTH RANGE) VALVE AND VALVE BOX	EA.
511	(SIZE) (TYPE)(DEPTH RANGE) VALVE AND VAULT	EA.
511	(SIZE)(TYPE)(DEPTH RANGE) VAULT	EA.
513	HYDROSTATIC PRESSURE TESTING AND DISINFECTION	L.SUM
518	STEEL CASING PIPE (CARRIER PIPE SIZE)	LF
522	CORROSION MONITORING SYSTEM	L.S.

TABLE OF CONTENTS

SECTION 600 – SANITARY SEWER

SECTION 600 – GENERAL REQUIREMENTS

600.01 – DESCRIPTION

This section covers general construction requirements of sanitary sewers and sewer appurtenances as described herein.

600.01.01 – DEFINITIONS

A) DIP – Ductile Iron Pipe
B) ENGINEER – The individual or firm responsible for the design associated materials needed for the completion of a project
C) Fitting – A part used to connect piping or tubing.
D) Inlet – The opening in a valve or fitting through which flow enters the valve or fitting.
E) N.P.T. – National Pipe Thread as specified in ANSI/ASME B1.20.1
F) OCWUT – Oklahoma City Water Utility Trust
G) Outlet – The opening in a valve or fitting through which flow from the waterline leaves the valve or fitting.
H) Owner – Oklahoma City Water Utility Trust and/or City of Oklahoma City
I) PVC – Polyvinyl Chloride

600.02 – PREQUALIFICATION

All Contractor's must be pre-qualified as to perform all Sewer Construction Work as required by the most recent ordinance, passed by the Council of the City of Oklahoma City. The Contractor must obtain all permits required by the City of Oklahoma City, State and Federal regulations and laws.

600.03 – CONSTRUCTION OUTSIDE CITY LIMITS

The Contractor performing work outside the corporate limits of Oklahoma City will comply with all ordinances, regulations, and policies of the county and city wherein the work is located. The Contractor must obtain any permits, provide barricades and lights, and make repairs as required by the responsible authorities. When performing work on any Oklahoma City assets, Contractors shall meet all requirements in Section 600.02 "General Requirements - Prequalification".

600.04 – TEST HOLES

Test hole information, when shown on the plans or included in the specifications, must only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole. Each bidder must make their own interpretation of the character and condition of the materials that will be encountered between test hole locations. Each

prospective Bidder may, at their own expense, make additional surveys and investigations as may be deemed necessary to determine conditions which will affect performance of the work.

600.05 –CONSTRUCTION SEQUENCE AND CONSTRAINTS

A) The Contractor must start at enough different locations to complete the entire contract within the contract duration specified.

B) The construction of all sewers must begin at the low point in the line in every case working toward the high point.

C) When the construction involves the building of main or submain sewers having one or more lateral or tributary, the construction of tributary lines must not be started until the main or submain sewer has been completed to the point where the tributaries or laterals discharge into it, except as may be approved by the Engineer. Approval by the Engineer does not relieve the Contractor of any responsibility for meeting the specified connections.

D) Sewer appurtenances must be constructed as soon as the sewer that they serve is constructed to their locations. Postponing of the construction of appurtenances until the sewer line has been completed, or the building of appurtenances in advance of the construction of the sewer line, will not be permitted.

E) The construction of sewers eighteen inches (18-in) in diameter and smaller for more than six hundred feet (600-ft), and sewers twenty-one inches (21-in) in diameter and larger for more than three hundred feet (300-ft) in advance of appurtenances which are incomplete or the construction of which has not been started, will not be permitted.

F) Unless otherwise directed by the Engineer and/or Owner, the Contractor must leave no more than nine hundred feet (900-ft) between backfilling operations and the complete restoration of paving, paving repairs, fencing, sodding, etc.

G) When temporary surfacing is provided for in the contract documents, the Contractor must complete temporary paving repair as per Section 824, “Temporary Surfacing”, immediately before backfill is completed.

H) The Contractor must take proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages caused by excavating or blasting, either to surface or subsurface structures, must be repaired or replaced by the Contractor at their own cost and expense.

600.06 – DELIVERY OF MATERIALS

Construction materials cannot be delivered to the site of the work more than three (3) calendar days in advance of their anticipated use nor can the quantity of pipe or other materials on hand at the site of the work at any time be in excess of the amount required to complete Six hundred feet (600-ft) of sewer unless with special permission of the Engineer.

Unless otherwise specified, all concrete used in construction of sewers and their appurtenances must have a minimum twenty-eight (28) day compressive strength of three thousand five hundred pounds per square inch (3,500-psi) and must conform with the applicable requirements of Section 900. All steel reinforcement used must be grade sixty (60) with a minimum yield strength of sixty thousand pounds per square inch (60,000-psi) and meet the applicable material requirements of Section 900.

600.07 – SEWER GRADES

A) General – The grade line shown on the plans is the elevation of the invert or flow line of the sewer. The sewer grade must be established by use of laser beam, or other methods approved by the Engineer.

B) Laser Beams – When laser beams are used to establish line and grade, they must first be calibrated in accordance with the equipment manufacturers recommended procedures. The Contractor must establish horizontal and vertical controls (offset stakes) with a transit or theodolite, or any other equipment approved by the Engineer. The Contractor may then proceed to establish line and grade using the laser equipment. In conjunction with the laser beam, the Contractor may also be required to provide temporary benchmarks at intervals as specified by the Engineer.

600.08 – STOPPERS OR BULKHEADS

Dead ends of all sewers, wyes, tees, etc., must be closed with approved stoppers secured in place with concrete. When shown on the plans or required by the Engineer, such openings must be filled in with brick masonry or concrete. Tight fitting stoppers or bulkheads must 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. When work is stopped temporarily on sanitary sewers twenty-four inches (24-in) in diameter and smaller, the exposed end of the pipe must be closed to prevent trash or debris from entering the pipe. Such stoppers need not be watertight.

600.09 – SURFACE DRAINAGE STRUCTURES

When not called for on the plans or specified as separate bid item, all surface drainage structures and appurtenances must be removed and replaced in a condition equal to or better than the original installation when required. No additional compensation will be

made for this work, and the cost be included in the other pay items.

600.10 – TEMPORARY SEWER AND DRAIN CONNECTIONS

When existing sewers have to be taken up or removed, the Contractor at his own expense, must provide and maintain temporary outlets and connections for all private or public drains, sewers, or sewer inlets. They must also take care of all sewage and drainage which will be received from these drains, sewers, and sewer inlets; and for this purpose, they must provide and maintain at their own expense, adequate pumping facilities and temporary outlets or diversions. They must construct such trough, pipe, or other structures necessary and be prepared at all times to dispose of drainage and sewage received from these temporary connections until such time as the permanent connections are built and have service. The existing sewers and connections must be kept in service and maintained under the contract, save where specified or ordered to be abandoned by the Engineer. All water or sewage must be disposed of in a satisfactory manner so that no nuisance is created and that the work under construction will be adequately protected. Temporary Sewer and Drain Connections must be constructed, maintained, and managed within the guidelines established within the Storm Water Pollution Prevention Plan (SWPPP), the City of Oklahoma City Storm Water Management Plan (SWMP), and Oklahoma Department of Environmental Quality (ODEQ)..

600.11 – CLEANUP

After installation of each section of sewer line, the Contractor must remove all spoils resulting from work, debris, construction materials and equipment from the site of work, grade, and smooth over surfaces on both sides of the line, and leave the right-of-way and easement in a clean, neat, and serviceable condition prior to sodding , seeding, and/or sprigging.

SECTION 601 – PIPE INSTALLATION

601.01 – DESCRIPTION

This section covers installation of pipes in open-cut trenches, in conformity with the lines, grades, and dimensions and as provided in applicable sections of these specifications.

601.02 – PIPE MATERIALS

601.02.01 – PIPE

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Materials	Section
Rigid	Vitrified Clay Pipe (VCP)	630
Flexible	Ductile-Iron Pipe (DIP)	631
	High Density Polyethylene (HDPE) Pipe	632
	Polyvinyl Chloride (PVC) Pipe	633
	Reinforced Fiberglass Pipe (RFP)	634

601.02.02 – EMBEDMENT MATERIAL

A) General – Embedment material must meet the requirements of Section 215, “Embedment Material”. Prior to delivery, the Contractor must submit laboratory tests for materials to be used for embedment and backfill. The Engineer prior to placement must approve materials.

B) Invoices – The Contractor must submit invoices for the purpose of complying with the minimum quantities necessary to complete installation pursuant to the appropriate standard details and the minimum dimensions specified.

601.03 – CONSTRUCTION METHODS

601.03.01 – BEDDING AND HAUNCHING

A) Rigid Pipes – All rigid pipes must be embedded in accordance with ASCE Manual No. 60, "Gravity Sanitary Sewer Design and Construction", Class "B" Bedding and in accordance with the dimensions and lines shown on the Standard Detail on Construction and meeting the requirements of Section 215, “Embedment Material”.

B) Flexible Pipes – All flexible pipes must be embedded in accordance with ASTM D-2321, "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe", and in accordance with the dimensions and lines shown on the Standard Details of Construction and meeting the requirements of Section 215, “Embedment Material”.

601.03.02 – INSTALLATION REQUIREMENTS

A) Shipping, Handling and Storage – Pipe must be transported from the manufacturer, to the project site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the project site, it must be carefully inspected for any damage that may have occurred in transit. The pipe must be handled at all times with care using padded slings or hooks. The pipe must not be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe will be rejected. All pipe and accessories must

be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe must be stored in cool location out of direct sunlight in accordance with the manufacturer's recommendations.

B) Quality of Work – Watertight joints, first grade material and accurate construction will be required. Furthermore, utmost care must be exercised in laying pipe to line and grade, constructing inverts in manholes, transitions, and other joints as may be required during construction.

C) Pipe Foundation – No sewer will be laid unless the foundation is in a condition satisfactory to the Engineer. Where trenches are excavated in soft, unsuitable soil, or rock, trench bottom must be stabilized in accordance with Section 212, "Trench Excavation and Backfill", when directed by the Engineer.

D) Trench Dewatering – The Contractor must keep stormwater and stream water out of the trench. The Contractor must maintain groundwater level below pipe or rip-rap.

E) Laying Requirements – All pipes, specials, fittings and other appurtenances must be examined carefully for damage and other defects before installation. The Owner retains the right to reject damaged and defective materials.

The pipe ends must be free of all lumps, blisters and they must be wiped clean of foreign materials such as dirt and sand before installation.

Pipe laying must proceed upgrade, starting at the lower end of the grade and with the bells uphill, using laser beams or other methods approved by the Engineer pursuant to this section.

Bell holes for bell-and-spigot pipe must be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes must be large enough to permit proper installation of pipe. Bell holes must not be excavated more than ten (10) joints ahead of pipe laying. Filling and ramming earth or other material beneath the pipe to raise it to grade will not be permitted.

The Contractor must use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances must be lowered carefully into the trench with suitable equipment, to prevent damage to the sewer main materials. In rock trenches, plywood shields or other approved means must be used to prevent the cradled pipe from swinging against the sides of the trench.

All joint preparation and joining operations must comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section. Rubber gaskets must be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces must be coated with the lubricant furnished with the

pipe.

Any damage to the pipe and/or rubber gasket, from any cause during installation of the pipeline will be cause for replacement, as directed by the Engineer, and at the expense of the Contractor.

After a section of pipe is properly installed and approved for backfill, the trench must be backfilled and compacted as per Section 212, “Trench Excavation and Backfill”.

601.04 – METHOD OF MEASUREMENT

Payment for "Sanitary Sewer Pipe" must be made at the unit price bid per linear foot of pipe installed for each size. The price established must be full compensation for all materials including pipe, material, labor, tools, equipment and incidentals necessary to complete this item of work. Payment does not include the cost of trench excavation and backfill nor foundation material for soft and unsuitable soil conditions.

Measurement for "Sanitary Sewer Pipe" must be from station to station through manholes, junction boxes and other small structures.

601.05 – BASIS OF PAYMENT

Payment for embedment material is included in “Sanitary Sewer Pipe”, The items measured as provided above will be paid for at the contract unit price bid:

SANITARY SEWER PIPE (SIZE) L.F.

SECTION 602 – SEWER SERVICE CONNECTION

602.01 – DESCRIPTION

This section covers construction of sewer service connections when called for on the plans or as directed by the Engineer

602.02 – MATERIALS

602.02.01 – PIPE MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Types	Pipe Material	Section
Rigid Flexible	Vitrified Clay Pipe (VCP)	630
	* Ductile-Iron Pipe (DIP)	631
	Polyvinyl Chloride (PVC) Pipe	633

* Not to be used for wye branches but for risers only.

602.02.02 – CONNECTION TYPES

The following connection types may be required to make sewer service connections: Connections for New Construction

A) Wye Branches – For new construction there must be installed wye branches of size and type shown on the plans with a minimum of four-inch (4-in) openings at locations shown on the plans or as designated by the Engineer.

B) External Connections to Existing Main – Connections to existing main may be accomplished as follows:

1) Saddles – Connections may be made by excavating to the existing main and cutting a hole using approved equipment and installing a saddle. When the existing main has been rehabilitated by a trenchless method of construction, the saddle connection must be made to the trenchless pipe and/or pipe liner specifications.

2) Tees – Connections may be made by removing a section of the existing pipe and installing a tee.

3) Wye Branches – Connections may be made by removing a section of the existing pipe and installing a wye branch.

4) Fittings, riser, and closure assembly must be used to make the connection and must be supplied in a nominal diameter a minimum of four inches (4-in). The external connections must be considered complete when backfilling and

subsequent surface restoration is completed.

C) Internal Connections (for Resin Impregnated Pipe Liner) – In the case where a resin impregnated pipe liner is installed an internal connection will be allowed along with the installation of a service liner extending to the limits of the right-of-way or easement, when it is included within the project. Otherwise, internal connections will not be allowed.

602.02.03 – RISER

A) General – Risers must be connected to sewer pipe using standard wyes, tees or saddles. No services may be connected to sewer pipe that is twenty-one inches (21-in) and larger in diameter unless directed by the Engineer.

B) Riser Construction – Particular care must be exercised in cutting the sewer pipe so that no damage is done to the pipe and its strength impaired by shattering or cracking of the pipe wall. The end of the fitting must not protrude beyond the inside surface of the sewer main. The annular space around the fitting must be completely filled and smoothly finished with Class "C" mortar with Type II cement.

The backfill must be thoroughly compacted under and above the pipe in the main sewer trench and up to at least the top of the concrete riser support. The backfill around the vertical pipe must be carefully placed and tamped avoiding disturbance of the alignment of the pipe and damage to the joints. The vertical pipe must be anchored to sewer trench wall with one-fourth inch (0.25-in) round hairpin bars.

The riser pipe must extend a minimum of twenty-four inches (24-in) above finish grade when not immediately being connected to a house service line. The riser pipe must be capped to protect from debris and/or water from entering.

A locator tape, green in color, and stating "CAUTION - SANITARY SEWER RISER PIPE BURIED BELOW' must be attached to the sanitary sewer riser and extend to a minimum of two feet (2-ft) above ground. The tape must be three inch (3-in) width unless otherwise specified by the Engineer.

602.02.04 – CONSTRUCTION METHODS

A) General – All work must be constructed in accordance with the Standard Details for Construction. Unless otherwise specified, sanitary sewer connections must be installed so that a plane through the center of the branch and the centerline of the main sewer must make an angle of forty-five degrees (45-degrees) with the horizontal. One cubic foot (1-cf) of concrete must be placed around each connection, the cost of which must be included in other items.

B) Wye & Tee-Wye Branches – Sewer Service Connections constructed with wye &

tee wye, also called combination wye, branches must include a twenty-two and half degree bend (22.5-degree) bend, elbow, and when required, a closure piece.

C) Tees – Sewer Service Connections constructed with tees must include a twenty-two and half degree bend (22.5-degree) bend, and when required, an elbow and a closure piece.

D) Saddles – Sewer Service Connections constructed with saddles must include straps, a twenty-two and half degree bend (22.5-degree) bend, and a closure piece.

E) Multiple Services - Multiple services or common service lines are not allowed. Each unit and/or dwelling must have a separate sewer service connection to the sewer main unless written approval from the Utilities Director is obtained.

602.03 – METHOD OF MEASUREMENT

Payment for "Sewer Service Connection" must be made at the unit price bid for each external connection. The price established must be full compensation for all material, labor, equipment, trench excavation, backfill, and incidentals necessary to complete this item of work.

When external sewer service connections are made in conjunction with installation of Formed-In-Placed Pipe (FIPP) per Section 607, “Formed-in-place Pipe (FIPP)”. Payment for external sewer connection must be made at the unit price bid for each "Point Repair" regardless of depth. External connection (reinstatement) of services must be considered incidental to the lining process and the cost must be included in other items. The price established for "Point Repair" must be full compensation for all material, labor, equipment, trench excavation, backfill, and incidentals necessary to complete this item of work.

Payment for "Riser Pipe" must be made at the unit price bid per linear foot of pipe for new sewer construction. The price established must be full compensation for materials, labor, tools, equipment and incidentals necessary to complete this item of work.

Payment for "Riser Pipe" for replacement and/or rehabilitative sewer construction must not be made directly but must be included in the cost for "Sewer Service Line" as described in Section 603, “ Sewer Service Line”.

602.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER SERVICE CONNECTION	EA.
RISER PIPE	L.F.

SECTION 603 – SEWER SERVICE LINE

603.01 – DESCRIPTION

This section covers service lines for future or existing connections. The service line must be installed to a point where an acceptable connection can be made to the existing service if necessary. Pipe must be supplied in nominal diameter a minimum of four inches (4-in).

603.02 – MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Vitrified Clay Pipe (VCP)	630
Flexible	Polyvinyl Chloride (PVC) Pipe	633

603.03 – CONSTRUCTION METHODS

The installation of a service line includes removing any cap or plug from existing riser, cutting and removing any existing service line, and reconnecting the riser and the existing service line if necessary.

603.04 – METHOD OF MEASUREMENT

Payment for "Sewer Service Line" must be made at the unit price bid per linear foot of pipe, including closure piece, and when required, adapters and other fittings. The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

603.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER SERVICE LINE L.F.

SECTION 604 – ABANDONING SEWER

604.01 – DESCRIPTION

This section covers filling of abandoned sewer lines with grout or concrete.

604.02 – MATERIALS

The materials must meet the requirements of Section 218.02, “Embedment Plugs – Materials” for "Flowable Fill Plugs".

604.03 – METHOD OF MEASUREMENT

Payment for "Abandoning Sewer" must be made at the unit price bid per cubic yard. The price established must be full compensation for furnishing and placing all materials, labor, tools, equipment and incidentals necessary to complete this item of work.

604.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

ABANDONING SEWER	C.Y.

SECTION 605 – PIPE BURSTING

605.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of bursting existing pipes as shown on the plans and in conformity with these specifications. The operation must be conducted with a hydraulic pulling or pushing apparatus and a pipe expander (i.e. pig and swab). The pipe expander must be pushed or pulled through the existing pipe on grade, widening the existing pipe material for insertion of the new pipe material.

605.02 – MATERIALS

605.02.01 – SUBMITTALS

The Contractor must furnish for the Engineer's approval, a plan showing his proposed method of handling, including the design for the equipment, equipment support of backstop, arrangement and position of jacks, pipe guides, etc., complete in assembled position. The approval of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

605.02.01 – PIPE MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Flexible	High Density Polyethylene (HDPE) Pipe	632
	Polyvinyl Chloride (PVC) Pipe	633

605.03 – CONSTRUCTION METHODS

605.03.01 – GENERAL

Where pipe is required to be installed under railroad embankments or under highways, streets, or other facilities by trenchless methods, construction must be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and cannot weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians must be furnished and maintained, as directed by the Engineer, until such time as the backfill has been completed and then must be removed from the site.

Suitable pit shafts, or trenches must be excavated for the purpose of conducting the trenchless operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work must be sheeted securely and braced in a manner satisfactory to the Engineer to prevent earth caving.

The removal of any obstruction that may be found to conflict with the placing of the pipe must not be measured for payment nor paid for as a separate contract pay item. The removal of any such obstruction must be included in the cost of other items.

Once the pipe installation has commenced it must be continued uninterrupted around the clock until the pipe has been installed between the specified limits.

Any pipe damaged during operations must be removed and replaced by the contractor at their expense.

The pits or trenches excavated to facilitate the operations must be backfilled immediately after the pipe has been installed.

605.03.02 – CLEANING SEWER LINES

Cleaning sewer lines must be accomplished in accordance with Section 609, “Cleaning Sewer Lines”.

605.03.03 – SEWER FLOW CONTROL

Sewer flow control must be accomplished in accordance with Section 608, “Sewer Flow

Control”.

605.03.04 – POINT REPAIR

Point repairs must be accomplished in accordance with Section 612, “Point Repairs”. Segments between two consecutive manholes that require more than five (5) point repairs for successful rehabilitation may be deleted, by the Engineer, from the specified work. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212, “Trench Excavation and Backfill”

605.03.05 – SEWER SERVICE CONNECTIONS

All sewer service connections must be accomplished and paid for in accordance with Section 602, “Sewer Service Connection”.

605.05 – METHOD OF MEASUREMENT

"Pipe Bursting" must be measured by the linear foot of pipe completed for each size. The price established must be full compensation for all materials, including pipe, labor, tools, equipment and incidentals necessary to complete this item of work.

605.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PIPE BURSTING (SIZE)	L.F.

SECTION 606 – SLIPLINING

606.01 – DESCRIPTION

This section covers rehabilitation of deteriorated sewer lines by trenchless method of sliding a liner pipe of smaller diameter into an existing circular pipeline, then if required, re-establishing service connections to the new liner pipe.

606.02 – MATERIALS

606.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as specified in these specifications.

A) General – The Contractor must submit source of materials for the specified liner pipe, or proposed liner pipe when alternate materials are specified. No liner pipe must be shipped to job site until all submittals have been reviewed and approved by the Engineer.

B) Construction and Laying Schedule – The Contractor must submit an area map of the project designating the beginning and ending points as well as complete pipe laying and time schedule and detail drawings. The map must also indicate the access points, length, and pipes to be installed. Unless surveyed plans accompany project specifications, all elevations must be determined and included in the Schedule. This must include verification of all elevations on as-built drawings when such information is provided.

C) Submittals - No pipe, special sections and fittings must be manufactured until all submittals have been reviewed and approved by the Engineer. The drawings and data must include but not be limited to the following for each size and class of pipe.

    1) Details of the proposed pipe

    2) Properties, strengths, etc. of pipe

    3) Details of joints

D) Certification of Material Compliance – A signed letter from the manufacturer stating that all material satisfies claims made by the manufacturer and meets the requirements specified. Reports of the plant test including, but not limited to, liner thickness, flexural strength, and flexural modulus must be submitted. The submittal shall be signed and sealed by a Professional Engineer licensed in the State of Oklahoma.

E) Insertion or Access Pits – The location and number of insertion or access pits must be planned by the Contractor and submitted in writing for approval by the Engineer prior to excavation. The pits must be located such that their total number must be minimized, and the footage of liner pipe installed in a single pull must be maximized. Locations of damaged pipe must be used for insertion pits as directed by the Engineer.

F) Sealing Compound and Grout – Contractor must submit proposed sealing compounds to be used for sealing liner pipe at the manholes and type of grout and grouting equipment to be used.

G) Jacking Loads – The Contractor must submit a complete record of all jacking loads for the insertion of the pipe liner. This information must be submitted to the Engineer for review after each insertion operation.

H) Copies – The Contractor must provide a digital copy of all submittals, and if

requested by the Engineer, hardcopies of any submittal must be provided as well.

606.02.02 – LINER PIPE MATERIALS

Acceptable liner pipe materials are as follows and must meet the requirements of the appropriate sections indicated below:

Pipe Type	Pipe Material	Section
Rigid	Vitrified Clay Pipe (VCP)	630
Flexible	High Density Polyethylene (HDPE) Pipe	632
	Polyvinyl Chloride (PVC) Pipe	633
	Reinforced Fiberglass Pipe (RFP)	634

606.03 – CONSTRUCTION METHODS

606.03.01 – CLEANING SEWER LINES

Cleaning sewer lines must be accomplished in accordance with Section 609, “Cleaning Sewer Lines”.

606.03.02 – SEWER FLOW CONTROL

Sewer flow control must be accomplished in accordance with Section 608, “Sewer Flow Control”.

606.03.03 – POINT REPAIR

Point repairs must be accomplished in accordance with Section 612, “Point Repairs”. Segments between two consecutive manholes that require more than five (5) point repairs for successful rehabilitation may be deleted, by the Engineer, from the specified work. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212, “Trench Excavation and Backfill”.

606.03.04 – INSPECTION OR ACCESS PIT EXCAVATION & BACKFILL

Before excavation is begun, it must be the responsibility of the Contractor to check with the various utility companies and determine the location of the utilities in the vicinity of the work area. The Contractor at no cost to the City must arrange temporary construction easements and/or right-of-way areas.

A) All excavations must be properly sheeted and shored in accordance with relevant specifications for trench safety systems. Any damage resulting from improperly shored excavations must be corrected to the satisfaction of the Engineer with no compensation due to the Contractor.

B) All open excavations must be kept secure at all times by the use of barricades with

appropriate lights and signs, construction tape, covering with steel plates, etc., or as directed by the Engineer.

C) The cost for diversion pumping required around an insertion pit, from a manhole upstream to a manhole downstream, must be per applicable item of these specifications.

D) Excavations initially begun as Point Repairs that, for convenience, are later used as Insertion Pits, must be treated as incidental to sliplining. If the point repair excavation is used as an insertion pit, the Contractor must not be required to replace the carrier pipe.

Excavation and backfill of insertion or access pits must be accomplished pursuant to Section 212, “Trench Excavation and Backfill”.

606.03.05 – LINER PIPE INSERTION

The insertion and installation of the liner pipe must be in accordance with appropriate ASTM Standard Specifications and the Manufacturer's Recommendations.

The liner pipe must be aligned in contact with the invert of the existing sewer. If more than one-third (1/3) of the top profile of the existing sanitary sewer line is not intact and cavities exist above the pipe, the condition of the sewer line must be considered unsuitable and the sliplining operation cannot be performed.

The Contractor must maintain sewage flow at all times. This may be accomplished by allowing flows to pass through the liner pipe. By-pass pumping may also be allowed.

Liner pipe must not be installed prior to the Engineer's approval. The liner pipe must be jacked, pushed or pulled, in case of a butt-welded polyethylene liner pipe (with no exceptions), into the existing pipe. An aqueous solution of Bentonite may be used to minimize the jacking load. For each section to be lined, insertion must be one continuous operation until the planned termination point is reached. Precautionary measures must be taken to ensure against scarring the liner or breaking the joints. It may be necessary to use a nose-cone to guide the pipe end past minor obstructions and prevent entry of debris and to put guards over the edges of the existing pipe at the inlet end to prevent their gouging the pipe during the insertion procedure. Once the insertion is initiated, it must continue to completion without interruption.

Total jacking loads must not exceed the manufacturer's recommendations. The Contractor must provide a suitable means of measuring jacking loads and must monitor the load as the liner pipe is being installed. If at any time the load appears to rise non-uniformly, indicating possible obstruction of the pipe, jacking operations must be terminated and the obstruction or other impediment removed before continuing.

Permanent bends to accommodate line or grade changes must be limited to radii

equivalent to a longitudinal strain recommended by the pipe manufacturer. At no time must this minimum allowable radius of curvature be exceeded.

The Engineer must approve the products employed in the sliplining process. A hydraulic or cable operated winching pipe pushing device may be used. The machine operator must closely and continuously monitor and control the jacking load in uniformity and magnitude. A jacking ring or device must be used to distribute the jacking load evenly over the entire surface perimeter of the pipe end. The Contractor must also utilize a device that holds stable a nearly inserted joint preventing damage to it while the following joint is shoved home. All joint operations must be made in full view of the inspector. The maximum pulling length recommended by the manufacturer must not be exceeded.

After insertion, the pipe must be allowed to normalize for the number of hours suggested by the pipe manufacturer to the temperature of the ground as well as recover any imposed strain before cutting the pipe to length between manholes.

606.03.06 – LINER PIPE SEALING

The annular space between the liner and the existing sewer main must be sealed at each manhole with a chemical seal and non-shrink grout. Seals must be placed in a band to form an effective watertight gasket in the annular space between the liner and the existing pipes in the manholes. The width of the band must be a minimum of twelve inches (12-in) or one-half (1/2) the diameter of the pipe, whichever is greater. It must be finished off with a non-shrink grout placed around the annular space from inside the manhole and must not be less than six inches (6-in) wide. The Engineer must approve the chemicals and materials. The Contractor must cut the liner so that it extends four inches (4-in) into the manhole. The Contractor must make a smooth, vertical cut and slope the area over the top of the exposed liner using non-shrink grout. The Contractor must also use cementitious grout to form a smooth transition with a reshaped invert and a raised manhole bench such that neither the sharp edges of the liner pipe, nor the concrete bench, nor the channeled invert can exist to catch debris and create a stoppage. The invert of the manhole must also be reworked (smoothed and built-up) to match the flow line of the new liner.

The liner pipe must be allowed to normalize to ambient temperatures as well as recover from any imposed strain, in accordance with the manufacturer's recommendation before being cut to fit between manholes and proceeding with reshaping and/or smoothing the manhole invert.

606.03.07 – LINER PIPE GROUTING

The annular space between the liner pipe and the existing pipe must be sealed with a grout having good flow characteristics, minimum shrinkage, and permanence of support. A minimum twenty-eight (28) day compressive strength of the grout must be one thousand pounds per square inch (1,000-psi) or greater must be required to assure the structural integrity of the rehabilitated pip e. The safe grouting pressure

must conform to the type and the requirements of the pipe used. The maximum grouting pressure must be in accordance with the liner pipe manufacturer's recommendations.

The sealing compound must be suitable for underwater application and have elastomeric properties. The annular space must be one hundred percent (100%) filled, but particular attention must be paid to those areas just downstream of manholes to avoid air traps. Equipment for placement of grout must be used so as to prevent segregation of the grout components and to cause the grout to flow around the liner and completely fill the voids in the annular space. Under no circumstances must grout be dropped down the shafts onto the liner. Grout must not be permitted to rise in the vertical shafts more than two feet (2-ft) above the top of the existing pipe. The Contractor must have operable vibrators on the job to aid the flow of the grout. The Contractor must have operable pumps on the project site to remove water from the vertical shafts as it is displaced by grout to prevent an excessive hydrostatic head on the liner. Pumping pressures during the grouting process must not exceed the collapse pressure of the liner pipe.

The Contractor must install a vent pipe higher than the upper end of the pipe to ensure that the annulus is completely filled with grout.

606.03.08 – SEWER SERVICE CONNECTIONS

All sewer service connections must be accomplished and paid for in accordance with Section 602, “ Sewer Service Connection”.

606.04 – TESTING

604.05.01 – TELEVISION INSPECTION

Television inspection must be accomplished in accordance with Section 614, “Television Inspection”.

604.05.02 – SMOKE TESTING

Smoke testing must be accomplished in accordance with Section 610, “Smoke Testing”.

604.05.03 – DYE-WATER TESTING

Dye-water testing must be accomplished in accordance with Section 611, “Dye-Water testing”.

606.04.04 – SEWER LEAKAGE TESTING

Leakage testing must be required after liner has been installed and prior to services being re-connected. Leakage testing must be conducted in accordance with Section 615, “Sewer Pipe Leakage Testing”.

606.04.05 – ACCEPTANCE OF SLIPLINING

Final acceptance of sliplining must be based on, but not be limited to, review of post-television inspection, leakage testing, and conformance with all provisions of these specifications as determined by the Engineer. The installed liner pipe must be watertight, smooth, and free from wrinkles, as well as defects, and improper house connections. Should any of these defects occur, the line must be excavated, repaired and/or replaced, and complete restoration must be made to the satisfaction of the Engineer at no additional cost to the City.

606.05 – METHOD OF MEASUREMENT

"Sliplining" must be measured along the pipe, through manholes, junction boxes, and other small structures. Payment for "Sliplining" must be made at the unit price bid per linear foot of line, for each size installed and must include liner pipe, grout for pipe sizes fifteen inches (15-in) and smaller, and buildup, shaping and reworking the manhole invert, and sealing the annular space, equipment, labor, tools, and incidentals necessary to complete this item of work. For larger pipes, "Grouting" must be paid for at the unit price bid per cubic yard. Addition of inverts/benches, if none already exist, will be considered incidental to the cost of "Sliplining".

606.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SLIPLINING (SIZE)	L.F.
GROUTING	C.Y.

SECTION 607 – FORMED-IN-PLACE PIPE (FIPP)

607.01 – DESCRIPTION

This section covers rehabilitation of existing deteriorated sewers by trenchless method of installing formed-in-place pipe (FIPP) as hereafter described.

607.02 – MATERIALS

607.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities as specified in these Specifications.

A) General – The Contractor must submit source of materials for the specified liner pipe, or proposed liner pipe when alternate materials are specified. No FIPP must be shipped to project site until all submittals have been reviewed and approved by the Engineer.

B) Construction Schedule – The Contractor must submit an area map of the project designating the beginning and ending points as well as the time frames for each inversion or insertion. The map must also indicate the access manholes, length, and FIPP thickness to be installed for said inversions and/or insertion runs. Unless surveyed Plans accompany project specifications, all elevations must be determined and included in the Construction Schedule. This must include verification of all elevations on as-built drawings when such information is provided.

C) Certification of Material Compliance – A signed letter from the manufacturer stating that FIPP meets the requirements of these specifications. The Contractor/manufacturer must submit Type "A" and "D" certifications for the material. See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications.

D) Quality Control Reports – The manufacturer's results of quality control tests performed on the actual material used. The reports must contain all the raw data and intermediate calculations, as well as the testing procedures. Vendor Quality Control submittal must include performance testing from the following:

Standard	Standard name	Characteristic
ASTM D2990	Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics	Resin or resin-tube long term strength performance
ASTM D5813 Section 6.4.1 and 6.4.3	Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems	Chemical corrosion performance
ASTM D5813 Section 6.4.2 and 6.4.3	Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems	Strain corrosion performance

E) Installation Manual – The Contractor must submit installation manual describing

the method of installation.

F) Copies – The Contractor must provide a digital copy of all submittals, and if requested by the Engineer, hardcopies of any submittal must be provided as well.

607.02.02 – FIPP MATERIALS

Acceptable FIPP materials are as follows and must meet the requirements of the appropriate sections indicated below:

FIPP Material Type	Section
Deformed High Density Polyethylene (HDPE) Pipe	632
Folded Polyvinyl Chloride (PVC) Pipe	633
Resin Impregnated Tube (i.e. Cured-In-Place Pipe)	638

607.02.03 – FIPP DESIGN BASIS

The minimum installed formed-in-place pipe material thickness's specified are determined based on the buckling requirements (equation #3) established in ASTM F-1216, "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube", Appendix X1. Design Consideration, Section X1.2.2 Fully Deteriorated Gravity Pipe Condition. The following design assumptions are used in determining the specified minimum thickness for the acceptable FIPP materials:

Design Parameter	Design Assumption
Mean inside diameter of original pipe, D	Same as pipe nominal diameter
Soil unit Weight, γ	120-lbpcf
Height of soil above top of pipe, H	Minimum 10-ft
Height of water above top of pipe, Hw	Same as height of soil above top of pipe
Live Load, WL	AASHTO H20
Water buoyancy Factor, Rw	0.67
Total external Load, %	Hydrostatic load+ (Rw) (earth prism load)+ Live load
Ovality of original Pipe, q	2%
Factor of Safety, N	2.00
Modulus of soil Reaction, E's	700-psi

607.03 – CONSTRUCTION METHODS

607.03.01 – GENERAL

The installation of formed-in-place pipe must be in accordance with appropriate ASTM Standard Specifications and the Manufacturer's recommendations. If no ASTM Standard exists for the installation, the licensor/Manufacturer must furnish, in detail, step-by-step procedures for review and approval by the Engineer.

Temperatures and pressures must be monitored and recorded throughout the installation process to ensure that each phase of the process is achieved at the approved manufacturers' recommended temperature and pressure levels. When requested by the Engineer, the Contractor must submit field records of temperatures, pressures, and other pertinent information regarding installation.

The minimum span for the FIPP must be the distance from inlet to outlet of the respective manholes unless approval to do otherwise is given by the Engineer. Individual runs can be made over one or more manhole sections but must not exceed Manufacturer's recommendations for maximum allowable tension during the pulling process. Care must also be taken to cut each end of the formed-in-place pipe as directed by the Manufacturer for extension into manholes before releasing tension.

The installed FIPP must form a waterproof seal with the manhole wall. If pipe fails to seal properly, a material compatible with the pipe and manhole must be used to provide a watertight seal.

607.03.02 – SEWER SERVICE CONNECTIONS

Prior to the installation of FIPP, the Engineer will review the pre-inspection videotapes and logs for each line to determine which services must be externally reconnected. Service connections that may be a source of I/I or root propagation must be externally replaced as directed by the Engineer. Such connections must include but not be limited to the following:

A) A cracked or collapsed connection.

B) Missing pipe segments around the connection

C) Presence of roots

D) Protruding or receding connections

External Connection of services must be executed as per Section 602, "Sewer Service Connection".
All sewer service connections must be accomplished and paid for in accordance with Section 602, "Sewer Service Connection".

607.03.03 – SEWER FLOW CONTROL

Sewer flow control must be accomplished in accordance with Section 606, "Sliplining".

607.03.04 – POINT REPAIR

Point repairs must be accomplished in accordance with Section 612, “Point Repair”. The Engineer, from the specified work may delete segments between two consecutive manholes that require more than five (5) point repairs or external connections to rehabilitate. At the discretion of the Engineer, these segments may be replaced by conventional excavation in accordance with Section 212, “Trench Excavation and Backfill”.

When performing an external connection, the Contractor may at his option perform a point repair prior to lining the pipe or to anchor a saddle to the liner after installation. Groups of services replaced within thirteen-foot (13-ft) span are accessed with one point repair using whichever method is used to make the connections.

607.03.05 – CLEANING SEWER LINES

Cleaning sewer lines must be accomplished in accordance with Section 609, “Cleaning Sewer Line”.

607.04 – FIPP MATERIAL TESTING

607.04.01 – GENERAL

Following the installation for each minimum design thickness, the Contractor must obtain one (1) sample from the formed-in-place pipe as follows:

A) Sample Locations – Sample locations must be determined by the Engineer. When necessary, a point repair must be done in order to obtain the sample, the cost of which must be paid for at the unit price bid per each point repair. The Contractor must cut each sample to a minimum of three feet (3-ft) in length and ship the samples to a laboratory designated by the Engineer for testing as described herein. The results of these tests must be forwarded to the Engineer directly from the approved laboratory for review.

B) Specimens – From each sample, five (5) specimens must be prepared to determine flexural bending properties, namely the initial flexural modulus and flexural strength and thicknesses. The results of each test must be used to determine average values.

C) Methods – Tests and measurements must be in accordance with ASTM Test Method D 790, “Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials”, and the calculated average values must meet the minimum material properties and thicknesses established in these Specifications.

D) Cost – The cost of each test, when the material passes, must be borne by the City. When average test results do not pass, the Contractor will be responsible for the cost.

E) Acceptance – When the average test meets the requirements of these Specifications, the testing will be considered accepted.

F) Penalty – In the event, the material fails to meet the requirements of these specifications, an actual factor of safety against buckling must be calculated and a penalty must be assessed in accordance with provisions specified in Section 607, “Formed-in-place Pipe (FIPP) ”. The actual factor of safety must be determined using the computed average values of test results and the assumed design parameters and equations specified in Section 607, “Formed-in-place Pipe (FIPP) ”.

607.04.02 – TELEVISION INSPECTION

Television inspection must be accomplished in accordance with Section 614, “Television Inspection” .

607.04.03 – SMOKE TESTING

Smoke testing must be accomplished in accordance with Section 610, “Smoke Testing”.

607.04.04 – DYE-WATER TESTING

Dye-water testing must be accomplished in accordance with Section 611, “Dye-Water Testing”.

607.04.05 – REDUCED VALUE DEDUCTION

Provided that the computed factor of safety is equal to or greater than the value specified, the penalty is not applicable. The penalty must be computed as a percentage of the bid unit price for the minimum design thickness represented by the test results, and applied to the total length of a run, in accordance with the following schedule:

Computed Factor of Safety	Penalty (%)
≥2.00	0
1.90 - 1.99	5
1.80 - 1.89	10
1.70 - 1.79	20
1.60 - 1.69	30
1.50 - 1.59	40
1.40 - 1.49	50
1.30 - 1.39	70
1.20 - 1.29	90
< 1.20	100

If the computed factor of safety for a specified design thickness fails to meet the required factor of safety, the following must apply:

On the run that the sample was taken from, the penalty applies to the entire run. A run must not be tested more than once.

The Contractor, at his option, may conduct additional tests on one (1) sample from other runs of the same design thickness. If so, the penalty for that run is determined from that test.

For runs not tested, the reduce valve deduction must be the highest from the other runs tested.

A run is defined as the full extent of an insertion beginning at a manhole or access point and extending continuously to a designated manhole or termination point. Sample locations for additional testing must be determined by the Engineer. The Contractor must be responsible for all costs in securing additional test samples (i.e., point repairs, etc.) and all laboratory costs whether the results are passing or failing. In lieu of the reduced value deduction, the Contractor may install additional formed-in-place pipe to meet the minimum factor of safety requirement.

607.04.06 – ACCEPTANCE OF THE FIPP

Final acceptance of the FIPP must be based on, but not limited to, review of closed circuit television inspection, the required material testing, and conformance with all provisions of these specifications as determined by the Engineer. Additionally, no groundwater must be observed, and all service entrances must be accounted for and unobstructed. The installed FIPP must be continuous over the entire length of a run between manholes and be smooth and free from substantial wrinkles, as well as flat spots, reverse curvature, defects, improper house connection cut-outs and installation over debris. Should any of these defects occur, the line must be excavated, repaired, and/or replaced, and complete restoration must be made to the satisfaction of the Engineer at no additional cost to the

City.

607.05 – METHOD OF MEASUREMENT

Payment for "Formed-In-Place Pipe" must be made at the unit price bid per linear foot of pipe for each size. External connections (reinstatements) of services must be considered incidental to the lining process and the cost for such must be included in this bid item. The price established must be full compensation for all labor and materials including FIPP material, installation, external connection of services, equipment, tools, testing, and incidentals necessary to complete this item of work. All lengths must be measured horizontally from centerline to centerline of manholes.

607.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FORMED-IN-PLACE PIPE (SIZE) L.F.

SECTION 608 – SEWER FLOW CONTROL

608.01 – DESCRIPTION

This section covers necessary sewer flow control to the extent required for each operation, as specified and directed by the Engineer.

608.01.01 – SEWER FLOW CONTROL FOR TELEVISION INSPECTION AND SMOKE TESTING

When depth of flow at the upstream manhole of the section being worked is above the allowable for television inspection, the flow must be reduced to the level shown below by operation of pumps, plugging, or blocking of the flow, or by pumping and bypassing of the flow as specified. Depth of flow must not exceed that shown below for the respective pipe sizes as measured in the manhole when performing television inspection.

Pipe Nominal Size (inch)	Allowable Depth of Flow (% of pipe diameter)
≤ 10	20
12 - 24	25
≥ 27	30

608.01.02 – SEWER FLOW CONTROL FOR ALL OTHER OPERATIONS

A) General – The line must be completely blocked off and plugged and all flows must be by-passed to the extent necessary or as required by the Engineer.

B) Plugging or Blocking – A sewer line plug must be inserted into the line upstream of the section being worked. The plug must be so designed that all or any portion of the sewage can be released.

C) Pumping and Bypassing – When pumping and bypassing is required the Contractor must supply the pumps, conduits, and other equipment to divert the flow of sewage around the manhole section in which work is to be performed. The bypass system must be of sufficient capacity to handle existing flow plus additional flow that may occur during a rainstorm. The Contractor will be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. If pumping is required engines must be equipped in a manner to keep noise to a minimum and must comply with noise limit codes for the City of Oklahoma City. Noise barrier device are required immediately when pumping operations begin.

D) Flow Control Precautions – When flow in a sewer line is plugged, blocked, or bypassed; sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved. The Contractor will t be liable for damages resulting from sewer surcharge.

608.02 – METHOD OF MEASUREMENT

Payment for "Sewer Flow Control" must be made at the unit price bid per lump sum. The price established must include furnishing and operation of pumping and by-passing, labor, tools, and incidentals necessary to complete this item of work. Plugging or blocking of the sewer flow must be considered incidental to the work and must not be considered for payment.

608.03 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER FLOW CONTROL	L.S.

SECTION 609 – CLEANING SEWER LINE

609.01 – DESCRIPTION

This section covers cleaning of existing sewer lines. The designated sewer manhole sections and the manholes themselves must be cleaned using mechanical, hydraulically propelled and/or high velocity sewer cleaning equipment. Selection of the equipment must be based on the condition of the sewer mains at the time the work commences. The equipment must be capable of removing dirt, roots, sand, rocks, grease, and other

materials from the sewer lines.

609.02 – EQUIPMENT

609.02.01 – APPROVAL OF CLEANING EQUIPMENT AND PROCEDURE

The Engineer must approve the cleaning system and plan for each manhole section. The Contractor must demonstrate the performance of the proposed cleaning equipment for use on the project. No work can begin until the Engineer gives such time approval.

609.02.02 – MECHANICALLY POWERED CLEANING EQUIPMENT

Bucket machines must be in pairs with sufficient power to perform the work in an efficient manner. Machines must be belt operated or have an overload device. Machines with direct drive that could cause damage to the pipe will not be allowed. A power rodding machine must be either a sectional or continuous rod type capable of holding a minimum of three hundred feet (300-ft) of rod. The rod must be heat-treated (tempered) steel. To ensure safe operation, the machine must be fully enclosed and have an automatic safety clutch or relief valve.

609.02.03 – HYDRAULICALLY PROPELLED CLEANING EQUIPMENT

Hydraulically propelled devices that require a head of water to operate must utilize a collapsible dam to obtain the head. The dam must be designed to easily collapse in the event of a sudden surcharge of the line to prevent damage to the sewer, property, etc. Sewer cleaning balls are acceptable for use only in sanitary sewers having a diameter of eighteen inches (18-in) or greater.

The movable dam must be of equal diameter as the pipe being cleaned and must provide a flexible scraper around the outer periphery to ensure effective operation.
Whenever possible, flows present in the sewer lines must be used to provide necessary fluid for hydraulic cleaning devices.

609.02.04 – HIGH-VELOCITY CLEANING EQUIPMENT

All high-velocity sewer cleaning equipment must be constructed for ease and safety of operation. The equipment must have a selection of two (2) or more high-velocity nozzles. The nozzles must be capable of producing a scouring action from fifteen degrees (15-degrees) to forty-five degrees (45-degrees) in all size lines designated to be cleaned. Equipment must also include a high-velocity gun for washing and scouring manhole walls and floor. The gun must be capable of producing flows from a fine spray to a solid stream. The equipment must carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel. Filler piping on the tank must have an air cap to prevent backflow and contamination of water supply system.

609.03 – CONSTRUCTION METHODS

609.03.01 – CLEANING PRECAUTIONS

Satisfactory precautions must be taken to protect the sewer lines from damage that might be inflicted by the improper use of cleaning equipment. Whenever hydraulically propelled cleaning force or any tools which retard the flow of water in the sewer line are used, precautions must be taken to ensure that the water pressure created does not cause any damage or flooding to public or private property being served by the manhole section involved. Additionally, the Contractor must not allow the overflow from sanitary sewers to enter storm sewers.

The Contractor, at no additional cost to the City, and to the satisfaction of the Engineer, must repair any damage inflicted upon the sewer, regardless of the cleaning method used.

609.03.02 – ROOT AND DEBRIS REMOVAL

All roots must be removed. Special attention must be given during the cleaning operation to assure complete removal of roots from the joints. Procedures may include the use of mechanical equipment such as rodding machines, bucket machines and winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners. Chemical root treatment may also be used.

A) When chemicals are used to aid in the removal of roots, the chemicals must be EPA registered and labeled for use in sewer lines and acceptable to all applicable State and City agencies.

B) All materials and mixing/application procedures for chemical root treatment must be consistent with the latest standards, requirements, and recommendations of the manufacturer of the chemical root treatment material used.

C) All sludge, dirt, sand, rocks, grease, and other solid or semi-solid material resulting from the cleaning operation must be removed at the downstream manhole of the section being cleaned. Passing of debris from manhole to manhole must not be permitted.

D) When hydraulic cleaning equipment is used, a suitable sand trap, weir, or dam must be constructed in the downstream manhole in such a manner that the solids must be trapped.

E) All solids or semi-solids resulting from the cleaning operations must be removed from the site and dispose at no additional cost to the City. The City will not provide a dumpsite for all debris removed from the sewers during the cleaning operation. The Contractor is responsible for coordination of disposal site and operations. Under no circumstances can sewage or solids removed therefrom be dumped onto

streets or into ditches, catch basins, storm drains, or sanitary sewer manholes.

609.04 – TESTING (CLEANING AND FINAL ACCEPTANCE

Acceptance of sewer line cleaning must be made upon the successful completion of the television inspection and must be to the satisfaction of the Engineer. If television inspection shows the cleaning to be unsatisfactory, the Contractor must be required to reclean and reinspect the sewer line until the cleaning is shown to be satisfactory.

609.05 – METHOD OF MEASUREMENT

Payment for "Cleaning Sewer Line" must be made at the unit price bid per linear foot of pipe regardless of size. The price established must be full compensation for furnishing and operation of all equipment, labor, tools, and incidentals necessary to complete this item of work. No deduction must be made for manholes.

609.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CLEANING SEWER LINE	L.F.

SECTION 610 – SMOKE TESTING

610.01 – DESCRIPTION

This section covers testing of sewer lines with smoke where the origin of a connection as an inflow source is unknown. Common uses are to determine storm sewer cross connections, roof leaders, cellar, yard, fountain and area drains, abandoned building sewer and faulty service connections, and point source inflow due to leaks in drainage paths and pending areas.

610.02 – CONSTRUCTION METHODS

Smoke testing must not be used in sewer lines suspected of having sags or water traps or those that are flowing full.

Smoke testing must not be conducted to locate service connection when the soil surrounding and above the pipe is saturated, frozen or snow covered.

Smoke generated from bombs or canisters must be non-toxic, odorless, and non-staining. Air blowers must have a minimum capacity of 3,390 cubic feet/ minute.

610.03 – TESTING

Police, Dispatch UCS, and fire departments must be notified daily of the test locations. Contractor must inform residents individually on the day of testing by personnel displaying proper identification as well as knocking on doors and delivering a notice explaining the process.

Photographs must be taken of all leaks discovered during testing and must be numbered and direction orientated. They must be taken close enough to clearly mark the point where the smoke is escaping.

The Contractor must also submit a photograph and a sketch of each leak describing its extent, the area and type of surface drained by it, the location or address, and the photograph number. The leak must be marked at the site.

610.04 – METHOD OF MEASUREMENT

"Smoke Testing" must be measured by the linear foot of sewer line tested. Payment for "Smoke Testing" must be made at the unit price bid per foot regardless of pipe size. The price established must include all materials, labor, tools, equipment and incidentals necessary to complete this item of work.

610.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SMOKE TESTING	L.F.

SECTION 611 – DYE-WATER TESTING

611.01 – DESCRIPTION

This section covers dye-water testing used for detecting inflow such as storm sewer cross connections and point source inflow leaks in drainage paths or ponding areas, roof leaders, cellar, yard and area drains, fountain drains, abandoned building sewers, and faulty service connections. Dye-water testing must only be performed as directed by the Engineer where the origin of a connection is questionable.

611.02 – CONSTRUCTION METHODS

The equipment needed for dye-water testing must be limited to that required to carry the water to testing site and to block the sewers before testing. Sandbags or sewer pipe plugs may be used to block the sewer sections.

611.03 – TESTING

When inflow sources are located on private properties, property owners must be notified before tests to identify in-flow sources.

A field log sheet must be filled out for each dye-water test whether or not a positive transference is observed.

A sketch must be made. The sketch must indicate exactly what was flooded and the relationship between that and the sewer system. A photograph must be made to accompany the sketch. The photograph must include the set up or the point of ingress.

Dye must be safe to handle, visible in low concentrations, miscible in water, inert to the soils and debris in the sewers, and biodegradable.

611.04 – METHOD OF MEASUREMENT

The cost of dye-water testing must be considered incidental, and no additional compensation must be made for this work and the cost of same must be included in the other pay items.

SECTION 612 – POINT REPAIR

612.01 – DESCRIPTION

This section covers replacement of short segments of sections of the existing pipe as specified or directed by the Engineer.

The point repair is made by excavation to repair a line or remove an obstruction such as dropped joints, pipe sags or bellies one-half inch (1/2-in) or greater, protruding service connections, or crushed or collapsed pipe, which cannot be removed or repaired by remote devices. All point repair must be completed before trenchless construction.

612.02 – MATERIALS

Acceptable pipe materials and fittings must meet the requirements of Section 601, “Pipe Installation” and 602, “Sewer Service Connection”

612.03 – CONSTRUCTION METHODS

All point repairs require the method of repair prior approval of the Engineer. Pipe and fittings for point repairs must be installed according to the provisions set forth in Section 601, “Pipe Installation”. Trench excavation and backfill must be accomplished in accordance with Section 212, “Trench Excavation and Backfill”.

The length of any point repair must not exceed thirteen feet (13-ft).

Site cleanup and replacement of trees, shrubs, hedges, and sod must be in accordance with the appropriate sections of the specifications.

612.04 – METHOD OF MEASUREMENT

Payment for "Point Repair" must be made at the unit price bid per each regardless of depth. The price established must include all material, equipment and labor costs for excavation, pipe, replacement, embedment materials, cleanup, and incidentals necessary to complete a point repair.

All sod, trees, shrubs, hedges, if required foundation material, and paving must be replaced and paid for directly in accordance with the appropriate section.

Removal of obstructions by internal means must be considered incidental to work. Television inspection and cleaning of sanitary sewer in pursuit of repair must be considered incidental to work.

612.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

POINT REPAIR	EA.

SECTION 613 – DEFLECTION TEST

613.01 – DESCRIPTION

This section covers deflection tests intended to be performed on all flexible pipe installations.

613.02 – TESTING

All test results must be signed and sealed by a Professional Engineer licensed in the State of Oklahoma. The test must be performed not less than thirty (30) calendar days after backfill has been placed. The maximum allowable deflection must not exceed five percent (5-percent) of the pipe's base internal diameter (Base ID). Base ID for PVC pipes must be calculated from measurements taken in accordance with ASTM D 2122, “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”, and according to procedures outlined in Appendix XI of ASTM D 3034, “Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings”. For HDPE pipes Base ID must be calculated from measurements taken in accordance with ASTM D 2122, “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”, and according to procedures recommended by the Manufacturer and

approved by the Engineer. For other flexible pipes, Base ID must be calculated in accordance with the manufacturer's recommended procedures and approved by the Engineer.

A mandrel (go/no-go) device cylindrical in shape must be hand-pulled by the Contractor through all sewer lines. Any sections of pipe not passing the mandrel test must be uncovered and the Contractor, at no additional cost to the City, must replace the pipe to the satisfaction of the Engineer. The repaired sections must be re-tested. All tests for pipes twenty-four inch (24-in) and larger must be performed in the presence of the Engineer.

The Engineer must approve the mandrel and the testing procedures. Proving rings furnished by the Contractor must be used to verify the mandrel diameter.

In lieu of mechanical measurement of deflection by a mandrel, manual measurement can be performed using an internal micrometer or telescoping gage accurate to plus or minus (±) one-thousandth (0.001”) inch. The manual measurement of the vertical internal diameter must be taken at the centerline of the installed pipe

613.03 – METHOD OF MEASUREMENT

Payment for "Deflection Test" must be made at the unit price bid per lump sum for pipes smaller than twenty-four inches (24-in) and per linear foot for pipes twenty-four inches (24-in) and larger in diameter. The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

613.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEFLECTION TEST (< 24”)	L.S.
DEFLECTION TEST (≥ 24”)	L.F.

SECTION 614 – TELEVISION INSPECTION (CCTV)

614.01 – DESCRIPTION

This section covers closed-circuit television (CCTV) inspection of existing sewer lines and rehabilitated and newly constructed sewer lines.

The work must consist of furnishing all labor, materials, accessories, equipment, tools, transportation, services and technical competence for performing all operations required to professionally execute the internal inspection of sewers in strict accordance with these specifications.

Information concerning depths of flow, manhole depths, air quality in the sewers, accessibility of manholes, traffic conditions, and other safety considerations are to be the sole responsibility of the Contractor to obtain and to incorporate the necessary provisions into the overall contract price to complete the specified work under the conditions existing in the sewers to be inspected.

For large-diameter sewer inspections, the Contractor may be required to submit sample video recordings from recently completed projects demonstrating the picture quality obtained with each available inspection system for pipe diameters twenty-seven inches (27-in) and larger.

All television testing must be performed in accordance with guidelines published by the National Association of Sewer Service Companies (NASSCO) and as modified or specified in these specifications

614.02 – EQUIPMENT

All television cameras used for inspection must be color units specifically designed and constructed for the method of inspection performed. Camera(s) may be modified by mounting on conventional or floating skids, or rafts, for use in multiple-diameter, sewer line inspection work. Units must have either automatic or remote focus and iris controls, and the complete system(s) must be operable in conditions of one-hundred percent (100%) humidity.

Lighting must be suitable to allow a clear picture of the entire periphery of the main sewer pipe. For large-diameter twenty-seven inches (27-in) and larger pipe, the camera lens must have not less than a sixty-five degree (65-degree) viewing angle. A radial viewing camera with a three hundred and sixty degree (360-degree) vertical rotation and a two hundred and seventy degree (270-degree) horizontal rotation, or any combination of the two, may be required to properly evaluate the condition of the main sewer and laterals. Lighting must operate in a manner that allows the viewed object to be illuminated no matter what the angel of the lens. For a radial viewing camera, the lighting must be built into the unit so that the lamp(s) remains aligned with the lens. A minimum illumination of three (3) lux with a light color in the twenty-two hundred degree Kelvin (2,200-degree K) to thirty-two hundred degree (3,200-degree K) range must be provided. Auxiliary lighting acceptable to the Engineer must be provided for large diameter pipe. For diameters of sixty inches (60-in) and greater, a minimum of one million (1,000,000) candlepower lighting in the thirty-two hundred degree Kelvin (3,200-degree K) range must be made available.

The Contractor must be responsible for having the necessary camera skids, floats, and rafts available to allow for inspection of lines in a manner acceptable to the City under live flow conditions.

In all cases, the complete video system (camera, lens, lighting, cables, monitors and

recorders) must be capable of providing a picture quality acceptable to the Engineer, and if unsatisfactory, equipment must be removed, and no payment must be made for unsatisfactory inspections.

614.03 – CONSTRUCTION METHODS

614.03.01 – GENERAL

The Contractor must use one of the following methods individually or in combination, as approved by the Engineer:

A) Conventional color inspection cameras specifically designed for use in sewer line inspection work, mounted on conventional camera skids or tracks.

B) Conventional color inspection cameras specifically designed for use in sewer line inspection work, mounted on floating skids or rafts.

C) Special industrial grade, color-inspection cameras contained in waterproof housings, and mounted on floating skids or rafts.

D) Special industrial grade, color-inspection cameras, either handheld or contained in waterproof housings, and carried manually through the sewer during inspection work.

614.03.02 – PROCEDURE

A) Pre-work Submittals for Inspection of Large Diameter Pipes – For pipes twenty-seven inches (27-in) and larger, the Contractor must submit a listing of actual measured flow depths and times of measurement at a sufficient number of locations to indicate the flow depths that could be expected during inspection work. A minimum of one (1) flow depth measurement must be provided for each line section at no additional cost to the City. Additional off-peak flow measurements (i.e., night flow measurements) may be requested by the Engineer at various locations, also at no additional cost to the City.

   A prestart-up meeting must be scheduled prior to beginning any internal pipe inspection work to review the Contractor's proposed inspection methods for each of the line section groupings. At that time, the Contractor must have available the necessary flow depth date as well as the overall listing of proposed inspection methods in each area.

B) Remote Inspections – Remote pipe inspections must be permitted in cases where conditions are, as determined by the Engineer, to be unsafe or impractical for manual inspections, and where acceptable picture quality can be obtained by the Contractor.

   The main sewer must be cleaned as directed by the Engineer and in accordance with Section 609, “Cleaning Sewer Line”, of grease, roots and debris that may hinder movement of inspection equipment through the lines. Major line obstructions that

require point repairs are excluded.

The maximum flow depth for remote inspection work in pipes twenty-four inches (24-in) and less is twenty percent (20-percent) of the pipe diameter.

For large pipe diameters twenty-seven inches (27-in) and greater, the maximum flow must be thirty percent (30-percent) of the pipe diameter. The contractor may be required to perform inspections during off-peak hours (night inspections) when specifically requested by the Engineer to obtain this flow standard.

No inspections must be performed where flow depths exceed fifty percent (50-percent) of pipe diameter without prior approval of the Engineer.

Suspended moisture or fog in pipes must be cleared with blowers. Filming must commence only when the ambient temperature above ground is a minimum of forty degrees Fahrenheit (40-degree F).

CCTV inspection must be done one manhole section at a time and the flow in the section being inspected must be suitably controlled as specified in Section 614, “Television Inspection”. The inspection must proceed from one section to another starting either upstream or downstream and completing in that order for the entire line. When an obstruction prevents the camera from passing through the entire manhole section, the inspection must be continued from the opposite manhole before proceeding to the next section.

The camera must be moved through the line at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. The maximum speed of the camera must not exceed thirty feet per minute (30-fpm). Caution must be taken to not linger in one spot allowing the heat generated from the unit to ignite roots, debris, etc.

The camera must be moved through the line by conventional means of manual winches, power winches, television cable, and powered rewinds or other devices, which do not obstruct camera view or interfere with proper documentation of the sewer conditions. In instances where manual or remote power winches are used to pull the camera through the sewer constant two-way communication must be set up between the two manholes of the line being inspected.

Accurate and continuous footage readings must be superimposed on the video recording for each line inspected by remote inspection methods. Also shown must be the date of inspection and a manhole number designation that corresponds to the field logs for each manhole on the line section inspected.

When specified, a lateral sewer camera must be employed to inspect up to twenty-five feet (25-ft) of the lateral. The lateral camera launcher must be brought into position by the main sewer television camera. Lateral sewers entering manholes must

be inspected with a mini push camera. Actual footage inspected must vary depending on the condition of the pipe. Videotapes of laterals may be in black and white and must show a view of the lateral connection by the main sewer camera before showing the internal view of the lateral by the launcher.

The Contractor must provide photographs developed from the television screen of problems revealed by the CCTV camera upon the request of the Engineer, as long as such photographing does not interfere with the Contractor's operations.

C) Manual (Walk Through) Inspections – Manual inspections must be required in lines where conditions will allow the Contractor's inspection crew to safely walk through the sewer. In general, lines sixty inch (60-in) in diameter and larger and having flow depths of less than twenty percent (20%) of the pipe diameter, must be manually inspected as directed by the Engineer.

Inspection crews must consist of two or more people. Blowers and exhaust fans must be available to provide ventilation for the sewer line being inspected.

Manual pipe inspections must be conducted in such a manner as to transmit the video signal to an aboveground viewing room to permit the Engineer to watch the inspection work live on a color monitor in the viewing facility. In addition, direct voice communication between the Engineer, the in-pipe inspection personnel, and the recording technician in the aboveground unit must be maintained at all times during the manual inspection work. Video recording equipment must also be located above ground in the inspection truck and accurate, continuous footage readings must be superimposed on the video recording for permanent record. Camcorders must not be permitted for use as the sole means of obtaining video records.

During manual inspections, the video camera must be used to look up sidelines and laterals, whenever practical. Conditions noted in these sidelines and laterals must be noted on the inspection logs and videotapes for the project. During manual inspections, digital color photographs must be obtained as instructed by the Engineer or as deemed necessary by the in-pipe technicians to document line conditions.

614.04 – DOCUMENTATION

A) Television Inspection Logs – Printed location records must be kept by the Contractor and will clearly show the location in relation to adjacent manhole of each infiltration point observed during inspection. In addition, other points of significance such as locations of building sewers, unusual conditions, roots, storm sewer connections, broken pipe, presence of scale and corrosion, and other discernible features will be recorded, and a copy of such records must be supplied to the Engineer. The video audio recording and written report of the condition of each lateral, if inspected, must be included along with an identification number corresponding to main sewer log and approximate locations of any pipe defects.

If preliminary inspection occurs in conjunction with a rehabilitation or replacement project, no construction activities must begin without prior review and subsequent approval by the Engineer of the work outlined in the submittals.

During large-diameter pipe inspections, the Contractor must document in writing observed conditions and comments given about each sewer line. These field logs must then be reviewed by the Contractor's technical staff, along with reviewing the associated video record, as a means of insuring that no defects or entries are omitted or incorrect, and as a means of gaining a second opinion as to the condition of each sewer line. Edited field logs must then be reprinted or typed for use in the final project reports. Detailed, one-page summaries must also be prepared for each line section inspected, during the data review, presenting the Engineer's synopsis of the general line condition and the relative severity of observed effects. These summaries must also be included in all field report copies immediately before each associated inspection report. Direct submittal of copies of the field technician's field logs, without this secondary review and summary pages, will not be acceptable.

Complete copies of the final project reports must be submitted to the City within fifteen (15) calendar days of completion of all field activities. The Contractor must provide a digital copy of all submittals, and if requested by the Engineer, hardcopies of any submittal must be provided as well.

An overall summary narrative must be provided in the final report describing the overall conditions found in each associated line section grouping and detailed summary tables must also be compiled showing those lines where major and significant defects were located.

Original recordings, along with the required submittals, must be forwarded to the Engineer upon completion of the inspection and will become the property of the City.

B) Video Audio Recordings – A forward introduction sequence stating the time and date, location or segment number, depth, diameter, and pipe material for each length between manholes must precede the recording of each line segment. The camera must progress through the pipe indicating the beginning manhole and destination manhole as it marks the footage continuously. Should there be a need to access the line from the other direction, a new introduction track must precede the setup, and the footage must begin at zero.

The camera must pause as it approaches a service so that the connection between pipe and service may be evaluated. The lens must then rotate to display the interior of the service. The service inspection should reveal any roots, cracks, or capped risers.

Audio description must accompany the visual. Operator's comments must contain verbal verification of footage and condition of each service, and any defects or unusual conditions noted in the main. When television inspection is performed as a part of

final examination for acceptance of project, it must be performed after all the lines have been constructed and within twenty-four hours (24-hr) of conducting deflection test on a line. It must be continuous and present each segment in the order laid out in the plans (e.g., Line A: station 0+00 to 4+00, station 4+00 to 8+00, Line 8: station 0+00 to 3+00, etc.).

All recordings must be digital format. Each deliverable should be accompanied by a Transmittal including the following: description of project and contents, showing the Owner's name, project number, project location, the date(s), lines recorded on the video, and name of the Contractor. If the quality of the recordings is not satisfactory to the Engineer, the lines must be rerecorded at the Contractor's expense.

C) Photographs – All photographs taken during manual, walk-through inspections must be properly documented.

Photographs taken from the monitor for remote television inspections must also be presented in the same manner as described above.

614.05 – METHOD OF MEASUREMENT

Payment must be made for pre-construction inspection, when required for construction, and post construction inspection only. Unless separately specified, all other recording and/or photographs requested by the Engineer must be considered incidental to the project and the cost included in the price for other items.

"Television Inspection" must be measured along the stations, through manholes, junction boxes and other small structures. Payment for "Television Inspection (CCTV)" must be made at the unit price bid per linear foot of pipe regardless of size. The price established must be full compensation for all equipment, labor, materials, mobilization, demobilization, reverse setups, recordings, reports, photographs, and incidentals necessary to complete these items of work.

614.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TELEVISION INSPECTION (CCTV)	L.F.

SECTION 615 – SEWER PIPE LEAKAGE TESTING

615.01 – DESCRIPTION

After backfilling has been completed, the Contractor must conduct infiltration, exfiltration or air tests as directed by the Engineer and submit the results of all testing to the Engineer. All tests must be performed in the presence of the Engineer for pipes twenty-four inches (24-in) and larger.

Immediately prior to conducting a test, the ground water level must be determined by boring a vertical hole adjacent to the pipe and measuring the distance to the water level, or by the use of a one inch (1-in) diameter pipe installed horizontally through the upstream manhole wall with a clear plastic tube connected to the pipe and extending vertically.

615.02 – TESTING

615.02.01 – INFILTRATION TEST

Where sewers are laid under the groundwater, infiltration testing must be conducted. If at any time the infiltration between two adjacent manholes is observed and measured to exceed ten gallons per inch (10-gpi) of nominal pipe diameter per mile of sewer per day. The Contractor must locate the leakage and must make such repairs as are necessary to reduce the infiltration. The infiltration must be measured under the direction of the Engineer by use of a weir or other suitable flow rate-measuring device furnished and installed by the Contractor.

615.02.02 – EXFILTRATION TEST

Where sewers are laid above the groundwater table, exfiltration testing must be conducted. Exfiltration tests must be conducted by blocking off the other openings in the upper manhole and plugging the line where it enters the lower manhole of the reach to be tested, filling the line and the manhole with water at least five foot (5-ft) higher than the top of the pipe or five feet (5-ft) higher than the ground water elevation whichever is higher, and measuring the water required to keep the water level in the manhole at a constant elevation. The test section must be filled not less than twelve hours (12-hr) prior to testing. The total exfiltration must not exceed ten gallons per inch (10-gpi) of nominal pipe diameter per mile (idm) of pipe per day for each reach tested. For purposes of determining the maximum allowable leakage, manholes will be considered as sections of pipe having an I.D. equal to the diameter times depth of the manhole. The exfiltration test must be maintained on each reach for at least two hours (2-hr) or longer if, in the opinion of the Engineer, this is necessary to locate all leaks.

The Contractor must provide all necessary piping between the reach to be tested and the source of water supply, together with equipment and materials required for the tests. The methods used and the time of conducting the exfiltration tests must be subject to the approval of the Engineer.

If the leakage in any reach exceeds the allowable maximum, the Contractor must locate the leakage and must make such repairs as are necessary for the pipe to pass testing. The pipe reach must be retested after the leaks are repaired.

615.02.03 – AIR TEST

Air tests must be conducted on each manhole-to-manhole section of sewer. The air test

must be performed in accordance with the following specifications.

A) Equipment – Equipment used must meet the following requirements:

Pneumatic plugs must have a sealing length equal to or greater than the diameter of the pipe to be inspected.

Pneumatic plugs must resist internal test pressure without requiring external bracing or blocking.

All air used must pass through a single control panel.

Three (3) individual hoses must be used for the following connections:

1) From the control panel to pneumatic plugs for inflation

2) From the control panel to sealed line for introducing the low-pressure air

3) From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

B) Procedures – All pneumatic plugs must be seal-tested before being used in the actual test installation.

One length of pipe must be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air must be introduced into the plugs to twenty-five pounds per square inch gauge (25-psig). The sealed pipe must be pressurized to five pounds per square inch gauge (5-psig). If a ground water level over the top of the pipe is present, the pressure in psig must be increased by the height of ground water level above top of pipe at upstream manhole divided by two and one third (2.33). The plugs must hold against this pressure without bracing and without movement of the plugs out of the pipe.

After a manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedures, the plugs must be placed in the line at each manhole and inflated to twenty-five pounds per square inch gauge (25-psig). Low-pressure air must be introduced into this sealed line until the internal air pressure reaches four pounds per square inch gauge (4-psig). At least two (2) minutes must be allowed for the air pressure to stabilize. After the stabilization period (three and one half pounds per square inch gauge (3.5-psig) minimum pressure in the pipe), the air hose from the control panel to the air supply must be disconnected. The portion of the line being tested must be termed "acceptable" if the time required in minutes for the pressure to decrease from three and one half (3.33-psig) to two and one half pounds per square inch gauge (2.5-psig) is not less than that shown in the following table:

Table 615.05.01 – Air Test Requirements

Pipe Nominal Size (In)	Minimum Test Time	Length for Min. Time (Ft)
6	2:50	751
8	3:47	564
10	4:43	450
12	5:40	376
15	7:05	302
18	8:30	250
21	9:55	215
24	11:20	188
27	12:45	167
30	14:10	150
33	15:35	138
36	17:00	125
42	19:50	107
48	22:40	94
54	25:30	83
60	28:20	75
66	31:10	68
72	34:00	63
78	36:50	58
84	39:40	54
90	42:35	51
96	45:20	47
>96	Per Engineer required time and length	

For lengths in excess of "Length for Minimum Time" given in table above, additional testing time to be added to the "Minimum Test Time" is determined from the following equation:

$$t = 0.011 (d2) (L)$$

where:

t = additional testing time, seconds
d = nominal pipe diameter, inches
L = additional length, feet

If the air leakage in any reach exceeds the allowable, it must be re-tested after the

leaks are repaired.

615.03 – METHOD OF MEASUREMENT

Payment for "Sewer Leakage Test" must be made at the unit price bid per lump sum for pipes smaller than twenty-four inches (24-in) and per linear foot for pipes twenty-four inches (24-in) and larger in diameter. The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

615.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SEWER LEAKAGE TEST (<24”)	L.S.
SEWER LEAKAGE TEST (≥24”)	L.F.

SECTION 616 – SANITARY SEWER MANHOLES

616.01 – DESCRIPTION

This section covers construction of sanitary sewer manholes. Manholes may be constructed of the following types at locations specified or directed by the Engineer:

A) Precast Reinforced Concrete

B) Cast-In-Place Non-Reinforced Concrete

616.02 – MATERIALS

616.02.01 – PRECAST REINFORCED CONCRETE MANHOLES

A) General – This specification covers construction of precast reinforced concrete manhole base sections, riser sections (walls) and appurtenances in accordance with ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”, and as modified herein.

B) Submittals – Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as specified in these specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

1) Concrete cylinder compressive test results as per ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”.

2) Amount and detail layout of steel reinforcement as per ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”.

3) Type "D" Certification for the specified protective coating, see section 109.17.02 "Control of Work and Materials - Materials Certifications - Types of Certifications" for details on types of certifications.

4) Daily log of applied protective coating per “Part 10 Protective Lining”, below.

C) Types – Components of manholes must be as follows:

1) Precast Risers and Grade Rings – Precast risers and grade rings must be cylindrical type.

2) Precast Tops – Precast tops must be of the following two types:

a) Concentric cone

b) Eccentric cone

3) Precast Base Sections – Base section types must be as follows:

a) Base riser section and separate base slab with Mastic sealer.

b) Base riser section with integral floor and preformed socket to accept a rubber ring.

D) Sizes – The standard internal diameter of a manhole must be four feet (4-ft). Non-standard internal diameters of five feet (5-ft), six feet (6-ft), and seven feet (7-ft) may be constructed when specified or called for on the plans.

E) Dimensions – The manholes must be constructed pursuant to the appropriate "Standard Details for Precast Reinforced Concrete Manholes", and/or as specified in ASTM C-478,“Standard Specification for Circular Precast Reinforced Concrete Manhole Sections”. The minimum wall thickness must be as specified in the following table or not less than one-twelfth (1/12) of the internal diameter of the largest cone or riser section or five inches (5-in), whichever is greater.

TABLE 616.02.01 - Manhole Diameter and Wall Thickness

Manhole Internal Diameter (feet)	Minimum Wall Thickness (inches)
4	5
5	5
6	6
7	7
8	8

F) Materials – All materials for construction of manholes must be in accordance with Section 6 of ASTM C-478,"Standard Specification for Circular Precast Reinforced Concrete Manhole Sections".

G) Design – Design including concrete properties, reinforcement type and grade, joints, manufacturing and physical requirements must be in accordance with Section 7 to 10 of ASTM C-478, "Standard Specification for Circular Precast Reinforced Concrete Manhole Sections".

Base slabs or floors must have a minimum riser thickness of six inches (6-in) for diameters up to and including forty-eight inches (48-in) and a thickness of eight inches (8-in) for larger diameters.

H) Manhole Steps and Ladders – Steps and ladders must not be constructed unless otherwise directed by the Engineer. If called for, they must conform to Section 13 of ASTM C-478, "Standard Specification for Circular Precast Reinforced Concrete Manhole Sections".

I) Handling – All lifting holes must be repaired with a mixture of cement and sand grout firmly packed.

J) Protective Lining– All inside surfaces (walls, bottom, and etc.) of pre-cast concrete manholes must be shop coated with a total dry film thickness of not less than 8 mils. The material Manufacturer must furnish an affidavit attesting to the successful use of their material as a lining for applications where sewage conditions are recognized as corrosive or otherwise detrimental to concrete. Coating materials must be stored, mixed, applied and cured in accordance with guidelines set by the Manufacturer. The applicator of the coating must be certified through the manufacturer.

For every manhole coated as required, a daily log must be kept indicating the date, weather conditions, size and identification numbers of manholes coated, and number of gallons of coating applied to each manhole. The average number of gallons applied per manhole must be equal to or exceed the Manufacturer's

recommended coverage rate for the coating.

K) Field Testing – When directed by the Engineer, a set of three cylinders, three inches (3-in) in diameter, must be cut from randomly selected manholes. Testing must be performed to verify compliance with the requirements of these specifications. Basis of acceptance for testing must be in accordance with the appropriate ASTM requirements.

L) Acceptance – Acceptance of manhole structure must be based on the conformance and performance of materials required in ASTM C-478, “Standard Specification for Circular Precast Reinforced Concrete Manhole Sections” and the Engineer's inspection of the installed product. The assessment must include, but not be limited to, the Engineer's random plant inspections during production, the quantity and the placement of reinforcement, surface fractures and roughness, and the test results of compressive strength performed on cores and cured cylinders in accordance with Section 7 of ASTM C-97, “Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone”.

616.02.02 – CAST-IN-PLACE NON-REINFORCED CONCRETE MANHOLES

A) General – This specification covers construction of cast-in-place non-reinforced manholes consisting of plain concrete walls with brick masonry or precast grade rings at the surface. Rings and covers (castings) must be constructed in accordance with the dimensions and requirements of the standard details.

B) Types – Manholes may be constructed of the following three (3) types, when called for on the plans:

1) Concentric Manholes

2) Eccentric Manholes

3) Offset Manholes

C) Sizes – The standard manhole size must be four feet (4-ft) internal diameter. Non-standard sizes may be constructed when called for on the plans or specified. The wall thickness must be a minimum of eight inches (8-in).

D) Dimensions – The manholes must be constructed pursuant to the appropriate "Standard Details for Cast-In-Place Non-Reinforced Concrete Manholes".

E) Materials – All materials for the construction of cast-in-place manholes must be in accordance with the Material Specifications.

F) Protective Coating – Protective coating will be required unless otherwise called for

on the plans or as directed by the Engineer.

G) Acceptance – Ready-mix concrete may be accepted on the basis of Type "E" Certification, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of the material to be satisfactory.

616.02.03 – MANHOLE INVERT AND BENCH

All loose materials must be removed prior to shaping the invert. The invert must be smooth, U-shaped, have a minimum depth of one half (1/2) pipe diameter and be channeled across the floor of the manhole using the materials specified herein to obtain the proper form and shape. The bench must also be formed and built up with concrete approved by the Engineer. Additionally, all work must comply with the appropriate "Standard Details for Precast Manhole Base Sections" and the "Standard Details for Cast-In-Place Non-Reinforced Concrete Manhole Base Section".

For precast manholes, inverts and benches must be formed and poured in place after manhole base and pipe sections are in place.

Materials used for invert or benches must not be allowed to enter the sewer line. Finished benches must be smooth and free of any defects that could cause the accumulation of debris.

616.02.04 – MANHOLE RING AND COVER

A) General – Cast iron rings, tops, covers, gratings and all cast iron fittings must be sound, true to form and thickness and neatly finished and must fit together in a satisfactory manner. Castings must be clean, uniform and whole, and without blow or sand holes, dorosit, hardspots, shrinkage, distortion or any other surface defects which would impair serviceability. Casting surfaces must be smooth and well cleaned by shot blasting or other approved cleaning method.

Plugging or filling of holes or other defects must not be permitted. Parting fins and pouring gates must be removed. Sharp edges resulting from fabrication must be dulled by any acceptable method to ensure safety in handling. Casting must conform to the requirements of the ASTM A-48, “Standard Specification for Gray Iron Castings”, Class "30 B" for rings and "35 B" for covers and the appropriate "Standard Details for Manhole Ring and Cover".

All rings and covers must be accurately and carefully placed. All rings must be bedded in a substantial layer of mortar, or a flexible ring seal, must have a full bearing, and must be set to the exact grade. Unless otherwise shown, the top of covers must be flush with, or slightly above, the surrounding surface. When each

cover is placed in any position on the ring, the side play must not exceed one eighth inch (0.125-in) in any direction. Wording and markings on covers must be in accordance with the Standard Details.

B) Rings – Rings must be manufactured in accordance with the "Standard Detail for Reversible Manhole Ring".

C) Covers –

1) General – Manhole covers must be manufactured in accordance with the appropriate Standard Details for Construction Unless otherwise specified or directed by the Engineer, non-vented manhole covers must not be used in the streets or paved areas.

2) Coating – When called for on the plans or specified, the underside of all manhole covers must be given one (1) coat of asphalt varnish after visual inspection and approval on the job site.

3) Hinged Ring and Covers – When hinge type covers are used they must include a drain and incorporate a ninety degree (90-degree) blocking system to prevent accidental closure. The cover also must be able to be open to 120 degree and be removed from the ring. Hinged covers must incorporate a spring bar locking system that automatically activates when closed. The cover must also comply to weight requirements of manhole covers and provide a watertight seal with replaceable gasketing per the standard details.

616.03 – CONSTRUCTION METHODS

A) Foundation – Manholes must be constructed in a dry excavation. A crushed rock foundation mat must be constructed under the manhole. The mat must be a minimum of six inches (6-in) thick. Placement of material and material properties must comply with all applicable requirements of this section.

B) Backfilling – Backfilling for all manholes must conform to the requirements of Section 212, “Trench Excavation and Backfill”.

C) Manhole to Pipe Connection at Inverts – Manhole to pipe connections must be made pursuant to Manufacturer's recommendations and Standard Details for Construction. In addition, flexible gasket pipe seals must be required where each pipe enters the wall of manholes. Where possible, the opening for each connecting sewer pipe must be circular and match the diameter of the pipe. For manholes built, over existing lines or for special conditions, horseshoe shaped openings must be accepted. The Engineer prior to construction must approve the method and materials used for grouting any remaining annular space. Flexible pipe seals must have a Type "D" Certification, See section 109.17.02 “Control of Work and

Materials – Materials Certifications – Types of Certifications" for details on types of certifications. The flexible pipe seals must be approved by the Engineer. The Engineer may request a visual inspection and a sample of the materials used at any time. All material furnished under certification must 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.

D) Above Invert Manhole to Pipe Connection – Above invert manhole to pipe connection must be constructed in accordance with the Standard Details.

E) Finishing Manhole to Grade – The manhole ring and cover must be adjusted to grade with concrete grade rings or steel risers and installed per manufactures instructions. Steel risers can be expandable and sloped to meet finished grade. The manhole ring and cover must be adjusted to grade with concrete grade rings or course(s) of brick masonry. All brick masonry must meet the requirements of the Material Specifications. Mortar must be Class D, to which has been added an approved admixture unless otherwise shown on the plans or provided in the bidding documents. All brick must be laid in a full bed of mortar and all joints must be shoved joints completely filled with mortar. The joints on the inside face or exposed face of the masonry must be rubbed full and cut as the brickwork is built up. The masonry must be built up in level courses, true to line, grade and dimension. Bats must be used only when necessary to close joints. All brick must be thoroughly wet down immediately before being placed unless otherwise permitted by the Engineer. All work must be completed and finished in a careful, professional manner. Old brick masonry must be thoroughly cleaned and wetted before joining new masonry thereto. Where a mortar coating is required it must have the minimum thickness shown on the plans, must be troweled and re-troweled until a uniform, smooth and impervious surface is obtained.

   All pipes that extend through masonry walls must be tightly sealed in the wall with mortar throughout the circumference of the pipe. The mortar must be pressed in and troweled off flush with the face of the wall.

F) Outside Waterproofing – When called for on the plans or specified, waterproofing must be required on the outside of manholes. The coating must have a minimum dry thickness of four mils (4-mils). Coatings must be environmentally non-hazardous. Spray applications must be shop applied, and field applications are limited to brush and roller. Acceptance of material used for Waterproofing must be on the basis of Type "D" Certification, see section 109.17.02 "Control of Work and Materials - Materials Certifications - Types of Certifications" for details on types of certifications, provided that all applicable requirements are met.

G) Extra Depth Manhole Wall – Where required to construct manholes beyond a depth of six feet (6-ft), manhole walls must be constructed to the depth called for on the plans or as directed by the Engineer. The construction requirements for

Extra Depth Manhole Wall are the same as for "Sanitary Sewer Manhole".

616.04 – TESTING

616.04.01 – MANHOLE INSPECTION

After manhole construction has been completed, the manhole must be visually inspected by the Engineer for acceptability. Visual inspection must be done to check for leaks, thin spots, honeycombs, voids, pinholes and conformance with these specifications.

616.04.02 – MANHOLE TESTING

Manhole testing must be accomplished in accordance with Section 617, “Manhole Testing”.

616.05 – METHOD OF MEASUREMENT

Payment for "Sanitary Sewer Manhole" must be made at the unit price bid per each size for a depth of zero feet (0-ft) to six feet (6-ft). The price established must be full compensation for excavation, backfill, crushed rock foundation, inverts and benches, walls and cones, manhole inserts when specified, ring and cover, protective coating, outside waterproofing when specified, removal of existing manhole when necessary or specified or called for on the plans, brick masonry or precast grade ring and all labor, materials, tools, equipment and incidentals necessary to complete this item of work.

Payment for "Extra Depth Manhole Wall" must be made at the unit price bid per vertical foot for each size. The price established must be full compensation for excavation, backfill, protective coating, outside waterproofing when specified, removal of existing manhole, brick masonry, and all labor, materials, tools, equipment and incidentals necessary to complete this item of work. Extra depth must be measured from the invert to within six feet (6-ft) below top of cover.

616.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) SANITARY SEWER MANHOLE (0-6 FT)	EA.
EXTRA DEPTH MANHOLE WALL (SIZE)	V.F.

SECTION 617 – MANHOLE TESTING

617.01 – DESCRIPTION

This section covers testing of manholes when called for on the plans or specified. Manholes must be tested, before acceptance, by either performing exfiltration or vacuum test. The Engineer must determine which test must be performed.

617.01.01 – EXFILTRATION TEST

All incoming and outgoing lines (including services) must be plugged, and the manhole filled with water up to the bottom of the manhole ring. If the water loss exceeds the maximum allowable as shown, the manhole must be considered to have failed the test. The Contractor must drain, perform the necessary repairs as directed by the Engineer, and then retest the manhole until it passes, all at no additional cost to the City.

Manhole Depth (feet)	Maximum Allowable Water Loss
< 8-ft	One-inch (1-in) over Five (5) minutes
> 8-ft	One-eighth inch (0.125-in) per vertical Foot of depth over five minutes (5-min)

617.01.02 – VACUUM TESTING

All incoming and outgoing sewer and service lines must be plugged, the plugs restrained, and the vacuum tester head placed on the manhole ring and sealed. A vacuum of ten inches Hg (10-in HG) must then be drawn on the manhole and the time measured for the vacuum to drop to nine inches Hg (9-in HG). The time measured must be not less than that shown on the following table.

TABLE 617.01.01 – Manhole Diameter and Time Measured

Manhole Internal Diameter (feet)	Time Measured (seconds)
4	60
5	60
6	60
7	70

617.02 – METHOD OF MEASUREMENT

Payment for "Manhole Testing" must be made at the contract unit price of lump sum for manholes on lines less than twenty-four inches (<24-in) and each for manholes on lines twenty-four inches and greater (≥24-in). The price established must be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work.

617.03 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE TESTING	LS. (< 24”)
MANHOLE TESTING	EA. (≥ 24”)

SECTION 618 – SANITARY SEWER MANHOLE REHABILITATION

628.01 – DESCRIPTION

This section covers rehabilitation of existing manholes. This section is to provide for all aspects of manhole rehabilitation and waterproofing using various procedures either singularly or in combination.

Sewer manhole rehabilitation must include the following work:

A) Plugging, patching, and waterproofing of the manhole structure, (including manhole chimney, corbel/cone, wall, and base with mortars), coatings and sealants to improve the surface condition, eliminate infiltration, and provide corrosion protection.

B) Lining or coating of manholes

C) Cleaning manholes

D) Reconstruction of benches and inverts

E) Repair or rebuilding of the manhole chimney and corbel to improve structural condition when excavation is required.

F) Removal of steps or ladder

G) Reinstallation or replacement of manhole rings and covers for grade adjustment, ring alignment, or inflow elimination

H) Elimination of infiltration/inflow under manhole rings

I) Elimination of inflow through and around manhole covers

618.02 – CONSTRUCTION METHODS

618.02.01 – SEWER FLOW CONTROL

Manhole sewer flow control must be accomplished in accordance with Section 608, “Sewer Flow Control”.

618.02.02 – CLEANING MANHOLES

Prior to any rehabilitation work on manholes, all concrete and masonry surfaces must be cleaned to the satisfaction of the Engineer. Grease, laitance, loose bricks, mortar, unsound concrete, and other materials must be completely removed. Water blasting with a minimum of five thousand pounds per square inch (5,000-psi) pressure at the nozzles must be the primary method of cleaning, however, other methods such as wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means may be required to properly clean the surface. Surfaces on which these other methods are used must be thoroughly rinsed, scrubbed, and neutralized to remove cleaning agents and their reactant products. All existing steps and ladders must be cut and disposed of properly. Install all products in accordance with manufacturer’s instructions regarding surface preparation, product application and curing.

618.02.03 – MANHOLE WATERPROOFING

Waterproofing of manholes must be accomplished in accordance with the requirements of Section 619 through 623.

618.02.04 – PATCHING

A) General – Work includes patching, reworking, and reforming of invert and bench. Dry voids, cracks, and spalls must be patched in concrete manholes. Brick manholes must be re-pointed and filled.

B) Material – Manhole waterproofing must comply to the following specifications.

1) Patching material must be formulated for use in high sulfide environments.

2) Patching material must be a premixed non-shrink cement-based patching material consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents, which has been formulated for vertical or overhead use.

3) It must not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents or promote the corrosion of steel with which it

may come into contact.

4) Set time must be less than thirty minutes (30-min) per ASTM C-191, “Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle” and designed to resist freeze-thaw environments.

5) One-hour compressive strength must be a minimum of two hundred pounds per square inch (200-psi) ASTM C-109, “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens) with a maximum volume change of 0.02-percent per ASTM C-596, “Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement”, and the ultimate compressive strengths must be a minimum of five thousand pounds per square inch (5,000-psi) per ASTM C109, “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)”. Bond strength must be a minimum of one hundred and forty-five pounds per square inch (145-psi).

6) If patching material is used in combination with a liner material, the products must be deemed compatible as determined by the Manufacturer.

C) Method – Loose material must be removed from the area to be patched or pointed exposing a sound subbase. Holes or voids around steps, joints or pipes, spalled areas and cavities caused by missing or broken brick must be patched and missing mortar repointed using a non-shrink patching mortar.

Cracks not subject to movement and greater than one sixteenth inch (0.0625-in) in width must be grouted out to a minimum width and depth of one-half inch (0.5-in) and patched with non-shrink patching mortar.

Epoxy grouts may be used for filling cracks and voids less than two inches (2-in) in any dimension when preparing surface for application of an epoxy resin lining. Install all materials in accordance with Manufacturer’s instructions regarding surface preparation, product application and curing.

618.02.05 – INVERT AND BENCH RECONSTRUCTION

This section covers the reconstruction of invert and bench of manholes. When called for on the Plans or bidding documents or as directed by the Engineer, manhole benches and inverts shall be reconstructed in accordance with applicable requirements of Section 616, “Sanitary Sewer Manholes”. Hydraulic cement shall meet the requirements of Section 618.04.04, “Sanitary Sewer Manhole Rehabilitation”.

618.02.06 – RAISING MANHOLE

Raising manhole must be accomplished in accordance with Section 457, “Raising

Manhole”.

618.02.07 – LOWERING MANHOLE

Lowering manhole must be accomplished in accordance with Section 458, “Lowering Manhole”.

618.04.08 – RESETTING EXISTING MANHOLE RING AND COVER

Resetting existing manhole ring and cover must be accomplished in accordance with Section 459, “Resetting Existing Manhole Ring and Cover”.

618.04.09 – SETTING NEW MANHOLE RING AND COVER

Setting new manhole ring and cover must be accomplished in accordance with Section 460, “Setting New Manhole Ring and Cover”.

618.04.10 – REHABILITATION METHOD

Manhole may be rehabilitated using one of the following methods as called for on the plans or as directed by the Engineer. Liner must not be applied until all other repairs have been completed.

Rehabilitation Methods	Section
Cast-In-Place Concrete Manhole Liner	624
Cementitious Manhole Liner (Spray Applied)	625
Cured-In-Place Manhole Liner	626
Composite Manhole Liner (Grouted)	627
* Elastomeric Manhole Coatings	628

* Note: This rehabilitation method may be used only on manholes that do not have exposed rebar or missing bricks.

618.04.11 – SERVICE CONNECTIONS

All services connections must be reinstated.

618.05 – TESTING

618.05.01 – MANHOLE TESTING

When called for on the plans or specified in the bidding documents, manhole testing must be accomplished in accordance with Section 617, “Manhole Testing”.

618.06 – METHOD OF MEASUREMENT

Payment for “Sanitary Sewer Manhole Rehabilitation” must be made at the unit price bid per vertical foot for each internal diameter. The price established must be full compensation for all materials and labor required to clean, patch, line, tools, equipment and incidentals necessary to complete this item of work.

Payment for this item must not be made until all rehabilitation on the manhole has been completed. Measurement must be made from the bottom of invert to the finished grade.

Payment for “Invert and Bench Reconstruction” must be made at the unit price bid per each. The price established must be full compensation for all materials and labor required to clean, patch, line, tools, equipment and incidentals necessary to complete this item of work.

618.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SANITARY SEWER MANHOLE REHABILITATION	V.F.
INVERT AND BENCH RECONSTRUCTION	EA.

SECTION 619 – MANHOLE WATERPROOFING

619.01 – DESCRIPTION

This section covers the requirements for the elimination of infiltration/inflow into manholes that are otherwise structurally sound. The waterproofing of the manhole must include base, walls, corbel/cone, and chimney of brick, block or pre-cast manholes.

619.02 – MATERIALS

619.02.01 – GENERAL

The materials used must be designed, manufactured, and intended for sewer manhole rehabilitation and the specific application in which they are used. The materials must have a proven history of performance in sewer manhole rehabilitation. The materials must be delivered to the project site in original unopened packages and clearly labeled with the Manufacturer's identification and printed instructions. All materials must be stored and handled in accordance with recommendations of the Manufacturer.

619.02.02 – MANHOLE WATERPROOFING MATERIALS

A) General – After cleaning and preparing surface in accordance with Section 618, “Sanitary Sewer Manhole Rehabilitation” and when necessary, prior to the application of coatings and linings, active leaks must either be stopped by

application of the materials specified herein or an approved equal. When applying a liner or coating, plugging or channeling infiltration through “bleed” pipes installed at the bottom of the manhole may also be done.

Manhole structure waterproofing includes the waterproofing of the manhole base, walls, corbel/cone and chimney. Waterproofing must be done during high groundwater conditions, unless done in conjunction with application of a liner or coating installed in accordance with Section 620, “Manhole Waterproofing”.

B) Cementitious Grout Materials – A premixed fast-setting, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerated agents not containing chlorides, gas-forming agents, or promote the corrosion of steel it may come in contact with, may be used. Set time must be approximately one minute (1-min). Ten minute (10-min) compressive strength must be approximately five hundred pounds per square inch (500-psi).

C) Chemical Grout Materials

1) General – All chemical grout or sealant must comply with EPA requirements for performance attributes for a sewer sealant. In addition, they must have the following characteristics:

a) While being injected, the chemical sealant must be able to react/perform in the presence of water (groundwater).

b) The cured material must withstand submergence in water without degradation.

c) The resultant sealant (grout) formation must prevent the passage of water (infiltration) through the sewer joint.

d) The sealant material, after curing, must be flexible as opposed to brittle.

e) In place, the sealant formation should be able to withstand freeze/thaw and wet/dry cycles without adversely affecting the seal.

f) The sealant formation must not be biodegradable.

g) The cured sealant must be chemically stable and resistant to the mild concentrations of acids, alkalis, and organics found in normal sewage.

h) Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.

i) Mixing of the component materials must be compatible with field operations

and not require precise measurements of the ingredients by field personnel.

j) Cleanup must be done without inordinate use of flammable or hazardous chemicals.

k) Residual sealing materials must be easily removable from the sewer line to prevent reduction or blockage of the sewage flow.

2) Types – The Contractor may use one of the following chemical waterproofing materials, or an approved equal:
   a) Acrylamide and Acrylic Base Gels – Acrylamide and Acrylic Base Gels must meet the following requirements:

      i) A minimum of ten percent (10-percent) acrylamide or acrylic base material by volume in the total sealant mixes. A higher concentration percentage of acrylic base material may be used to increase strength or offset dilution during injection.

      ii) The ability to tolerate dilution and react in moving water during injection.

      iii) A viscosity of approximately two (2) centipoise which can be increased with additives.

      iv) A constant viscosity during the reaction period

      v) A controllable reaction time from ten seconds (10-sec) to one hour (1-hr) for acrylamide base gels and from five seconds (5-sec) to six hours (6-hr) for acrylic base gels

      vi) A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, flexible gel

      vii) The ability to increase mix viscosity, density, and gel strength, by the use of additives

   b) Polyacrylamide Base Gel – Polyacrylamide Base Gel must meet the following requirements:

      i) A minimum of ten percent (10-percent) polyacrylamide base material by volume in the total sealant mix. A higher concentration percentage of polyacrylamide base material may be used to increase strength or offset dilution during injection

      ii) The ability to tolerate some dilution and react in moving water during injection

iii) A viscosity of thirty to thirty-five (30-35) centipoise at ten percent (10-percent) solids as applied. The ability to increase mix viscosity, density and gel strength by use of additives

iv) A controllable reaction time from ten seconds (10-sec) to five minutes (5-min)

v) A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, firm, flexible gel

vi) A resistance to degradation over a pH range of two (2) to ten (10)

vii) A non-hazardous viscous liquid having ACUTE ORAURAT and Desnai/Rabbit LD60 greater than thirty-two g/kg (32-gpkg) and sixteen g/kg (16-gpkg), respectively

viii) The ability to use water to clean packers and pumps

c) Urethane Base Gel – Urethane Base Gel must meet the following requirements:

i) One (1) part urethane pre-polymer thoroughly mixed with between five (5) and ten (10) parts of water by weight.

ii) A liquid pre-polymer having a solids content of seventy seven percent (77-percent) to eighty three percent (83-percent), specific gravity of 1.04 (8.65-ppg), and a flash point of twenty degrees F (20-degree F)

iii) A liquid pre-polymer having a viscosity of six hundred (600) to twelve hundred (1,200) centipoise at seventy degrees Fahrenheit (70-degrees F) that can be pumped through five hundred feet (500-ft) of one-half inch (0.5-in) hose with a one thousand pounds per square inch (1,000-psi) head at a flow rate of one ounce per second (1-ozps)

iv) The water used to react the pre-polymer should have a pH of five (5) to nine (9)

v) A cure time of eighty seconds (80-sec) at forty degrees Fahrenheit (40-degrees F), fifty-five seconds (55-sec) at sixty degrees Fahrenheit (60-degrees F), and thirty seconds (30-sec) at eighty degrees Fahrenheit (80-degree F) when one (1) part pre-polymer is reacted with eight (8) parts of water only

vi) A cure time that can be reduced to ten seconds (10-sec) for water

temperatures of forty degrees Fahrenheit (40-degree F) to eighty degrees F (80-degree F) when one (1) part pre-polymer is reacted with eight (8) parts of water containing a sufficient amount of gel control agent additive

vii) A relatively rapid viscosity increases of the pre-polymer/water mix. Viscosity increases from about ten (10) to sixty (60) centipoise in the first minute for one (1) to eight (8) pre-polymer/water ratio at fifty degrees F (50-degree F)

viii) A reaction (curing) which produces a chemically stable and non-biodegradable, tough, flexible gel

ix) The ability to increase mix viscosity, density, gel strength and resistance to shrinkage by the use of additives to the water

d) Cementitious Coating Material – A liquid polymer modified hydraulic waterproof coating, which must provide a secure (mechanical and chemical) bond per ASTM C-1072, "Standard Test Methods for Measurement of Masonry Flexural Bond Strength".

i) The material must be available in contrasting colors. When fully cured, the two (2) coat or three (3) coat system must be able to withstand a hydrostatic pressure of seven pounds per square inch (7-psi) or thirty pounds per square inch (30-psi), respectively, without any visible leaks.

ii) Install all products in accordance with manufacturer's instructions regarding surface preparation, product application and curing.

619.03 – CONSTRUCTION METHODS

619.03.01 – Grout Waterproofing Method

A) Equipment – The basic equipment must consist of pumps, containers, injection packers, hoses, valves, and all necessary equipment and tools required to seal manholes. The chemical injection pumps must be equipped with pressure meters that will provide for monitoring pressure during the injection of the grout sealants. When necessary, liquid bypass lines equipped with pressure-regulating bypass valves will be incorporated into the pumping system.

B) Plugging Procedure – At each point of leakage within the manhole structure a hole must be carefully drilled from within the manhole and must extend through the entire manhole wall. In cases where there are multiple leaks around the circumference of the manhole, fewer holes may be drilled, providing all leakage is stopped from these holes. Grout ports or sealant injection devises must be placed in these previously drilled holes in such a way as to provide a watertight seal between the holes and the

injection device. A hose, or hoses, must be attached to the injection device from· an injection pump. Chemical sealing materials as specified must then be pumped through the hose until material refusal is recorded on the pressure gauge mounted on the pumping unit or a predetermined quantity of sealant has been injected. Care must be taken during the pumping operation to ensure that excessive pressures do not develop and cause damage to the manhole structure. Upon completion of the injection, the ports must be removed, and the remaining holes filled with mortar and finished flush by trowel with the surface of the manhole wall or other surface. The mortar used must be a non-shrink patching mortar meeting the requirements of Section 618, “Sanitary Sewer Manhole Rehabilitation”. Small leaks may be sealed without drilling and with grout delivered directly into the site with a caulking applicator.

C) Packing Procedure – Dry twisted jute oakum is soaked in polyurethane resin and then manually packed into cavity at site of active flow. Cementitious grouts may be mixed into a thick slurry and then packed directly into gravity. Both procedures require holding the product in place until material sets and the leak is stopped.

D) Cementitious Waterproof Coating Method – A waterproof, cementitious coating as specified herein must be applied to all surfaces, from and including the manhole bench to the bottom of the frame. The material must be applied to surfaces that are free of cracks or voids wider than one-sixteenth inch (0.0625-in). Coating may be applied over minor leaks and weeping around bricks, but major leaks will need to be plugged with cementitious or chemical grout before coating. A minimum of two (2) coats (of contrasting colors) must be applied to manholes zero feet (0-ft) to fifteen feet (15-ft), and three (3) coats applied to depths greater than fifteen feet (15-ft). When completed, the coating must be free of any cracks or holes.

After proper curing of the applied materials, any "bleed" pipes that were used must be removed, and the holes plugged and coated with the specified materials.

619.04 – TESTING & INSPECTION OF WATER PROOFING

After the specified waterproofing work has been completed, the manholes must be visually inspected and tested by the Contractor (as required) in the presence of the Engineer and found to be acceptable.

Manhole structure waterproofing must be visually inspected for water tightness against leakage of water into the manhole. All visible leaks and defects observed during inspection must be repaired to the Engineer's satisfaction.

619.05 – METHOD OF MEASUREMENT

Payment for "Manhole Waterproofing" must be made at the unit price bid per each. The price established must be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

619.06 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE WATERPROOFING	EA.

SECTION 620 – MANHOLE JOINT WATERPROOFING

620.01 – DESCRIPTION

This section covers waterproofing of joints in pre-cast concrete manholes. The work includes the sealing of barrel joints when general structural sealing is not required.

620.02 – CONSTRUCTION METHODS

Chemical Grout Sealing – Chemical grout sealing must be accomplished in accordance with Section 620, “Manhole Waterproofing”.

Cementitious Sealing – Cementitious sealing must be accomplished in accordance with Section 619, “Manhole Waterproofing”.

Expanded Gasket – Elastomeric polyurethane resin-soaked oakum method, using dry twisted jute oakum or resin rod with polyurethane resin (water activated) may be used.

Manufactured Seal **–** Manufactured manhole joint seal that generally conforms to the requirements of Section 621, “Manhole Ring Waterproofing”, with a stainless steel restraining hoop may be used. Detailed installation procedures must be in accordance with the manufacturer's instructions. Internal Joint Seals meet or exceed the physical requirements of ASTM C-923, “Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals”. The stainless steel expansion band meets or exceeds ASTM A-240, Type 304 standards, “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”.

620.03 – TESTING

Inspection and testing of waterproofing must be accomplished in accordance with Section 619 “Manhole Waterproofing”.

620.04 – METHOD OF MEASUREMENT

Payment for "Manhole Joint Waterproofing" must be made at the unit price bid per each joint. The price established must be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

620.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE JOINT WATERPROOFING	EA.

SECTION 621 – MANHOLE RING WATERPROOFING

621.01 – DESCRIPTION

This section covers manhole ring waterproofing.

621.01.01 – GENERAL

Manhole ring waterproofing includes the sealing of the ring joint area and the chimney above the cone of the manhole with either a manufactured or applied internal or external flexible seal. The seal must be designed to prevent leakage of water into the manhole through these areas throughout a twenty-year (20-yr) design life. The seal must remain flexible, allowing repeated vertical movements of the frame due to frost lift, ground movement, or other causes of up to two inches (2-in) and/or repeated horizontal movement of the frame due to thermal movement of pavement or other causes of up to one-half inch (0.5-in).

621.02 – CONSTRUCTION METHODS

621.02.01 – GENERAL

Manhole ring waterproofing must be accomplished by the following methods as directed by the Engineer.

A) Manufactured Chimney Seal

1) General – This product cannot be used on cones or where chimneys are "out of round" by more than two inches (2-in). If the flexible portion of the seal is made of a rubber type product, it must have a minimum thickness of three-sixteenth inch (0.1875-in), a minimum unexpanded width of eight inches (8-in) and be fabricated from a high-grade rubber compound conforming to the applicable requirements of ASTM C-923, “Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals”. The internal seal must have a double pleated and the external seal have a corrugated, expandable center section. Any extension used in conjunction with the sleeve to increase coverage must be made of the same material and have the same minimum thickness as the sleeve and be designed to be mechanically attached to the sleeve. The bands used for compressing the sleeve and extension against the

manhole must be fabricated from minimum sixteen (16) gauge sheet, if channeled, or five-sixteenth inch (0.3125-in) diameter, if round, stainless steel conforming to ASTM A240, “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”, Type 304, for sheet and ASTM A479, “Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels”, Type 304, for rods. Any screws, bolts or nuts used on these bands must be stainless steel conforming to ASTM F-593, “Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs”, and 594, “Standard Specification for Stainless Steel Nuts”, Type 304. The internal seal or its appurtenances must not extend into the manhole opening to prevent or unduly restrict manhole entry. If the seal is constructed of another flexible material, it must have both tensile and tear strength equal to or greater than that of the rubber when tested in accordance with the applicable ASTM procedures.

2) Installation – The contact surfaces for the sleeve and extensions must be clean, reasonably smooth and circular, and free of excessive voids. If the masonry surface is rough or irregular and will not provide an effective seal, it must be smoothed with mortar. A bead of butyl rubber caulk must be applied to the bottom-sealing surface of the seal or extension to fill minor irregularities in the masonry surface. After the rubber sleeve has been placed in the proper position, the bands are positioned and individually tightened or expanded as required to provide a watertight seal.

B) Extension – When an extension is used, its top must be positioned in the bottom band recess prior to installing the bottom band. The bands are then positioned in the extension and tightened or expanded as required to provide a watertight seal. Installation procedures must be in accordance with the manufacturer's instructions.

C) Applied Ring Seal – An applied seal is one that is achieved by applying a product, approved by the Engineer, either between the precast adjusting rings of the chimney and under the ring or to either the inside or outside surface of the chimney and ring to provide a seal that meets the performance criteria contained in this section. If the applied sealing product is a butyl compound, all of the surfaces that are to be sealed must be clean, dry and dust free.

D) Flexible Ring Seal – For application of flexible ring seal between joints, the waterproofing seal must be applied only when setting the manhole ring to brick or cast-in-place manholes. For precast manholes, the waterproofing seal must be applied between all adjustment ring joints including adjustment ring/cone joint, and to set the manhole ring.

E) Elastomeric Polyurethane Resin-Soaked Oakum Method – If the applied seal utilizes the elastomeric polyurethane resin-soaked oakum method, each joint must consist of two (2) concentric rings of two inch (2-in) oakum. The outer ring must be saturated with the urethane-base foam chemical-sealing material. The inner ring, saturated with

water, must be placed to prevent urethane foam from entering the manhole. The oakum saturated with urethane must be sprayed with water. When foaming begins, the frame must be set in place.

F) If the applied sealing product is a type of material that is applied to either the inside or outside surfaces of the ring and chimney and/or corbel/cone, the surface against which it is applied must be clean, and free of rust, dust, oil, loose material and other contaminants. The product must be applied by trowel, roller, or by spraying to achieve a thickness of not less than one hundred mils (100-mils). The sealing material must extend far enough onto the ring to ensure bonding and cover enough of the chimney to ensure sealing. Application procedures must be in accordance with the manufacturer's instructions.

621.02.02 – SETTING EXISTING OR NEW MANHOLE RING AND COVER

Setting of the manhole ring and cover must be in accordance with ring seal manufacturer's instructions.

621.03 – TESTING

Inspection and testing of waterproofing must be accomplished in accordance with Section 621, “Manhole Ring Waterproofing”.

621.04 – METHOD OF MEASUREMENT

Payment for "Manhole Ring Waterproofing" must be made at the unit price bid per each manhole. The price established must be full compensation for all materials, tools, labor, including resetting of existing manhole ring and cover, equipment and incidentals necessary to complete this item of work.

When waterproofing manhole ring requires installation of a new manhole ring and cover, a separate payment for the new manhole ring and cover must be made in accordance with Section 616 “Sanitary Sewer Manholes”.

621.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE RING WATERPROOFING	EA.

SECTION 622 – MANHOLE COVER WATERPROOFING

622.01 – DESCRIPTION

This section covers the waterproofing of manhole covers.

622.01.01 – GENERAL

Manhole cover sealing includes either the replacement of or sealing of existing manhole covers. All of the methods described, herein, require the thorough cleaning of the ring surface by wire brushing. Detailed installation procedures must be in accordance with the manufacturer's instructions.

622.02 – CONSTRUCTION METHODS

A) Cover Conversion – Reuse the existing cover by making it watertight. This is accomplished by installing a gasket between the cover and the cover-bearing surface of the ring and plugging the vent and pick holes. One of the plugs must be removable to facilitate removal of the cover.

   Manhole cover gaskets and plugs must be molded from a high-quality rubber compound such as Nitrile, EPDM or a blend thereof. The rubber product must have a minimum tensile strength of two thousand pounds per square inch (2,000-psi) with a hardness durometer of sixty (60) ± five (5). The cover gasket must be provided with an outside rib and have a minimum thickness of three-thirty seconds inch (0.09375-in).

B) Manhole Insert – Use the existing cover in conjunction with a watertight insert that is installed under the cover and prevents entry of water into the manhole. The manhole insert must be designed to prevent inflow through and around manhole covers and manufactured to fit the manhole ring upon which the manhole cover rests.

   The manhole insert must be manufactured from a corrosion-resistant material able to withstand the environment of a sanitary sewer system, road salts, oils and fuel that it may come in contact with. The material must be freeze-thaw resistant and withstand a temperature range of minus fifty degrees Fahrenheit (-50-degrees F) to two hundred forty-five degrees Fahrenheit (245-degrees F). The manhole insert must have a minimum thickness of one-eighth inch (0.125-in).

   The insert must have an approved system of relieving gas and vacuum pressure and must be complete with a closed-cell neoprene or polyethylene gasket with adhesive backing installed on the underside of the insert rim by the manufacturer. The insert must have a corrosion-resistant strap installed within the bowl for ease of installation and removal. The manhole insert must be fully seated upon the manhole ring and cover replaced to complete the installation.

622.03 – TESTING

Inspection and testing of waterproofing must be accomplished in accordance with Section 619 “Manhole Waterproofing”.

622.04 – METHOD OF MEASUREMENT

Payment for "Manhole Cover Waterproofing" must be made at the unit price bid per each manhole. The price established must be full compensation for all materials, tools, labor, equipment and incidentals necessary to complete this item of work.

622.05- BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MANHOLE COVER WATERPROOFING	EA.

SECTION 623 – GROUT CURTAIN WATERPROOFING METHOD

623.01 – DESCRIPTION

This section covers waterproofing manholes by installing a grout curtain.

623.01.01 – GENERAL

When specified or called for on plans, a chemical grout curtain may be installed to prevent infiltration. Ports must be drilled in a checkerboard fashion in the manhole chimney, corbel, and wall, and a chemical grout is pumped into the surrounding soil through the ports surrounding the manhole to create an impermeable "curtain". For brick and block manholes, the procedure may involve the use of a two coat cementitious liner as described in Section 625, “Cementitious Manhole Liner”, in combination with the grout curtain.

623.02 – CONSTRUCTION METHODS

623.02.01 – SURFACE PREPARATION

The manhole surface must be cleaned, patched, and infiltration stopped in accordance with Section 618, “Sanitary Sewer Manhole Rehabilitation”.

623.02.02 – GROUT PORTS OR INJECTORS

Holes must be drilled and grout ports or chemical grout injection devices installed to

ensure proper grouting of the soil outside of the manhole. Some additional ports may be placed after the application of the cementitious liner.

623.02.03 – WATERPROOF COATING

Two (2) or three (3) coats, as required, of a cementitious liner must be applied as required after any chemical grout is pumped. The liner must provide a dam to optimize the grout sealing application and must extend from the manhole base to the bottom of the ring seal.

623.02.04 – CHEMICAL SEALING

Chemical grout gel must be injected into the soil surrounding the manhole as needed for complete sealing, using the same equipment and procedures as required earlier in this section. Grouts injected into near-surface and chimney-corbel areas must be modified with shrink control agents, gel reinforcing agents and accelerators as needed for the type of chemical gel used.

623.03 – METHOD OF MEASUREMENT

Payment for "Grout Curtain" must be made at the unit price bid per vertical foot of manhole. The price established must be full compensation for all materials and labor including waterproofing grout, liner materials, surface preparation, application, tools, equipment and incidentals necessary to complete this item of work.

623.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

GROUT CURTAIN	V.F.

SECTION 624 – CAST-IN-PLACE CONCRETE MANHOLE LINER

624.01 – DESCRIPTION

This section covers utilization of an internal forming system for casting a structurally independent three inch (3-in) concrete wall within the existing manhole. The liner is constructed of high-strength concrete in one pour without seams and without disrupting sewer flows.

624.02 – MATERIALS

624.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as

specified in these specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) The Contractor must submit test reports of the concrete mix design meeting the requirements the following sub sections.

624.02.02 – GENERAL

Unless otherwise specified, the concrete must be a standard (Type 1/Type II) Portland cement mix, ASTM C-150, "Standard Specification for Portland Cement", with three-fourth inch (0.75-in) minus coarse aggregate, ASTM C-33, "Standard Specification for Concrete Aggregates", Size No. 67, producing a minimum twenty-eight day (28-day) compressive strength of four thousand pounds per square inch (4,000-psi) at full cure. When directed by the Engineer, a high-strength, quick-setting cement grout must be used for positioning and sealing the form at the manhole base.

624.02.03 – FORMS

Segmented stackable steel forms having cylindrical and conical sections with either eccentric or concentric cones are employed. The assembled internal manhole form must have sufficient stiffness and strength to preclude shifting and/or collapse during concrete placement and to ensure safe entry during the procedure. The assembled form must have appropriate cross section size to provide an annular space with a three inch (3-in) average and a one and one-half inch (1.5-in) minimum thickness.

624.03 – CONSTRUCTION METHODS

624.03.01 – SURFACE PREPARATION

The Contractor must use cleaning methods that are adequate to remove loose material from the manhole in accordance with Section 618, "Sanitary Sewer Manhole Rehabilitation". All existing manhole steps or ladders are to be removed. The Contractor must take all necessary precautions to prevent falling debris from damaging the manhole trough and/or entering the sewer. Install all products in accordance with manufacturer's instructions regarding surface preparation, product application and curing. If there is no product being installed, you must submit to the Engineer the method of Surface preparation. This submittal must include any method references ISO 8501 cleanliness levels and or SSP surface cleanliness number. Infiltration through existing manhole walls that would adversely affect the material used in the annular space must be eliminated or reduced to an acceptable level in accordance with Section 619 to 623.

624.03.02 – GENERAL

The Contractor must place block-outs as needed to provide pipe inlets and outlets of the same diameter through the new concrete wall. All flows through the manhole must remain active unless otherwise directed by the Engineer.

The internal form must be sized, erected and braced as necessary to assure that the new interior wall has an average thickness of three inches (3-in) with a one and one-half inch (1.5-in) minimum, extending from the manhole base to the bottom of the corbel/cone. The wall thickness may decrease to a minimum of one and one-half inches (1.5-in) at the top of the corbel/cone and through the chimney portion of the manhole. The finished opening must have a minimum diameter of twenty inches (20-in) unless otherwise specified.

The form must be positioned, sealed and finished at the manhole base using cement grout to assure that concrete does not enter the sewer during the procedure. As the concrete is placed, it must be consolidated to assure that it makes contact with the form and fills all pockets, seams and cracks within the annular space. The Contractor must use adequate but not excessive vibration that might cause segregation of the concrete components. The top of the new concrete interior must not extend into the manhole ring.

When the concrete has sufficiently cured to preclude slump or damage, the form must be removed. The resultant concrete manhole wall must be smooth and free of honeycomb and areas of segregated aggregate.

624.04 – TESTING

A set of nine (9) concrete cylinders, three inch (3-in) by six inch (6-in), must be made from each day's work with the date, location and job recorded on each. Testing must be in accordance with ASTM C-39, "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens". A laboratory must make the cylinders for testing. A seven (7) day and a twenty-eight (28) day compression test will be made and recorded using three (3) of the samples for each test. Three (3) samples will be held for further instructions by the Engineer should the twenty-eight (28) day compression test results fail to meet the specifications.

624.05 – METHOD OF MEASUREMENT

Payment for "Cast-In-Place Concrete Manhole Liner" must not be made separately but is included in the unit price bid for "Manhole Rehabilitation" per Section 618, "Sanitary Sewer Manhole Rehabilitation".

SECTION 625 – CEMENTITIOUS MANHOLE LINER

625.01 – DESCRIPTION

This section covers the application of a premixed cementitious blend of binders, materials, aggregates, glass fiber and other additives. After mixing with water, the material is spray applied directly to all interior surfaces of manhole in an even application consisting of multiple passes. Install all products in accordance with manufacturer's instructions regarding surface preparation, product application and curing. If spray method is not used, the proposed method must be submitted and receive approval from the Engineer. Once

applied, material to be troweled and sponge finish which must restore structural integrity and provide corrosion protection. The material should be capable of persisting in environments having pH levels down to 1.0. Materials that cannot meet this requirement will not be considered due to the conditions of the manholes.

625.02 – MATERIALS

All additions to cementitious manhole liners must conform to the requirements of ASTM C-94, “Standard Specification for Ready-Mixed Concrete”. The material may be the following proprietary pre-blended product or approved equal:

A) Calcium Aluminates– CAC mix must be made with one hundred percent (100-percent) pure fused calcium aluminate clinker and calcium aluminate cement (minimum alumina content of both the cement portion as well as aggregates must be thirty eight percent (38-percent) and used per manufacturer’s recommendations in applications where there is moderate to severe evidence of hydrogen sulfide (biogenic) corrosion.

B) Portland Cement - A mixture of cementitious and pozzolanic materials, micro-silica one hundred percent (100-percent) virgin polypropylene fibers, and other additives. This can also consist of a mixture of Portland cement, especially graded aggregates, synthetic fibers, and admixtures. This can also consist cementitious material enhanced with Donna Fill, a fine-graded granite aggregate.

C) Geopolymer Lining Material - must be a factory blended, one-component (just add water), eco-friendly (low carbon footprint), fiber reinforced, ultra-dense geopolymer mortar synthesized from reactive SiO_2 and Al_2O from industrial byproducts, enhanced with monocrystalline quartz aggregate. This material must be designed to restore structural integrity while eliminating the infiltration of groundwater, provide enhanced corrosion resistance and must be specifically formulated for ease of mechanical pumping, spraying and spin casting.

   A process to rule out cementitious products and to quantitatively classify a Geopolymer must include oxide composition testing using X-Ray Fluorescence (XRF). Prior to testing, the geopolymer precursor must be isolated by screening the original untreated, unground product through a 200# mesh screen, to remove aggregate and fibers. Once isolated, the precursor must be analyzed by X-Ray Fluorescence (XRF) and must result in the % weight of Calcium Oxide (CaO) being less than 25% of the total oxides.

D) Physical Properties – The cementitious liner must have the following minimum properties at twenty-eight (28) days:

Physical Properties	Test Method	Minimum Value

Compressive Strength	ASTM C-495, ASTM C39/ C109	Minimum 8,000
Tensile Strength	ASTM C-496	300 psi
Flexural Strength	ASTM C-293	600 psi
Shrinkage	ASTM C-596	0%
Bond		130 psi
Density, when applied		105 pcf

625.03 – EQUIPMENT

The equipment must be of a type necessary for the application of the proprietary product used as recommended by the manufacturer and approved by the Engineer.

625.04 – CONSTRUCTION METHODS

625.04.01 – SURFACE PREPARATION

Surface preparation must comply with Section 636.04.01, “Cast-in -Place Concrete Manhole Liner – Construction Methods – Surface Preparation”. Install all products in accordance with manufacturer’s instructions regarding surface preparation, product application and curing.

625.04.02 – APPLICATION

The materials must be mixed and applied in accordance with the manufacturer's written instructions using approved equipment. The material must be spray applied directly to the prepared manhole surface. The material must be troweled and then sponge finished after each coat. All cementitious liner materials, approved herein, must completely cover the interior surface of the manhole with a minimum thickness of one-half inch (0.5-in).

625.05 – TESTING

Testing must be done in accordance with Section 624, “Cast-in-Place Concrete Manhole Liner”.

625.06 – METHOD OF MEASUREMENT

Payment for "Cementitious Manhole Liner" must not be made separately but is included in the unit price bid for "Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 626 – CURED-IN-PLACE MANHOLE LINER

626.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer manholes by the installation of a resin impregnated flexible felt tube, inverted into the existing manhole. Cured-In-Place Liner and its minimum thickness must conform to the requirements of ASTM F-1216, “Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube”.

626.02 – MATERIALS

A) Tube – The tube must be compatible with the resin system and must consist of one or more layers of flexible felt or an equivalent woven or nonwoven material. The material must be able to stretch to fit irregular manhole sections. Allowance must be made in the fabrication of the tube so that the installed, formed-in-place-pipe fits snugly to the interior circumference of the existing manhole, while allowing for stretching during inversion.

B) Resin – The resin must conform to the requirements of Section 657.02, “Resin Impregnated Tube – Materials”.

C) Minimum Physical Properties – The cured resin impregnated tube must conform to the requirements of Section 638, “Resin Impregnated Tube”.

D) Chemical Resistance – The resin impregnated tube must conform to the requirements established in Section 638, “Resin Impregnated Tube.

E) Minimum Thickness – The installed liner must have a minimum SDR of 60 and must meet the following minimum thicknesses for various manhole internal diameters. All manholes must be lined with a minimum one inch (1-in) liner regardless of the internal depth. To ensure a fully structural, all manholes are required to be lined with a minimum one inch (1-in) thickness.

Internal Diameter (feet)	Minimum Thickness (inch)
4	1.00
5	1.00
6	1.20
7	1.40
8	Per Engineer’s requirement

F) Submittals – The Contractor must provide appropriate submittals in accordance with Section 607 “Formed in Place Pipe (FIPP)”.

626.03 – CONSTRUCTION METHODS

The Contractor must designate a location where the tube will be vacuum impregnated prior to installation. The Engineer must inspect the materials and the "wet-out" procedure and approve the location.

The wet-out tube must be installed in the manhole using a top inversion. The inversion ring must be built above the top of the manhole to an elevation required to create the standpipe section.

The tube must be banded to the inversion ring with the impermeable plastic membrane side out and inverted through the ring with a minimal amount of water. The inversion must be continued with a minimal amount of water until the tube reaches the bottom of the manhole.

After the inversion is completed, the water must be pumped out if required, and personnel should enter the manhole to manually adjust the tube to fit smoothly against the manhole wall. The tube must then be filled with water to the predetermined level and the curing process must begin.

The Contractor must then supply a suitable heat source and water recirculation equipment. The equipment must be capable of uniformly raising the water temperature to a level required to effectively cure the resin.

The heat source must be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge must be placed between the tube and the manhole at or near the bottom to determine the temperature during cure. Water temperature in the manhole during the cure period must be as recommended by the resin manufacturer.

Initial cure must be deemed to be completed when inspection of the exposed portions of the tube appear to be hard and sound and the temperature sensor indicates that the temperature is of a magnitude to realize an exotherm. The cure period must be of a duration recommended by the resin manufacturer and may require continuous recirculation of the water to maintain the temperature.

The Contractor must cool the hardened tube to a temperature below one hundred degrees Fahrenheit (100-degrees F) before relieving the hydrostatic head in the inversion standpipe. Cool down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being pumped out of the manhole.

The liner must be cut off below the manhole cover and sealed as specified. The finished product must be continuous over the entire manhole and be free from dry spots, delamination and lifts. It must also meet the leakage requirements or pressure test specified. During the warranty period, any defects must be repaired at the Contractor's

expense.

After the liner has been cured in place, the Contractor must reconnect the existing pipes entering the manhole as designated by the Engineer. This must be done from the interior of the manhole by cutting the tube at the pipe openings.

If due to broken or misaligned pipe at the manhole wall the tube fails to make a tight seal, the Contractor must apply a seal at that point in accordance with Section 607, “Formed-in-Place Pipe (FIPP)”.

626.04 – METHOD OF MEASUREMENT

Payment for “Cured-In-Place Manhole Liner” must not be made separately but is included in the unit price bid for "Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 627 – COMPOSITE MANHOLE LINER

627.01 – DESCRIPTION

This section covers rehabilitation of sanitary sewer manholes by the installation of a flexible plastic liner with profiled cross section cast into a structurally independent concrete wall three inch (3-in) thick or as directed by the Engineer.

627.02 – MATERIALS

627.02.01 – SUBMITTALS

Proposed grouting procedure including type of formwork used and/or measures taken to prevent buckling of liner, and cone entry assembly must be submitted to the Engineer for review and approval. The Contractor must submit a certificate that the PVC liner furnished under this specification is in conformance with the material and mechanical requirements in the appropriate ASTM and as specified herein. Submittals for concrete mix design must be in accordance with Section 624,“Cast-in-Place Concrete Manhole Liner”.

627.02.02 – GENERAL

A) Grout or Concrete – Grout components must be clean, fresh, and stored in suitable dry condition. Premixed grout and grout admixtures must be used in accordance with the manufacturer's instructions and approved by the Engineer. The grout or concrete must conform to the requirements of Section 624, “Cast-in-Place Concrete Manhole Liner”.

B) PVC Liner – The liner must be of the following types or approved equal:

1) PVC Panels or Coils – The PVC materials must be made from compounds specified for PVC pipe extrusion suitable for potable water and sanitary sewer, and DWV (Drain/WasteNent) with less than ten (10%) percent fillers and must conform to ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds” cell classifications 12454-B, or 13364-A, or 13364-B. The minimum panel base thickness and minimum panel "tee" profile height of the PVC panels must be as follows, unless otherwise specified by the Engineer:

Dimensions	Minimum Size (inches)
Base Thickness	0.06
"Tee" Profile Height	0.40

2) PVC Sheeting **–** The plastic liner must be a white, high-polymer, vinyl chloride sheeting capable of being cast into the concrete and made an integral part of the structure. It must have a minimum thickness of sixty-five mils (65-mils), and must be capable of resisting strong acid, alkaline and salt solutions.

C) HDPE Liner **–** HDPE manhole liner system must be fabricated from polyethylene pipe manufactured in accordance with ASTM F-894, “Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe”. The liner must have a minimum ring stiffness constant (RSC) of 63, and meet the material requirements of Section 632, “High Density Polyethylene (HDPE) Pipe”.

627.03 – CONSTRUCTION METHODS

627.03.01 – PVC PANELS OR COILS

A) Liner Installation (Panels) – If the Contractor chooses to use the PVC liner in the form of panels, the panels must be cut and trimmed to fit as near as practical to the internal circumference of the structure. The panels must be placed commencing at the bottom of the manhole with the male locking edge of the panel to the bottom of the manhole. The bottom edge of the first panel must be set in a bed of fast-setting grout. The panels must be kept square with the vertical wall. A bead of selected sealant/adhesive, approved by the Engineer, and of sufficient width to seal the joint must be applied to the female locking edge and the end-joining piece prior to the locks being engaged. The locks must be snapped together. End joints must be made with a manufacturer supplied/approved plasticized end-joining material which must under-lap the panels by not less than three inches (3-in). The end joints must be staggered so the joints are not aligned. A bead of the approved sealant/adhesive must be placed over the end joint after panel installation. If necessary, the panels may be shimmed off the wall to avoid

discontinuities on the surface, or to achieve a more circular interior wall than the original as may be approved by the Engineer.

B) Liner Installation (Coils) – If the Contractor chooses to use the PVC liner in the form of a one hundred fifty foot (150-ft) to two hundred foot (200-ft) coil of continuous strip, the liner must be placed commencing at the bottom of the manhole. The ribbed profile of the strip must be kept offset from the wall by vertical studs/spacers to maintain annular gap to grout (concrete) thickness specified. The strip is manually spirally wound around the interior of the manhole to a height that will exceed a scribe line on the liner that matches the bottom contour of the manhole by two revolutions. The bottom contour of the manhole is then scribed onto the liner. The liner is then cut along the scribe line so as to fit the interface of the bottom of the manhole and the wall. The liner is then positioned down into a bed of hydraulic cement. Winding then proceeds upward with the ribbed profile of the strip spaced from the wall as required. If necessary, the strip may be shimmed off the wall to avoid discontinuities of the wall surface. A bead of selected sealant approved by the Engineer, of sufficient width to seal the joint must be applied to the male locking edge prior to the locks being engaged. The locks must be snapped together with a rubber mallet or other means approved by the manufacturer. Additional coils of PVC strip may be introduced by joining the ends of the strip by means of a manufacturer supplied joiner pad inserted on the ribbed side of the strip. The joint must be sealed on both sides of the strip with the approved sealant and pinned with a nylon fastener if required. Alternatively, the ends of successive coils may be joined in a simple lap joint by grinding off the "T's" on one end and overlapping the other end piece by three inches (3-in) to four inches (4-in) and joining the two with PVC solvent cement. The edge locks on the lapped piece must be removed also and these locks must be aligned on both edges at the mating ends. This process must be done above ground with adequate ventilation. The strip must be wound just past the designated liner height. After grouting and grout set, the liner must be trimmed to the designated height.

C) Grouting – Once the liner is in place, the hydraulic cement bed at the bottom of the manhole is checked to determine if additional sealing is required. At the top and around the liner must be placed a series of tubes that act as grout injection tubes. Alternatively, or in addition, grout holes may be drilled in the PVC lining at appropriate points and grout pumped into them until satisfactory fill is obtained. When grouting holes are used, the holes must be sealed with PVC plugs upon grout completion. The grouting plan must be reviewed and approved by the Engineer in advance of the work. Care must be taken not to allow the hydrostatic pressure of the fluid grout to buckle with the PVC liner. When required, temporary rigid vertical supports must be placed on the inner perimeter of the PVC liner while the grout is being placed.

D) Lining of Cone/Corbel – The materials used in cone/corbel lining must consist of truncated pie sections made by diagonally cutting two strips of material and inserting these, along the diagonal cut, into a center joiner strip supplied by the

manufacturer. After trimming the ends to approximate the circular radiuses of the top and bottom of the cone and sealing all joints with approved sealant, the truncated pie sections must be fitted together by interlocking the edges to form the cone lining. The cone lining must then be braced and grouted after appropriate sealing at the bottom.

627.03.02 – INSTALLATION OF PVC SHEETING

Forms must be sized, erected, and braced as necessary to assure that the new interior wall must have a minimum thickness of one and one half inches (1.5-in) extending from the manhole base to the top of the cone section conforming generally to the interior dimensions of the existing structure. When casting a structurally independent wall three inches (3-in) in thickness or greater, an internal diameter of forty-two inches (42-in) must be maintained in the existing manhole.

The form must be positioned, sealed, and finished at the manhole base to ensure that concrete does not enter the sewer. The PVC liner must be fitted securely to the exterior of the steel forms during erection. When the forms are removed, any joints in the liner must be cleaned and fusion or extrusion welded. When directed by the Engineer, the interior surface including welded joints must be spark-tested with a holiday detector at fifteen thousand volts (15,000-V) to twenty thousand volts (20,000-V). Any holidays or defects in the liner must be repaired and retested.

The concrete must be carefully placed in such a manner as to prevent segregation of the cement and aggregate. The concrete must be consolidated to fill all pockets, seams, and cracks within the existing wall. When the concrete has sufficiently cured to preclude slump or damage, the form must be disassembled and removed.

Jointing seams in the plastic liner will be fusion welded by qualified personnel using only factory- approved methods and techniques. The welding operation of any joint must be continuous until that joint has been completed. The welding strip must be centered over the cleaned surfaces to be joined and fused across its entire width using a hot air welding gun producing temperatures ranging between five hundred degrees Fahrenheit (500-degrees F) and six hundred degrees Fahrenheit (600-degrees F).

627.03.03 – HDPE LINER

The surrounding roadway material or soil must be excavated, and the existing chimney and cone sections must be removed. Undamaged precast sections may be salvaged and reused as directed by the Engineer. All debris must be properly disposed of off-site at the contractor's expense.

The outer diameter of the liner must not exceed ninety-seven percent (97%) of the internal diameter of the existing manhole. The liner must be installed spigot end up and accurately trimmed around the bottom to conform to existing benches and sewer lines. The HDPE liner must be centered in the manhole and the bottom edge set using a seal between liner

and bench and crown of pipes at bottom of manhole. Pipe stubs must be installed through the liner wall matching inverts and flow lines and sealed with an approved mastic before grouting annulus. The pipe material must be a diameter equal to or slightly larger than the existing pipe.

Sound construction practice must be taken in the placement of grout to ensure that the annulus is free of voids and the liner is not buckled during the grouting operation. The annulus must be filled to the bottom of the top rib on the polyethylene liner.

A polyethylene flat top or cone with bell assembly must be installed on spigot end of liner and sealed with closure gasket or mastic as directed by the Engineer. The precast cone or slab and ring sections must be placed so that they are fully supported by the existing concrete walls leaving an approximately one fourth inch (0.25-in) space between the polyethylene and precast top sections. The ring or cone section of the liner must be trimmed so that the frame and lid will be fully supported by the concrete walls. The space between the entry sections must be grouted. All remaining concrete grout exposed to the sanitary sewer environment must be coated in accordance with Section 628, “Elastomeric Manhole Coating”.

627.04 – TESTING

Testing must be done in accordance with Section 624, “Cast-in-Place Concrete Manhole Liner”.

627.05 – METHOD OF MEASUREMENT

Payment for "Composite Manhole Liner" must not be made separately but is included in the unit price bid for "Sanitary Sewer Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 628 – ELASTOMERIC MANHOLE COATING

628.01 – DESCRIPTION

This section covers application of elastomeric coatings to the interior surfaces of a manhole to provide a high level of corrosive protection. The coatings may be sprayed, rolled, brushed or applied by trowel as required by the manufacturer. The material must be suitable for overhead, vertical and horizontal surfaces.

628.02 – MATERIALS

628.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities as

specified in these specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) a certificate that the coating furnished under this specification is in conformance with the material and mechanical requirements in the appropriate ASTM and as specified herein.

B) The ambient temperatures at time of application must be recorded by the Contractor and submitted by the Contractor to the Engineer.

628.02.02 – GENERAL

The coating systems may be one of the following types:

A) High-Build Epoxy Coatings – The coating material must be a two (2) part, one hundred percent (100%) solids epoxy-resin with fibrous and flake fillers specifically designed for sanitary sewer applications. The coating material must have the following minimum properties as listed in the following table:

	Test Method	Minimum Value
* Tensile Strength	ASTM D-638	8,000-psi
*Tensile Elongation	ASTM D-638	20-percent
* Compressive Strength	ASTM D-2240	80 ShoreD
+ 25% Sulfuric Acid	ASTM C-267	o28 days
* Solids by Volume		100%

* System cured for 7 days at 25-degrees C
\+ Topping cured for 3 weeks at 25-degrees C
o Days without deterioration after continuous contact with fresh chemical at 25-degrees C

B) Polyurea Coating Systems – The coating material must be urethane-based one hundred percent (100%) solids resin with chemically resistant fillers specifically designed for sanitary sewer applications. The coating material, tested at 25-degrees C, must have the following minimum properties as listed below:

	Test Method	Minimum Value
* Tensile Strength	ASTM D-412	1,800 psi
* Recoverable Elongation	ASTM D-412	300%
* Surface Hardness	ASTM D-2240	80 Shore A
+ 20% Sulfuric Acid	ASTM C-267	28 days
* Solids by Volume		100%

* System cured for 7 days at 25-degrees C

+ Topping cured for 3 weeks at 25-degrees C
- Days without deterioration after continuous contact with fresh chemical at 25-degrees C

628.03 – CONSTRUCTION METHODS

628.03.01 – SURFACE PREPARATION

Infiltration must be stopped, and surface preparation must be accomplished in accordance with Section 624, “Cast-in-Place Concrete Manhole Liner”. Install all products in accordance with manufacturer’s instructions regarding surface preparation, product application and curing. Mechanical cleaning must be done to provide a good bond between the epoxy coating or the Polyurea coating and the substrate. Water blasting with a minimum of five thousand pounds per square inch (5,000-psi) must be done to remove oil, grease and foreign materials from all surfaces to be coated. For brick manholes, use a minimum of six thousand pounds per square inch (6,000-psi) of water pressure. In areas where the concrete has become softened due to chemical attack, several millimeters of the wall surface must be removed using water pressures of twenty-five thousand pounds per square inch (25,000-psi) to thirty-five thousand pounds per square inch (35,000-psi), or as recommended by the coating manufacturer, to ensure that a sound substrate is exposed. Surfaces must be made damp or dry as required by the Manufacturer before application of coating system begins.

628.03.02 – APPLICATION

The material must be mixed and applied, in two (2) or three (3) coats, in accordance with the Manufacturer's written instructions, using approved equipment. When applying a Polyurea coating, all surfaces to be coated must be primed as required by the manufacturer. The material must be applied to all interior surfaces of the manhole with a minimum thickness of one hundred mils (100-mils).

The Contractor must allow a minimum of two hours (2-hrs) cure time before returning the manhole to active flow conditions or as recommended by the manufacturer. After seven day (7-day) cure, the liner's surface must be free of runs, sags, and other irregularities that indicate improper application practice. When directed by the Engineer, liner must be repaired following the Manufacturer's recommendation and to the Engineer's satisfaction.

628.04 – METHOD OF MEASUREMENT

Payment for "Elastomeric Manhole Coating" must not be made separately but is included in the unit price bid for "Sanitary Sewer Manhole Rehabilitation" as per Section 618, “Sanitary Sewer Manhole Rehabilitation”.

SECTION 629 – ABANDONING/REMOVING MANHOLE

629.01 – DESCRIPTION

This section covers abandoning or removing existing manholes when called for on the plans or specified. This work must be accomplished following abandoning and plugging existing sewer lines.

629.02 – CONSTRUCTION REQUIREMENTS

A) Abandoning Manhole – This work must be accomplished in accordance with the Standard Detail for Abandoning Manholes. The manhole must be broken down to a point three feet (3-ft) below proposed or existing grade and filled with sand and/or concrete.

B) Removing Manhole – This work must be accomplished in accordance with the Standard Details for Construction except the manhole must be broken down to a point two feet (2-ft) below any proposed construction or totally removed when directed by the Engineer.

C) Construction – Manhole must be filled with sand backfill and must be compacted in accordance with the requirements of Section 212, “Trench Excavation and Backfill”.

Salvaged materials, including ring and cover must be disposed of by the Contractor.

629.03 – METHOD OF MEASUREMENT

Payment for "Abandoning or Removing Manholes" must be made at the unit price bid per each manhole. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

629.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

ABANDONING MANHOLE	EA.
REMOVING MANHOLE	EA.

SECTION 630 – VITRIFIED CLAY SEWER PIPE (VCP)

630.01 – DESCRIPTION

This section covers vitrified clay pipe and fittings intended to be used for the conveyance of sewage and industrial waste. Pipe may be supplied in sizes ranging from four inches (4-in) to forty-two inches (42-in).

630.02 – MATERIALS

630.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities as specified in these Specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) Type "A" Certification for pipes and Type "D" Certification for fittings, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications. These certifications must be prepared by the manufacturer and must consist of a certified copy of a report covering tests conducted by an approved laboratory. Tests performed must be sufficient to determine the conformance of the material to the Standard Specifications. Such tests must have been conducted on samples obtained from the lot or lots of material in the shipment.

B) Tests results for Three-Edge Bearing Tests, Hydrostatic Tests, Joint Tests, Joint Leakage, Absorption, and Compressive Strength Tests.

C) The Contractor must provide a digital copy of all submittals, and if requested by the Engineer, hardcopies of any submittal must be provided as well.

630.03 – CONSTRUCTION METHODS

630.03.01 – OPEN-CUT CONSTRUCTION

A) General – All vitrified clay pipes and fittings must be extra strength and conform to the requirements of the appropriate ASTM listed below or as modified herein

1) ASTM C-700, Standard Specification for "Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
2) ASTM C-425, Standard Specification for “Compression Joints for Vitrified Clay Pipe and Fittings”
3) ASTM C-12, Standard practice for “Installing Vitrified Clay Pipelines”

Minimum laying lengths must not be less than five and one-half feet (5.5-ft) for pipes twelve inches (12-in) and smaller, and seven find one-half feet (7.5-ft) for pipes fifteen inches (15-in) and larger in diameter.

Pre-fabricated joints must be of a type where the same resilient material is used both on the spigot end and the bell end of the pipe. Other type joints may be approved by the Engineer in writing and must similarly conform to the requirements of said ASTM C-425, “Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings”.

B) Maximum Depth of Cover – The maximum depth of cover above top of the pipe must not exceed the value shown in the table below. The maximum depth of cover for each pipe size is based on AASHTO HS-20 live loading, ordinary clay backfill with kμ' of 0.130 and a unit weight of one hundred twenty pounds per cubic foot(120-pcf), a design load safety factor of 1.30, Class "B" Bedding Installation, the maximum trench width specified in Section 212, "Trench Excavation and Backfill", and the minimum required three-edge bearing strength, for each pipe size as specified in ASTM C-700, "Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated".

TABLE 630.03.01 - Maximum Depth of Cover

Nominal Size (inches)	Minimum Three-Edge Bearing Strength (lb./ft)	Maximum Depth of Cover (feet)
4	2000	25
6	2000	25
8	2200	20
10	2400	18
12	2600	16
15	2900	15
18	3300	14
21	3850	14
24	4400	14
27	4700	13
30	5000	13
33	5500	13
36	6000	13
39	6500	13
42	7000	12

630.03.02 - TRENCHLESS CONSTRUCTION

A) General- All VCP and fittings must conform to the requirements of ASTM C-1208, "Standard Specification for Vitrified Clay Pipe and Joints for Use in Microtunneling, Sliplining, Pipe Bursting, and Tunnels".

B) Sliplining Installations - Pipes used for sliplining installations must meet the following requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (3-in) smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three inches (33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.

   a) In addition, the maximum outside diameter, and wall thickness of VCP liner pipe must be as follows:

Existing Sewer Line Nominal Inside Dia. (inches)	Maximum Outside Diameter of VCP (inches)	Minimum VCP Wall Thickness (inches)
12	10.50	1.31
15	14.17	2.17
18	15.60	1.75
21	15.60	1.75
24	20.70	2.50
27	24.55	2.43
30	28.60	2.80
33	31.03	2.86
36	33.46	2.95
42	37.80	3.15

630.04 – METHOD OF MEASUREMENT

Payment for "Vitrified Clay Sewer Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

630.05- BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

VITRIFIED CLAY SEWER PIPE (VCP) (SIZE) L.F.

SECTION 631 – DUCTILE IRON PIPE (DIP)

631.01 – DESCRIPTION

This section covers Ductile Iron Pipe (DIP) and fittings intended to be used for conveyance of sewage and industrial waste. Pipes may be supplied in sizes ranging from four inches (4-in) to sixty-four inches (64-in) in diameter.

631.02 – MATERIALS

631.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities as specified in these Specifications. When requested by the Engineer, the Contractor must submit the following, but not limited to, for review and approval:

A) Type "A" Certification for pipe, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications.

B) Type "D" Certification for elastomeric gasket, See section 109.17.02 “Control of Work and Materials – Materials Certifications – Types of Certifications” for details on types of certifications,

C) Shop drawings of the pipe and joints

D) Documentation of an ongoing Manufacturer's quality control program

All material furnished under certification must 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.

631.02.02 – GENERAL, FITTINGS

All ductile iron pipe and fittings must conform to the requirements of the following ASTM Standards listed below or as modified herein.

A) ASTM A-746, Standard Specifications for Ductile Iron Gravity Sewer Pipe

B) AWWA C-111/ANSI A21.11, Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

C) AWWA C-150/ANSI A21.50, Thickness Design of Ductile-Iron Pipe

D) AWWA C-151/ANSI A21.51, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lines Molds, for Water or Other Liquids

E) AWWA C-600, Installation of Ductile Iron Water Mains, and their Appurtenances

Pipe must be provided on nominal lengths of twenty feet (20-ft). Pipe joints must be push-on joints and comply with all applicable requirements of AWWA C-111/ANSI A21.11, “Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings”.

631.02.03 – COATING AND LINING

A) Exterior Coating – The exterior of ductile iron pipe, specials and fittings must be coated with an asphaltic coating in accordance with ASTM A-746, Section 6.1, “Standard Specification for Ductile Iron Gravity Sewer Pipe”. The coating must have a minimum thickness of one mil (1-mil). The finished coating must be smooth, continuous and strongly adherent to the pipe. Any damage to the outside coating during shipping, storage, handling and installation must be field repaired with a fresh coating in accordance with the Manufacturer's recommendations.

B) Interior Lining – Interior surfaces of pipe and fittings must be lined with forty (40) mils of Virgin Polyethylene complying with ASTM D-1248, “Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable”. The lining materials must be compounded with a minimum of two percent (2%) carbon black to resist ultraviolet rays.

631.02.04 – MINIMUM PIPE DESIGN

Unless otherwise specified, Ductile Iron Pipe must have the following nominal thickness, in inches, and pressure class shown in the following table.

TABLE 631.02.04 – Minimum Pipe Design - DIP

Pipe Nominal Size (inches)	Depth of Cover (feet)									
	< 10-ft		>10-ft and <15-ft		>15-ft and <20-ft		>20-ft and <25-ft		>25-ft and <30-ft	
	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C -151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151	Nominal Thickness (Inches)	Standard Pressure Class AWWA C-151
4	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
6	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
8	0.25	360	0.25	350	0.25	350	0.25	350	0.25	350
10	0.26	360	0.26	350	0.26	350	0.26	350	0.26	350
12	0.28	360	0.28	350	0.28	350	0.28	350	0.28	350

18	0.31	260	0.31	250	0.31	250	0.31	350	0.34	300
24	0.33	200	0.33	200	0.33	200	0.38	300	0.38	300
30	0.34	160	0.34	150	0.34	150	0.42	250	0.45	300
36	0.38	160	0.38	150	0.38	150	0.47	250	0.50	300
42	0.41	160	0.41	150	0.41	150	0.52	250	0.63	350
48	0.46	160	0.46	150	0.46	150	0.64	300	0.70	350
54	0.51	160	0.51	150	0.51	150	0.72	300	0.79	350
60	0.54	160	0.56	150	0.54	150	0.76	300	0.83	350
64	0.56	160	0.56	150	0.56	150	0.80	300	0.87	350

631.03 – METHOD OF MEASUREMENT

Payment for "Ductile Iron Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

631.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DUCTILE IRON PIPE (DIP)(SIZE) L.F.

SECTION 632 – HIGH DENSITY POLYETHYLENE (HDPE) PIPE

632.01 – DESCRIPTION

This section covers High Density Polyethylene (HDPE) pipe and fittings intended to be used for conveyance of sewage and industrial waste.

632.02 – MATERIALS

632.02.01 – SUBMITTALS

Submittals must be furnished in accordance with Section 631, "Ductile Iron Pipe".

632.02.02 – PIPE MATERIALS

The HDPE pipe must be made of high density plastic compound meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in ASTM D-1248, "Standard Test Method for Staining of Porous Substrate by Joint Sealants", and with an established hydrostatic design basis (HDB) of not less than sixteen hundred pounds per square inch (1,600-psi) for water at 73.4 degrees Fahrenheit determined in accordance with ASTM Test Method D-2837, "Standard Test Method for Obtaining Hydrostatic Design

Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products".

Materials must also meet the requirements of cell classification PE 345434C or higher cell classification with light color inside, when classified in accordance with ASTM D-3350, "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials", and as shown below.

HDPE pipes manufactured for trenchless installations such as sliplining, pipe bursting, etc. may be made, entirely or having inside surface, in light color (e.g. natural, white, green, etc.) to allow light reflection for robotic television inspection. Contractor/Manufacturer must provide certification that the product has sufficient UV stabilizer for a minimum two years (2-yr) of storage life and meets the requirements established in the following table at the time of installation.

Property	ASTM Test Method	Minimum Value
Density	D-1505	0.941 (gm/cm^3)
Melt Index	D-1238	< 0.15 (gm/10 min.)
Initial Flexural Modulus	D-790	110,000-psi
Long-Term Flexural Modulus	*	28,200-psi
Initial Flexural Strength	D-790	3,000-psi
Long-Term Flexural Strength	*	1,500-psi
Environmental Stress Crack Resistance, Test Condition C, (failure % = hours)	D-1693	F20(20% of Failure Point) = 192
Hydrostatic Design Basis	D-2837	1,500-psi

Color & Ultraviolet Stabilizer	D-3350	Black with minimum 2% carbon black

* Note: The long-term values are considered to be for a continuous load duration of fifty years (50-yr) for design loading conditions and must be certified by the Manufacturer.

632.02.03 – SOLID WALL (HDPE)

A) General – All solid wall HDPE pipes may be used for open-cut and sliplining installations, in sizes ranging from six inches (6-in) to forty-eight inches (48-in) in diameter. All solid wall HDPE pipe and fittings must be manufactured in accordance with ASTM F-714, "Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter".

B) Joint System – Sections of polyethylene pipe must be assembled and joined on the project site. Jointing must be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions.

The butt-fusion method for pipe jointing must be carried out in the field by operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe Manufacturer. These joints must have a smooth, uniform, double rolled back bead made while applying the proper melt, pressure, and alignment. It must be the sole responsibility of the Contractor to provide an acceptable water-tight butt-fusion joint. Butt fusion procedures must be qualified in accordance with Title 49 Code of Federal Register, Part 192.283 and personnel qualified in accordance with 49 CFR 192.285.

C) Pipe Stiffness – For all open-cut installations, HDPE pipe must have a minimum pipe stiffness of forty-six pounds per square inch (46-psi) as determined in accordance with ASTM D-2412, "Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading".

632.02.04 – PROFILE WALL (HDPE)

A) General – All open or closed profile wall HDPE pipe and fittings may be manufactured in accordance with ASTM F-894, "Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe". Pipes must be supplied in sizes from eighteen inches (18-in) to one hundred and twenty inches (120-in) in diameter. Regardless of size, open profile wall pipes will be allowed only on sections of pipe when there are no apparent service connections. Otherwise, open profile wall pipes will not be allowed.

B) Pipe Stiffness – For all installations specified, HDPE pipe and fittings must have a minimum pipe stiffness of forty-six pounds per square inch (46-psi) as determined in accordance with ASTM D-2412, "Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading".

C) Joint System – Pipe joining system must be gasketed type and consist of integrally formed bell and spigot, one which is designed to accommodate a gasket, which when assembled forms a watertight seal by the radial compression. Joints must provide a watertight seal and meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

D) Gaskets – Gaskets must meet the requirements of ASTM F-477, “Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe” and be molded into a circular form or extruded to the proper section, then spliced into circular form, and must be made of a properly cured high grade elastomeric compound. The basic polymer must be neoprene, synthetic elastomer, or a blend of both. The gasket must be designed with an adequate compressive force, so as to affect a positive seal under all combinations of joint tolerances. Natural rubber gaskets will not be acceptable.

E) Lubricant – The lubricant used for assembly must have no detrimental effect on the gasket or on the pipe. Type and application of the lubricant must be in accordance with the manufacturer's recommendations.

632.03 – CONSTRUCTION METHODS

632.03.01 – SLIPLINING

A) General **–** Pipes used for sliplining installations must meet the following requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (≤ 33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (> 3-in) smaller than the nominal I.D. of the existing pipe.
2) For existing pipes with a nominal I.D. greater than thirty-three inches (> 33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.

3) In addition, sliplining pipes must meet the requirements outlined in parts 2 or 3 as applicable.

B) **Solid Wall HDPE Pipes**

1) General – Solid Wall HDPE Pipes must meet the requirements of Section 632, “ High Density Polyethylene (HDPE) Pipe”, Parts "A" and "B”.

2) SDR **–** The HDPE liner pipe must have the following minimum Standard Dimension Ratio (SDR) for various depths:

Maximum Depth of Cover (feet)	SDR
10	26
15	21
20	19
30	17

3) Outside Diameter – The minimum outside diameter (O.D.) of HDPE liner pipe must be as designated below:

Existing Sewer Line Nominal Inside Diameter (inches)	Minimum O.D. of Liner (inches)
8	7.125
10	8.625
12	10.750
15	12.750
18	16.000
21	18.000

24	22.000
27	24.000
30	28.000
33	30.000
36	32.000
42	36.000
48	42.000
54	48.000

C) Profile Wall HDPE Pipes – Profile wall HDPE pipe must meet the requirements of Section 632, “High Density Polyethylene (HDPE) Pipe” Parts "A" through "E".

632.03.02 – PIPE BURSTING, BORING, AND TUNNELING

The HDPE pipe used for these installations must meet the material requirements of Section 632, “High Density Polyethylene (HDPE) Pipe” and meet the SDR requirements of Section 632, Paragraph B 2 and have a minimum inside diameter equal to nominal pipe size. Outside diameter requirements of Section 632 Paragraph B 3 are not applicable.

632.04 – METHOD OF MEASUREMENT

Payment for "High Density Polyethylene (HDPE) Pipe” must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

632.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

HIGH DENSITY POLYETHYLENE (HDPE) PIPE (SIZE) L.F.

SECTION 633 – POLYVINYL CHLORIDE (PVC) PIPE

633.01 – DESCRIPTION

This section covers polyvinyl chloride (PVC) pipe and fittings intended to be used for

conveyance of sewage and industrial waste.

633.02 – MATERIALS

633.02.01 – SUBMITTALS

Submittals must be furnished in accordance with Section 631, “Ductile Iron Pipe (DIP)”.

633.02.02 – SOLID WALL (PVC)

All solid wall PVC pipe and fittings must conform to the requirements of the appropriate ASTM listed below or as modified herein.

A) ASTM D-3034 – Standard Specification for “Type PSM Poly (Vinyl Chloride) (VC) Sewer Pipe and Fittings”. Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi) and a minimum SDR of thirty-five (35). Pipe and fittings may be supplied in sizes ranging from four inches (4-in) to fifteen inches (15-in) in diameter.

   The pipe must be made of PVC plastic having a cell classification of 12454-B or 12454-C or 12364-C or 13364-B (with minimum tensile modulus of 500,000-psi) as defined in ASTM D-1784. The fittings must be made of PVC plastic having a cell classification of 12454-B, 12454-C, or 13343-C as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”.

   Elastomeric Gasketed Joints must be used to provide a watertight seal and must meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

B) ASTM F-679 **–** Standard Specification for “Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings”. Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi) and a minimum SDR of thirty-five (35). Pipe and fittings may be supplied in sizes ranging from eighteen inches (18-in) to thirty-six inches (36-in) in diameter.

   The pipe and fitting materials must be made of PVC plastic having a minimum cell classification of 12364-C or 12454-C as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”. Homo-polymer PVC compounds must equal or exceed the requirements of the above listed minimum cell classification number.

   Integral Bell Gasket Joint must be used to provide a watertight seal and must meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and

Sewer Plastic Pipes Using Flexible Elastomeric Seals".

C) Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi). Pipe and fittings may be supplied in sizes ranging from four (4-in) inches to eighteen (18-in) inches in diameter.

The pipe must be made of PVC plastic having a minimum cell classification of 12164-B as defined in ASTM D-1784, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals". The fittings must be made of PVC plastic having a cell classification of 12454-C or 13343-C as defined in ASTM D-1784, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals".

Elastomeric Gasketed Joints must be used to provide a watertight seal and must meet the requirements of ASTM D-3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals". Joints must also be compatible to ASTM D-3034, "Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings" joint dimensions.

633.02.03 – PROFILE WALL (PVC)

All profile (open or closed) wall PVC pipe and fittings must conform to the requirements of the appropriate ASTM listed below and modified herein. Regardless of size, open profile wall pipes will be allowed only on sections of pipe when there are no apparent service connections. Otherwise, open profile wall pipe will not be allowed.

A) ASTM F-794 – Standard Specification for "Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter". Pipe and fittings must have a minimum stiffness of forty-six pounds per square inch (46-psi). Pipe and fittings may be supplied in sizes ranging from eighteen inches (18-in) to forty-eight inches (48-in) in diameter.

The pipe and fittings must be made of PVC plastic having a minimum cell classification of 12454-B or 12364-C as defined in ASTM D-1784, "Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds".

Gasketed Joint Systems must be used. The integral bell gasketed joint, coupling or fitting joints must be designed so that when assembled, the gasket will be compressed radially on the pipe spigot or in the bell to form a watertight seal. The joints must be designed to comply with and show no leakage when tested in accordance with ASTM D-3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals".

Closed profile PVC pipes manufactured with a gasketed joint coupling system, with no bell and spigot, may be used for sliplining installations.

Couplings must form a watertight seal when assembled with plain end pipe and show no sign of leakage when tested in accordance with ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals” defined at top of section.

B) ASTM F-949 – Standard Specification for “Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings”. Pipe and fittings must have a minimum stiffness of fifty pounds per square inch (50-psi). Pipe and fittings may be supplied in sizes ranging from twelve inches (12-in) to thirty-six inches (36-in) in diameter.

The pipe must be made of PVC plastic having a minimum cell classification 12454-B or 12454-C as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds”. The fittings must be made of PVC plastic having a cell classification of 12464-B, 12464-C, or 13343-C as defined in ASTM D-1784, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

Elastomeric Gasketed Joints must be used to provide watertight seal and must meet the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

633.02.04 – SPECIAL PVC PIPE

Special PVC pipe and fittings must conform to the requirements of the appropriate standards listed below or as modified herein.

A) ASTM D-2241 – Standard Specifications for Polyvinyl Chloride (PVC) Pressure-rated Pipe (SDR Series). Pipe and fittings must have a minimum SDR of thirty-two and one-half (32.5) and may be supplied in sizes ranging from four inches (4-in) to thirty-six inches (36-in) in diameter.

The pipe and fittings must be made of PVC compounds having a cell classification of 12454- B, 12454-C, or 14333-D as defined in ASTM D-1784, “Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”.

Elastomeric gasketed joints meeting the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”, must be used to provide a watertight seal.

B) AWWA C-900-16, or as revised– Standards for PVC Pressure Pipe from four inches (4-in) through sixty inches (60-in). Pipes must have a minimum DR rating of eighteen (18) for diameters four inches (4-in) through twelve inches (12-in). For

pipes greater than twelve inches (12-in) in diameter, the minimum DR must be thirty-two and one-half (32.5). Diameters listed here are cast Iron Outside Diameters.

The pipe and fittings must be made of PVC compounds having a cell classification of 12454- A or 12454-B as defined in ASTM D-1784, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”.

Elastomeric gasketed joints meeting the requirements of ASTM D-3139, “Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals” when measured in accordance with ASTM D-2122, “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”, must be used to provide a watertight seal.

633.02.05 – GASKETS AND LUBRICANTS

Gaskets and lubricants must conform to the applicable requirements of Section 632 “High Density Polyethylene (HDPE) Pipe” and 633 “Polyvinyl Chloride (PVC) Pipe”

633.02.06 – CHEMICAL RESISTANCE

All PVC pipe and fittings must have demonstrated a resistance to damage when subjected to exposure and/or contact with liquid sewage and/or gasses associated with sewage and/or high hydrogen sulfide concentration.

633.03 – CONSTRUCTION METHODS

A) Methods for PVC

1) Open-Cut – PVC pipe and fittings must meet the requirements of Section 652 as applicable.

2) Pipe Bursting – PVC pipe and fittings must conform to the requirements of Section 652.

3) Jacking – PVC pipe and fittings must conform to the requirements of Section 652.

4) Boring and Tunneling – PVC pipe and fittings must meet the requirements of Section 652.

5) Micro or Small Diameter Tunneling – PVC pipe and fittings must meet the requirements of Section 652

B) General – PVC pipe must be manufactured with a gasketed joint coupling system with no bell and spigot providing a watertight seal and meeting the requirements of ASTM D-3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”. PVC pipe must meet the material requirements specified in Section 652.02 “Polyvinyl Chloride (PVC) Pipe - Materials”. The Contractor must submit detailed drawings of joints to the Engineer for review and approval prior to manufacturing.

C) Dimensions – Pipes used for sliplining – installations must meet the following general requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (3-in) smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three inches (33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.

In addition, sliplining pipes must minimum pipe inside diameter specified and must meet the following requirements:

Existing Sewer Line Nominal Inside Diameter (inches)	Minimum O.D. of Liner (inches)	Maximum I.D. of Liner (inches)
24	22.110	As Specified on the plans and or contract Documents
27	25.115	
30	28.232	
33	31.415	
36	31.415	
42	37.800	

48	44.200	
64	60.670	

633.04 – METHOD OF MEASUREMENT

Payment for "Polyvinyl Chloride Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

633.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

POLYVINYL CHLORIDE (PVC) (SIZE) L.F.

SECTION 634 – REINFORCED FIBERGLASS PIPE (RFP)

634.01 – DESCRIPTION

This section covers reinforced fiberglass pipe and fittings intended to be used for the conveyance of sewage and industrial waste.

634.02 – MATERIALS

634.02.01 – SUBMITTALS

Submittals must be furnished in accordance with Section 631, "Ductile Iron Pipe(DIP)".

634.02.02 – GENERAL

All pipes, joints and fittings must be manufactured in accordance with the requirements of ASTM D-3262, "Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe", or as modified herein. Pipes must be supplied in sizes twelve inches (12-in) and larger.

Pipes must be centrifugally cast, fiberglass-reinforced polyester resin.

Prior to manufacturing, the pipe supplier must provide the Engineer with test reports certifying that the pipe has been tested in accordance with and exceeds all minimum requirements of ASTM D-2992, "Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings", ASTM D-3262, "Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe", and ASTM D-3681, "Standard Test Method for Chemical Resistance of "Fiberglass" (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition". Manufacturer's "in house" testing reports WILL NOT be

acceptable as a substitute for independent laboratory testing.

634.02.03 – MINIMUM PIPE STIFFNESS

The pipe stiffness must be a minimum of forty-six pounds per square inch (46-psi) when measured in accordance with ASTM D-2412, “Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading”, for all installations except jacking. Other pipe stiffness’s may be used when called for on the plans or as directed by the Engineer.

634.02.04 – MATERIAL COMPONENTS

A) Resin System – The Manufacturer must use only approved polyester or epoxy resin systems for which he can provide a proven history of performance for the intended application. The historical data must have been acquired from a composite material of similar construction and composition as the proposed product.

B) Glass Reinforcements – The reinforcing glass fibers used to manufacture the components must be of highest quality commercial grade of E-glass filaments with binder and sizing compatible with impregnating resins.

C) Fillers – Sand may be used as fillers providing that sand must be a minimum ninety-eight percent (98%) silica with a maximum moisture content of 0.2 percent (0.2%).

D) Additives – Resin additives, such as pigments, dyes, and other coloring agents, if used, must in no way be detrimental to the performance of the product nor must they impair visual inspection of the finished product.

E) Internal Liner Resin – The internal liner resin must be suitable for service as sewer pipe and must be inert to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Provide the certified test results from an independent laboratory that the pipe exceeds the requirements of ASTM D-3681, “Standard Test Method for Chemical Resistance of “Fiberglass” (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition”.

634.02.05 – DIMENSIONS

A) General – Pipe outside diameters must be in accordance with AWWA Standards C-151/A21.51, “Ductile-iron Pipe, Centrifugally Cast” and C-950, “Fiberglass Pressure Pipe” and as shown below. The minimum wall thickness(es) shown are for a minimum pipe stiffness of forty-six pounds per square inch (46-psi).

Nom. Pipe Dia. (inches)	Pipe O.D. (inches)	Min. Wall Thickness
12	13.20	0.30
14	15.30	0.34
16	17.40	0.38
18	19.50	0.42
20	21.60	0.46
24	25.80	0.54
30	32.00	0.66
36	38.30	0.78
42	44.50	0.90
48	50.80	1.02
54	57.10	1.14
60	62.90	1.26
66	69.20	1.38
72	75.40	1.50
78	81.60	1.62
84	87.00	1.74
90	94.30	1.86
96	100.60	1.98
102	108.00	2.13

Pipe must be supplied in nominal lengths of ten feet (10-ft) or twenty (20-ft) feet for Jacking, and twenty feet (20-ft) for all other installations. For sliplining installations, where radius curves in the existing pipe or limitations in the entry pit dimensions restrict the pipe to shorter lengths, nominal sections of ten feet (10-ft) or six and two-thirds feet (6.33-ft) must be used. Actual laying length must be the nominal plus or minus (±) two inches (2-in). Except for special order lengths, all pipes must be furnished in the nominal lengths specified herein. All pipe ends must be square to the pipe axis plus or minus (±) one-fourth inch (0.25-in), or plus or minus (±) five-tenths percent (0.5%) of the nominal diameter (whichever is greater).

B) Jacking Installations – Minimum pipe wall thickness measured at the bottom of the spigot gasket groove where the wall cross-section has been reduced, is determined from the maximum allowable jacking load, and must not be less than as shown in the table below:

TABLE 634.02.05 - Jacking Installations Wall Thickness

Nom. Pipe Dia. (inches)	Pipe O.D. (inches)	Min. Wall Thickness (inches)

12	13.20	0.39
14	15.30	0.41
16	17.40	0.42
18	19.50	0.44
20	21.60	0.46
24	25.80	0.60
30	32.00	0.68
36	38.30	0.81
42	44.50	1.03
48	50.80	1.10
54	57.10	1.22
60	62.90	1.29
66	69.20	1.32
72	75.40	1.34
78	81.60	1.54
84	87.00	1.76
90	94.30	1.78
96	100.60	1.88

C) Sliplining Installations – Pipes used for sliplining installations must meet the following general requirements:

1) For existing pipes with a nominal inside diameter (I.D.) less than or equal to thirty-three inches (≤33-in), the outside diameter (O.D.) of the sliplining pipe must not be more than three inches (3-in) smaller than the nominal I.D. of the existing pipe.

2) For existing pipes with a nominal I.D. greater than thirty-three inches (>33-in), the O.D. of the sliplining pipe must not be more than six inches (6-in) smaller than the nominal I.D. of the existing pipe.
3) In addition, sliplining pipes must meet the following requirements:

Exist. Sewer Line Nominal Inside Diameter (inches)	RFP Liner O.D. (inches)	Wall Thickness (inches)
15	13.20	0.30
18	15.30	0.34
21	19.50	0.42
24	21.60	0.46
27	25.80	0.54
30	27.00	0.60
33	30.00	0.66

36	32.00	0.66
42	38.30	0.78
48	44.50	0.90
54	50.80	1.02
60	57.10	1.14
66	62.90	1.26
72	69.90	1.38
78	75.40	1.50
84	81.60	1.62
90	87.00	1.74
96	94.30	1.86
102	100.60	1.98

634.02.06 – JOINTS

A) General – Unless otherwise specified, the pipe must be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets for all installations except jacking and sliplining installations. The joints must meet the performance requirements of ASTM D-4161, “Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals”.

B) Sliplining Installations – Unless otherwise specified, the pipe must be field connected with low-profile fiberglass bell and spigot joints. The joints must meet the performance requirements of ASTM D-4161, “Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals”.

C) Jacking Installations – Unless otherwise specified, the pipe must be field connected with sleeve couplings or bell spigot joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joint must have the same outside diameter (O.D.) as the pipe, so when the pipes are assembled, the joints are flush with the outside surface.

634.02.07 – GASKETS AND LUBRICANTS

Gaskets and lubricants must conform to the requirements of Section 631, “Ductile Iron Pipe".

634.02.08 – FITTINGS

Where applicable, flanges, elbows, reducers, tees, wyes, laterals, and other fittings must, when installed, be capable of withstanding all operation conditions. Acceptable

configurations include contact molded or mitered fiberglass properly protected standard ductile iron, fusion bonded epoxy coated steel and stainless steel constructions.

The tolerance of the angle of an elbow and the angle between the main and leg of a wye or tee must be plus or minus (±) two degrees (2-degrees). The tolerance on the laying length of a fitting must be plus or minus (±) two inches (2-in).

634.03 – METHOD OF MEASUREMENT

Payment for "Reinforced Fiberglass Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

634.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REINFORCED FIBERGLASS PIPE (RFP) (SIZE)	L.F.

SECTION 635 – STEEL CASING PIPE

635.01 – DESCRIPTION

This section covers steel pipe intended to be used as a carrier pipe for sanitary sewer aerial crossings or casing pipe for boring and micro and small diameter tunneling installations.

635.02 – MATERIALS

635.02.01 – SUBMITTALS

Review and approval of the Contractor submittals, by the Engineer, must not be construed in any way as relieving the Contractor and the Manufacturers of their responsibilities for Manufacturing steel pipe and fittings as described herein. When requested the Contractor must submit the following, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of material to be satisfactory:

A) Type "A" certification for pipe and coating, See section 109.17.02 "Control of Work and Materials – Materials Certifications – Types of Certifications" for details on types of certifications.

B) Shop drawings of pipe, joints, and seams

C) Documentation of manufacturer's on-going quality control program.

635.02.02 – GENERAL

A) General – Steel pipe must conform to ASTM A139, “Standard Specification for Electric-Fusion (ARC) Welded Steel Pipe (NPS 4 and Over)”. The steel material must be new, smooth wall, carbon steel, Grade B, with minimum sixty thousand pounds per square inch (60,000-psi) tensile strength, and minimum thirty-five thousand pounds per square inch (35,000-psi) yield strength.

The pipe must be straight seam pipe, seamless pipe, or spiral weld pipe. For spiral weld pipe, the spiral must be one hundred percent (100%) welded, and the weld's height over the outside wall surface must be equal to or less than three-sixteenths inch (0.1875-in). All steel pipe must be square cut and must have a roundness such that the difference between the major and minor outside diameters must not exceed one percent (1%) of the specified nominal outside diameter or one-fourth inch (0.25-in), whichever is less. The outside circumference must be within plus or minus (±) one percent (1%) of the nominal circumference or within plus or minus (±) one-half inch (0.5-in), whichever is less. The pipe must have a maximum allowable straightness deviation in any ten-foot (10-ft) length of one-eighth inch (0.125-in). Steel pipe joints must be continuously welded with an approved butt weld. The welds must attain the full strength of the pipe and must result in a fully watertight section. The welded joints must conform to the requirements of AWWA C-206, “Field Welding of Steel Water Pipe”.

B) Boring Installations

1) Casing Pipe Size – The Contractor will submit to the Engineer the proposed steel casing pipe size and thickness for approval prior to purchase and installation.

2) Casing Pipe Thickness – Steel casing pipe must the following minimum thickness(es), in inches, for the indicated maximum depth of cover(s), in feet

OUTSIDE DIAMETER	UNDER HIGHWAY		UNDER RAILROAD		
(inches)	Wall Thickness (inches)	Maximum Cover (feet)	BNSF (Uncoated) Wall Thickness (inches)	Union Pacific Wall Thickness (inches)	Maximum Cover (feet)
<12	0.188	30	0.250	0.25	30
16	0..250	30	0.281	0.3125	30
18	0.250	30	0.322	0.322	30

20	0.250	30	0.344	0.344	30
24	0.250	30	0.406	0.406	30
30	0.322	30	0.469	0.469	30
36	0.375	30	0.531	0.531	30
42	0.375	25	0.563	0.563	30
48	0.438	25	0.625	0.625	25
54	0.438	25	0.719	Over 48" Must Be Approved by U.P.R.R.CO.	20
60	0.438	25	0.781		20
66	0.438	20	0.875		20

3) Micro and Small Diameter Tunneling – The steel casing pipe minimum wall thickness for micro and small diameter tunneling must be one-fourth inch (0.25-in).

4) Aerial Crossings – The minimum thickness for steel carrier pipe must be three-sixteenths inch (0.1875-in) and one-fourth inch (0.25-in) for diameters of forty-two inches (42-in) and less, and greater than forty-two inches (42-in), respectively.

635.02.03 – EXTERIOR PROTECTIVE COATING

Exposed exterior surfaces must have protective coating, shop applied coal-tar enamel, conforming to the requirements of AWWA C-203, “Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation”. The coating thickness must be forty mils (40-mils), applied in two (2) coats.

635.03 – METHOD OF MEASUREMENT

Payment for "Steel Casing Pipe" must be made at the unit price bid per linear foot for each Carrier pipe size. Installation method will be included in the payment for "Steel Casing Pipe." The price established must be full compensation for furnishing and installing of all materials including, labor, tools, equipment, and incidentals necessary to complete this item of work.

635.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid

STEEL CASING PIPE (CARRIER PIPE SIZE) L.F.
BORE AND STEEL ENCASEMENT (CARRIER PIPE SIZE) L.F.
STEEL ENCASEMENT BY TRENCHING (CARRIER PIPE SIZE) L.F.

SECTION 636 – DEFORMED HIGH DENSITY POLYETHYLENE PIPE

636.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by installation of a deformed High Density Polyethylene (HDPE) extruded pipe. The process must use steam and air pressure to progressively inflate the deformed HDPE pipe to conform to the existing pipe wall.

636.02 – MATERIALS

Materials must meet the requirements of Section 631, “Ductile Iron Pipe”, except that it must be Class B as defined in ASTM D-1248, “Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable”. The minimum cell classification must be PE 3464340, white color, as defined in ASTM D-3350, “Standard Specification for Polyethylene Plastics Pipe and Fittings Materials”.

636.02.01 – MINIMUM THICKNESS

Unless otherwise specified, the installed HDPE pipe must have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in these specifications and design assumptions outlined in Section 607, “Formed – in Place Pipe (FIPP)”.

Pipe Nominal Size (inch)	Depth of Cover (feet)				
	<10-ft	>10-ft or <15-ft	>15-ft or <20-ft	>20-ft or < 25-ft	>25-ft or <30-ft
8	0.307	0.358	0.409	0.450	0.487
10	0.383	0.448	0.511	0.562	0.608
12	0.460	0.538	0.613	0.675	0.730
15	0.575	0.672	0.766	0.844	0.912
18	0.690	0.806	0.919	1.012	1.097
21	0.805	0.941	1.072	1.181	1.277
24	0.920	1.075	1.226	1.350	1.460

636.03 – METHOD OF MEASUREMENT

Payment for "Deformed High Density Polyethylene Pipe" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

636.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEFORMED HIGH DENSITY POLYETHYLENE PIPE (SIZE) L.F.

SECTION 637 – FOLDED POLYVINYL CHLORIDE (PVC) PIPE

637.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by the insertion of a heated, folded PVC pipe which is then pressurized internally causing it to sequentially unfold and expand against the interior surface of the existing pipe.

637.02 – MATERIALS

The installed folded PVC pipe must meet the performance requirements of ASTM D-3034, "Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings". In addition, the PVC Compound used, must conform to the properties outlined in ASTM D-1784, "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals", Classification 12454-B or 12454-C and as outlined below:

PROPERTY	ASTM METHOD	MINIMUM VALUE
Pipe Stiffness	D-2412	46-psi
Pipe Impact Strength	D-2444	220-lb/ft
Pipe Flattening	D-3034	60% Deflection
Initial Flexural Modulus	D-790	360,000-psi
Long-Term Flexural Modulus	*	180,000-psi
Tensile Strength	D-638	6,000-psi

* Note: The long-term values are considered to be for a continuous load duration of fifty years (50-yr) for design loading conditions and must be certified by the manufacturer.

637.02.01 – MINIMUM THICKNESS

Unless otherwise specified, the installed PVC pipe must have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in these specifications and design assumptions outlined in Section 607, “Formed – in Place Pipe (FIPP)”.

Pipe Nominal Size (inch)	Depth of Cover (feet)				
	<10-ft	>10-ft or <15-ft	>15-ft or <20-ft	>20-ft or < 25-ft	>25-ft or <30-ft
8	0.165	0.193	0.220	0.243	0.262
10	0.207	0.242	0.275	0.303	0.328
12	0.248	0.290	0.330	0.364	0.393
15	0.310	0.362	0.413	0.455	0.493

637.03 – METHOD OF MEASUREMENT

Payment for "Reinforced Fiberglass Pipe” must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

637.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FOLDED POLYVINYL CHLORIDE (PVC) PIPE (SIZE) L.F.

SECTION 638 – RESIN IMPREGNATED TUBE

638.01 – DESCRIPTION

This section covers reconstruction and rehabilitation of sanitary sewer lines by the installation of a resin impregnated flexible felt tube (i.e. Cured-In-Place Pipe, CIPP), inverted into an existing sewer line. Resin impregnated tube must conform to the requirements of ASTM F-1216, “Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube”.

638.02 – MATERIALS

A) Tube – The tube must be compatible with the resin system and must consist of one or more layers of flexible felt or an equivalent woven or nonwoven material. The material must be able to stretch to fit irregular pipe sections and conform to changes in alignment. Allowance must be made in the fabrication of the tube so that the installed CIPP fits snugly to the interior circumference of the existing pipe while allowing for stretching during inversion.

B) Resin – The resin must be a thermoset and catalyst type, or an epoxy resin and hardener that is compatible with the inversion process.

C) Minimum Physical Properties – The cured resin impregnated tube must meet the minimum physical properties as specified below:

Property	ASTM Method	- Minimum Value (psi)	+ Minimum Value (psi)
Initial Flexural Strength	D-790	4,500	4,000
Long-term Flexural	*	2,250	2,000
Initial Flexural Modulus	D-790	250,000	400,000
Long-term Flexural	*	125,000	200,000

Notes:
-Materials with initial flexural modulus of 250,000 psi
+Materials with initial flexural modulus of 400,000 psi
*The long-term values are considered to be for a continuous load duration of fifty (50) years for design loading conditions and must be certified by the manufacturer.

D) Chemical Resistance – The resin impregnated tube must be fabricated from materials with when cured must be chemically resistant to withstand internal exposure to domestic sewage. Chemical resistance testing must be performed in accordance with Appendix X2 of ASTM F-1216, “Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube” and meet all the requirements specified therein.

638.02.01 – MINIMUM THICKNESS

Unless otherwise specified, for the materials indicated, the installed resin impregnated tube must have the following minimum thickness(es), in inches, shown below, meeting the requirements stated in Section 638.02 and design assumptions outlined in Section 638.02. Should the Contractor propose a resin system that differs from Section 607, “Formed – in Place Pipe (FIPP) – Materials – FIPP Design Basis” they must submit the proposed physical properties for design and calculated minimum thickness for review and approval by the Engineer. The Engineer must be the sole judge as to the appropriate minimum thickness to be furnished and the use of the product.

Pipe Nominal Size (inches)	Depth of Cover (feet)									
	<10-ft		>10-ft or <15-		>15-ft or <20-		>20-ft or <25-		>25-ft or <30-ft	
	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)	- Minimum Thickness (Inches)	+ Minimum Thickness (Inches)
8	0.187	0.153	0.218	0.187	0.249	0.213	0.274	0.235	0.297	0.254
10	0.233	0.191	0.273	0.234	0.311	0.266	0.343	0.293	0.371	0.317
12	0.280	0.229	0.328	0.280	0.373	0.319	0.411	0.352	0.445	0.380
15	0.350	0.286	0.410	0.350	0.467	0.400	0.514	0.439	0.556	0.475
18	0.420	0.344	0.491	0.420	0.560	0.479	0.617	0.627	0.667	0.670
21	0.490	0.401	0.673	0.490	0.653	0.558	0.719	0.615	0.777	0.665
24	0.560	0.458	0.655	0.560	0.746	0.888	0.822	0.703	0.889	0.760
27	0.630	0.515	0.736	0.630	0.839	0.718	0.925	0.791	1.000	0.855
30	0.700	0.573	0.818	0.700	0.933	0.798	1.027	0.879	1.111	0.960
33	0.770	0.630	0.900	0.770	1.026	0.877	1.130	0.966	1.222	1.045
36	0.840	0.687	0.982	0.840	1.119	0.957	1.233	1.054	1.333	1.140
42	0.980	0.801	1.145	0.980	1.306	1.117	1.438	1.230	1.655	1.330
48	1.120	0.916	1.309	1.119	1.492	1.276	1.644	1.406	1.777	1.520
54	1.260	1.030	1.473	1.259	1.679	1.436	1.849	1.581	2.000	1.710
60	1.400	1.145	1.636	1.400	1.865	1.595	2.054	1.757	2.221	1.900
66	1.540	1.260	1.800	1.540	2.052	1.754	2.260	1.932	2.443	2.100
72	1.680	1.373	1.963	1.679	2.238	1.914	2.465	2.108	2.665	2.280
78	1.820	1.490	2.127	1.819	2.423	2.073	2.671	2.284	2.888	2.470
84	1.960	1.602	2.291	1.959	2.611	2.233	2.876	2.459	3.110	2.660
90	2.100	1.717	2.454	2.100	2.798	2.392	3.082	2.635	3.332	2.850
96	2.240	1.831	2.618	2.239	2.984	2.552	3.284	2.811	3.554	3.040

Notes:
-Materials with initial flexural modulus of 250,000-psi
+Materials with initial flexural modulus of 400,000-psi

638.03 – METHOD OF MEASUREMENT

Payment for "Resin Impregnated Tube" must be made at the contract unit price per liner foot. The price established must be full compensation for all materials and labor including materials, surface preparation, application, tools, equipment, site cleanup and incidentals necessary to complete this item of work.

638.04 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

RESIN IMPREGNATED TUBE (SIZE) L.F.

SECTION 639 – SPECIAL SANITARY SEWER PIPE

639.01 – GENERAL

This section covers installation of sewer pipes, as specified herein, at locations called for on the plans, as required to satisfy minimum horizontal and vertical clearance requirements, from waterline, wells, and petroleum storage tanks, as established by the Oklahoma Department of Environmental Quality (DEQ).

639.02 – PIPE MATERIALS

Acceptable pipe materials and fittings must meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Flexible	Ductile-Iron Pipe (DIP)	631
Flexible	Polyvinyl Chloride (PVC) Pipe	633

639.03 – CONSTRUCTION METHODS

Pipe installation must be in accordance with the requirements and in conformance with the applicable sections of these specifications. If joining dissimilar pipe materials, concrete collars, as per "Standard Detail for Pipe Encasement & Collar", must be used.

639.04 – METHOD OF MEASUREMENT

Payment for "Special Sanitary Sewer Pipe" must be made at the unit price bid per linear foot installed for each size. The price established must be full compensation for all materials including pipe, concrete collars when necessary, labor, tools, equipment, and incidentals necessary to complete this item of work. Payment must not include the cost of trench excavation and backfill nor foundation and embedment materials.

"Special Sanitary Sewer Pipe" must be measured along the pipe, through manhole, junction boxes and other small structures.

639.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SPECIAL SANITARY SEWER PIPE (SIZE) L.F.

SECTION 640 – PIPE ENCASEMENT AND COLLAR

640.01 – DESCRIPTION

This section covers protection of sewer lines by concrete pipe encasement and collar when called for on the plans, or as directed by the Engineer.

640.02 – CONSTRUCTION REQUIREMENTS

A) General – Pipe encasement and collar must be constructed in accordance with the "Standard Detail for Pipe Encasement and Collar".

B) Pipe Encasement – Pipe encasement must be placed to the limits shown on the plans.

C) Collar – Collar must be concrete encasement placed to a minimum twelve inches (12-in) on either side of the joint.

640.03 – METHOD OF MEASUREMENT

Payment for "Pipe Encasement" and "Collar" must be made at the unit price bid per cubic yard of concrete. The price established must be full compensation for labor, materials, including concrete, tools, equipment, and incidentals necessary to complete this item of work.

SECTION 641 – AERIAL CROSSING

641.01 – DESCRIPTION

This section covers construction of aerial sewer crossing as shown on the plans. Each crossing involves excavation and backfill, construction of reinforced concrete bases and piers, carrier pipe, sewer pipe, and all incidental work.

641.02 – MATERIALS

A) Sewer Pipes – All pipes must conform to the requirements of Section 601, “Pipe Installation”.

B) Carrier Pipe **–** Acceptable carrier pipe material must meet the requirements of the appropriate section listed below:

Carrier Pipe Material	Section
Steel Casing Pipe	635

C) Formed Reinforced Concrete – Unless otherwise specified, all concrete used in construction of sanitary sewers and their appurtenances must have a minimum twenty-eight (28) day compressive strength of thirty-five hundred pounds per square inch (3,500-psi). All steel reinforcement used must be grade sixty (60) with a minimum yield strength of sixty pounds per square inch (60,000-psi).

641.03 – CONSTRUCTION METHODS

A) General – Construction of aerial crossing must be as called for on the plans and in accordance with the "Standard Detail for Aerial Crossing".

B) Casing Spacers – Casing spacers must be PVC with stainless steel bands. Use and positioning of spacers shall be in accordance with manufacturer's recommendations

C) Plugging Pipe Ends – Plugging Pipe Ends must comply with the requirement of Section 252.04, "Boring – Construction Methods", Part "D".

D) Piers – Pier construction must comply with all applicable subsections of section 400.

1) When the material encountered at footing grade of a bridge bent or pier is found to be partially of rock or incompressible material, and partially of a compressible material, the foundation cannot be placed until the Engineer has inspected the footing and authorized such changes found necessary to provide an adequate foundation.
2) Plans for forms and falsework for concrete piers which spans over twenty (20) feet in length and for all widening details must be submitted to the Engineer for review and approval. Similar plans must be submitted for other units of structure if requested by the Engineer. The plans shall be prepared on standard twenty-two (22) inch by thirty-six (36) inch sheets
3) Unless otherwise specified, top of caps and piers will be given a smooth finish with a steel trowel. Other surfaces must be wood float finished and striped with a fine brush leaving a fine grained texture.
4) Holes for anchor bolts in piers may be drilled or may be formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. The plugs or sleeves shall be withdrawn after the concrete has set. Formed holes must be of such diameter to permit horizontal adjustments of the bolts. The bolts shall be set carefully in mortar. In lieu of the above methods of placing, anchor bolts may be set to exact locations in concrete when it is placed
5) The minimum covering measured from the surface of the concrete to the face of any reinforcing bar must be not less than two (2) inches or as otherwise

shown on the plans. In the footings of abutments and retaining walls and in piers the minimum covering must be three (3) inches.

641.04 – METHOD OF MEASUREMENT

A) Payment for "Aerial Crossing" must be made at the unit price bid per linear foot of pipe and steel casing in accordance to Section 635 " Steel Casing Pipe". for each size. The price established must be full compensation for materials including carrier pipe, sanitary sewer pipe, casing spacers, plugging pipe, tie-down straps, anchor bolts, and all tools, labor, equipment, and incidentals necessary to complete this item of work.

B) Payment for "Concrete Collar with Spread Footing" must be made at the unit price bid per each. The price established must be full compensation for excavation and backfill, compacted rock foundation, materials including reinforced concrete for footing and collar, labor, tools, equipment, and incidentals necessary to complete this item of work.

C) Payment for "Pier" must be made at the unit price bid per vertical foot for each pier shaft for either Type I or Type II. The price established must be full compensation for excavation materials, including reinforced concrete for piers, labor, tools, equipment, and incidentals necessary to complete this item of work. Measurement for payment must be made from the top of the collar to the bottom of the pier.

641.05 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

AERIAL CROSSING (SIZE)	L.F.
FOOTING	EA.
PIERS(TYPE)	V.F.

SECTION 642 – SANITARY SEWER CONSTRUCTION STANDARD BID ITEMS

642.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of sanitary sewers and their appurtenances. Additional bid items may be called out in the bidding documents, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
601	SANITARY SEWER PIPE (SIZE)	L.F.
602	SEWER SERVICE CONNECTION	EA.
620	RISER PIPE	L.F.
603	SEWER SERVICE LINE	L.F.
604	ABANDONING SEWER	C.Y.
605	PIPE BURSTING (SIZE)	L.F.
606	SLIPLINING (SIZE)	L.F.
606	GROUTING	C.Y.
607	FORMED-IN-PLACE PIPE (SIZE)	L.F.
608	SEWER FLOW CONTROL	L.S.
609	CLEANING SEWER LINE	L.F.
610	SMOKE TESTING	L.F.
612	POINT REPAIR	EA.
613	DEFLECTION TEST (<24”)	L.S.
613	DEFLECTION TEST (≥24”)	L.F.
614	TELEVISION INSPECTION (CCTV)	L.F.
615	SEWER LEAK TEST (<24”)	L.S.
615	SEWER LEAK TEST ((≥24”)	L.F.
616	(SIZE) SANITARY SEWER MANHOLE(0-6FT)	EA.
616	EXTRA DEPTH MANHOLE WALL(SIZE)	V.F.
617	MANHOLE TESTING (<24”)	LS.
617	MANHOLE TESTING (≥24)	EA.
618	SANITARY SEWER MANHOLE REHABILITATION	V.F.
618	INVERT AND BENCH RECONSTRUCTION	EA
619	MANHOLE WATERPROOFING	EA.
620	MANHOLE JOINT WATERPROOFING	EA.
621	MANHOLE RING WATERPROOFING	EA.
622	MANHOLE COVER WATERPROOFING	EA.
623	GROUT CURTAIN	V.F.
629	ABANDONING MANHOLE	E.A.
629	REMOVING MANHOLE	E.A.
630	VITRIFIED CLAY SEWER PIPE (VCP)(SIZE)	L.F.
631	DUCTILE IRON PIPE (DIP)(SIZE)	L.F.
632	HIGH DENSITY POLYETHYLENE (HDPE) PIPE (SIZE)	L.F.
633	POLYVINYL CHLORIDE (PVC) (SIZE)	L.F.

Sanitary sewer Bid items continued

SECTION	DESCRIPTION	UNIT
634	REINFORCED FIBERGLASS PIPE (RFP) (SIZE)	L.F.
635	STEEL CASING PIPE (CARRIER PIPE SIZE)	L.F.
635	BORE AND STEEL ENCASEMENT (CARRIER PIPE SIZE)	L.F.
635	STEEL ENCASEMENT BY TRENCHING (CARRIER PIPE SIZE)	L.F.
636	DEFORMED HIGH DENSITY POLYETHYLENE PIPE (SIZE)	L.F.

637	FOLDED POLYVINYL CHLORIDE (PVC) PIPE (SIZE)	L.F.
638	RESIN IMPREGNATED TUBE (SIZE)	L.F.
639	SPECIAL SANITARY SEWER PIPE (SIZE)	L.F.
641	AERIAL CROSSING (SIZE)	L.F.
641	FOOTING	EA.
641	PIERS (TYPE)	VF.

TABLE OF CONTENTS
SECTION 700

SECTION 700 – TRAFFIC CONTROL

SECTION 701 - CONSTRUCTION REQUIREMENTS

701.01 – DESCRIPTION

This section covers general construction requirements for traffic control devices and appurtenances.

702.01 – MATERIALS

Materials certifications shall conform to section 106.12 a through c of the Oklahoma Department of Transportation Standard Specifications for Highway Construction 1999 or latest revision thereof.

Certifications must be mailed in quadruplicate to :

City of Oklahoma City
Traffic Management Division
420 West Main Street, Suite 600
Oklahoma City, OK 73102

Certifications will be checked for conformance with the applicable Specifications and an approved copy will be returned to the Contractor.

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

703.03 – CONSTRUCTION METHODS

701.03.02 – SIGNAL REPLACEMENT

Where existing signals are in operation, they shall remain in operation until the new signals are substantially complete and capable of operating in either pre-timed, recall or fully actuated modes. Exceptions may be made with permission of the Engineer.

701.03.03 – TRAFFIC SIGNAL START UP

The Contractor must notify the Traffic Management Division a minimum of two (2) working days prior to the start of operation of all new, upgraded or otherwise modified traffic signals.

SECTION 710 – ACTUATED SIGNAL CONTROLLER

710.01 – DESCRIPTION

This section covers the minimum design and operation requirements for two (2) through sixteen (16) phase solid state vehicle actuated traffic signal controllers, cabinets and accessory equipment. All traffic signal controllers, cabinets, and accessory equipment shall meet the requirements of NEMA Publication No. TS2-1992 or its latest revision in addition to the requirements of this specification. Catalog sheets shall be provided to the Engineer on items bid after award of the Contract.

710.02 – MATERIALS

710.02.01 – CONTROLLER UNIT, GENERAL

Interface, physical, functional and environmental standards shall meet the requirements specified by NEMA Publication No. TS2-1992 or its latest revision for Type 2 controller units. The controller unit shall be modular in design. Modules shall be easily removable without the use of special tools. The controller shall be capable of storing all timing in RAM with the power off and without the use of batteries. It shall be possible to upload or download all data through a standard RS232 port to a laptop computer. All controller features shall be in accordance with NEMA Publication TS2-1992 including all of the following:

A) All standard timings
B) Overlaps
C) Preemption operation
D) Diamond phasing
E) Sequential phase operation
F) Split dual ring operation
G) Converting all phases to overlaps

710.02.02 – CONTROLLER DISPLAY

The controller display shall provide simultaneous (i.e., concurrent) presentation, where concurrent states exist, of all of the following states/functions:

Phase Information:

A) Phase or phases in service (one per phase)
B) Phase or phases next to be serviced (one per phase)
C) Presence of vehicle call (one per phase)
D) Presence of pedestrian call (one per phase) The following shall be displayed simultaneously for all phases.

Status of Active Phase in the Ring:

E) Initial
F) Extension
G) Yellow change
H) Red clearance
I) Walk
J) Pedestrian clearance
K) Reason for Green termination
    1) Gap-out
    2) Maximum time-out
    3) Force-off
L) Rest state (dwell)

M) Processor Monitor Indicator (one per controller)

Items A through L shall be displayed by a liquid crystal display (LCD). Item M may be displayed on an LCD or by a discrete indicator. Controller display shall turn off automatically within 5 minutes of last keyboard entry.

710.02.03 – TIMING DISPLAY

The timing display shall use an LCD and shall indicate the current vehicle phase and active interval with a countdown in whole seconds of the time remaining on the active interval. If maximum recall is "on" for the current phase, maximum timing countdown shall be displayed. All displays shall be viewable in direct sunlight.

710.02.04 – PROGRAMMING

The controller shall provide for all control decisions to be performed by a microprocessor. All control functions shall be menu selectable by keyboard entry.

710.02.05 – INTERVAL KEYBOARD ADVANCE

When reading the stored timing for any interval, it shall be possible to read the timing on the next interval in sequence on the same phase with a maximum of one keystroke.

710.02.06 – TIMING INTERVAL

The timing for all phases of each interval shall be displayed at the same time on one screen.

Timing entry shall be maintained for a minimum of 30 days with the removal of power from the

controller without the use of a discrete battery.

710.02.07 – PROGRAMMABLE FUNCTIONS

All programmable functions and variables shall be accessible through :

A) an integral keypad on the face of the unit, and

B) via Port 2 RS-232C Interface and a personal computer

710.02.08 – CONDITIONAL SERVICE

The controller shall provide conditional service operation. This function, when enabled, causes the controller to monitor the time remaining on any even numbered phase which is opposed by an even numbered phase that has gapped out. If the time remaining is sufficient to allow at least a minimum service of its associated odd numbered phase, the controller shall cause the gapped out phase to terminate and shall re-service the odd numbered phase. The opposing odd numbered phase shall not be serviced at this time. It shall be possible to select each barrier separately.

710.02.09 – OVERLAPS

All overlaps shall be generated internally and meet the specifications of NEMA publication No. TS2-1992 or its latest revision. Overlaps shall be keyboard programmable.

710.02.10 – DIAMOND OPERATION

It shall be possible to set up the controller to operate the intersection as a diamond intersection through the keyboard alone utilizing any of the following phasing schemes. This shall be a standard built in function of the controller unit.

A) Lead-Lead
B) Lag-Lead
C) Lead-Lag
D) Lag-Lag
E) TTI-Lead

The phasing schemes listed are identical to those developed by the Texas Transportation Institute, (TTI) and utilized in TTI's PASSER-III software.

710.02.11 – TIME BASE CONTROL

The controller unit shall include provisions for internal Time Base Control meeting the requirements of NEMA Publication TS2-1992 Section 3.8, or its latest revision.

710.02.12 – ACTUATED COORDINATION

The controller unit shall include an internal coordinator. The coordinator shall accept Timing Plan (Dial/Split) and Offset commands from traditional (pre-timed) interconnect systems, from a companion Time Base program, and/or an Internal System Interface.

710.02.13 – PREEMPTION OPERATION

The controller shall provide for preemption operation for emergency vehicles and railroads. A minimum of six (6) separate preempts shall be provided. When both emergency vehicle and railroad preemption are utilized in the same system, railroad preemption shall take priority over emergency vehicle preemption. Preemption shall be a standard built in function of the controller unit.

710.02.14 – PROCESSOR MONITOR

The controller shall have a Processor Monitor to monitor microprocessor operation in accordance with NEMA Publication TS2-1992 Section 3.9.3.1.2 or its latest revision. If failure occurs in the microprocessor, the processor monitor shall initiate flashing operation and the processor monitor indicator on the face of the controller unit shall illuminate.

710.02.15 – DIAGNOSTIC TESTER

The controller unit shall have, as optional equipment, a diagnostic tester for performing comprehensive troubleshooting tests. Displays on the tester or on the controller unit shall indicate a valid completion of the test or an error code that can be translated to locate a component failure.

SECTION 711 – CABINET AND ACCESSORIES

711.01 – DESCRIPTION

The cabinet and all accessories equipment shall meet the requirements of NEMA Publication TS2-1992 or its latest revision in addition to the requirements of this specification. All auxiliary equipment shall be furnished in the price bid for controllers.

711.02 – MATERIALS

711.02.01 – CABINET MATERIALS

Cabinets shall be fabricated of either sheet aluminum or cast aluminum. Sheet aluminum cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.2.2.1, or its latest revision. Cast aluminum cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.2.2.2, or its latest revision. Cabinet finish and surface preparation shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.7.3, or its latest revision.

711.02.02 – MINIMUM CABINET DIMENSIONS

The controller cabinet shall conform to the dimensions listed in Table 7.3-1 of NEMA Publication TS2-1992 SECTION 7.3 or its latest revision.

711.02.03 – CABINET SHELVES

The cabinet shall be provided with a sufficient number and sizes of substantial metal shelves or brackets to support the controller unit and auxiliary equipment. The equipment and shelves shall be arranged so that it is possible to remove any piece of auxiliary equipment from the cabinet without removing any other piece of auxiliary equipment.

711.02.04 – CABINET MOUNTING

Cabinets shall be either base-mounted or pedestal mounted as shown on the Plans. Pedestal-mounted cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.8.2. or its latest revision. Base-mounted cabinets shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.8.3. or its latest revision.

711.02.05 – VENTILATION SYSTEM

The controller cabinet shall be equipped with a ventilation system which meets the requirements of NEMA Publication TS2-1992 SECTION 7.9 or its latest revision. All air intakes into the cabinet shall be equipped with filters meeting the requirements of SECTION 7.9.2.3 of NEMA TS2-1992.

711.02.06 – MAIN DOOR

Cabinets shall be provided with a full front door that provides complete access to the interior of the cabinet. The cabinet door shall meet all the requirements of NEMA Publication TS2-1992 Sections 7.5.1 through 7.5.6 or its latest revision.

711.02.07 – MAINTENANCE AND POLICE PANELS

The cabinet shall be provided with a maintenance panel inside the main door and a police panel accessible from a separate door attached to the main door. Maintenance and Police Panels are described in the sections below.

711.02.08 – MAINTENANCE PANEL

The Maintenance Panel shall be located on the inside of the cabinet door and shall contain the following switches:

A) Auto/Flash Switch
B) Controller Power Switch
C) Stop Timing Switch
D) Detector Test Switches (push button type, one for each vehicle and pedestrian phase)

711.02.09 – POLICE PANEL

The Police Panel shall be located in the Police Compartment which shall be accessible from a door located on the outside of the main door. The Police Compartment and Door shall meet the requirements of NEMA Publication TS2-1992 SECTION 7.5.7 or its latest revision. The Police Panel shall contain one Auto/Flash switch.

711.02.10 – PRINT HOLDER

A heavy-duty clear plastic print holder shall be securely attached to the inside door of the cabinet to provide storage for the cabinet wiring diagrams. The minimum dimensions for the print holder shall be nine (9) by twelve (12) inches.

711.02.11 – CABINET ELECTRICAL DESIGN

Cabinet wiring shall be in accordance with these Specifications and NEMA Publication TS2-1992 Section 5 or its latest revision.

711.02.12 – POWER REQUIREMENTS

The controller and all auxiliary equipment housed within the cabinet assembly shall be designed to operate from 89-135 VAC 60 $\pm$ 3 Hertz single-phase alternating current. Distribution of the AC Power throughout the cabinet shall not occur until the AC+ has first passed through all of the power protection devices or as explicitly permitted by this Specification or by NEMA Publication TS2-1992 or its latest revision.

711.02.13 – AC+ POWER PROTECTION DEVICES

The power protection devices shall include a minimum 30 amp main AC+ power circuit breaker, a minimum fifteen (15) amp auxiliary AC+ power circuit breaker, radio interference suppressor, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controllers and auxiliary equipment housed within the cabinet.

711.02.14 – TERMINALS AND FACILITIES INTERFACE

The Terminals and Facilities Interface shall be designed to meet the requirements of NEMA Publication TS2-1992 Section 5.3.2 or its latest revision.

711.02.15 – GROUNDING SYSTEM

The grounding system shall meet the requirements of NEMA Publication TS2-1992 Section 5.4.2.1, or its latest revision.

711.02.16 – CIRCUIT BREAKERS

The AC+ field service shall be connected to circuit breakers as shown in Figure 5.4.2-1 of NEMA Publication TS2-1992 Section 5.4.2.1. Circuit breakers shall meet the requirements of NEMA Publication TS2-1992 Section 5.4.2.2. The circuit breakers shall be capable of manual operation and clearly marked to indicate the ON and OFF positions. The circuit breaker shall have an adequate rating (amps) to handle the present and future cabinet and signal load.

711.02.17 – RADIO INTERFERENCE SUPPRESSION

The cabinet shall be equipped with a Radio Interference Suppressor meeting the requirements of

NEMA Publication TS2-1992 Section 5.4.2.5, or its latest revision.

711.02.18 – SURGE PROTECTION

An Innovative Technology model #HS-P-SP-120A-60A-RH Protector transient voltage surge suppressor or equivalent shall be installed between the AC power and cabinet mounted on the side of the cabinet immediately adjacent to the AC terminal block.

711.02.19 – WIRING AND INSULATION

The cabinet load bay shall be hard wired. Printed circuit runs will not be accepted.

All terminals shall be permanently identified in accordance with the cabinet wiring diagram.

Wiring of the cabinet load bay shall meet the requirements of NEMA Publication TS2-1992 Section 5.2 or its latest revision.

711.02.20 – AC+ CONVENIENCE OUTLET

A convenience receptacle shall be provided meeting the requirements of NEMA Publication TS2-1992 Section 5.4.2.6 or its latest revision.

711.02.21 – ILLUMINATION

The cabinet shall be furnished with a fluorescent lamp meeting the requirements of NEMA Publication TS2-1992 Section 5.4.2.7.1 or its latest revision. The "On-Off" switch for the lighting fixture shall be a door actuated switch that turns the light on when the door is open and off when the door is closed.

711.02.22 – DETECTOR RACK

Inductive loop vehicle detectors shall be rack mounted. The detector rack shall meet the requirements of NEMA Publication TS2-1992 Sections 5.3.4 through 5.3.4.5 or there latest revision in addition to the following :

A) The detector rack chassis shall be hinged on one side allowing the unit to swing out a minimum of 90 degrees for access to the units edge connector wiring.
B) The remote reset circuits shall be fully operational.
C) All delay inhibits shall be wired to the associated phase green.

711.02.23 – SOLID STATE LOAD SWITCHES

Load switches shall meet the requirements of NEMA Publication TS2-1992 Section 6.2 through 6.2.4 or its latest revision.

711.02.24 – LOAD SWITCH SOCKETS

Load switch sockets shall meet the requirements of NEMA Publication TS2-1992 Section 5.3.2.1 or its latest revision.

711.02.25 – SOLID STATE FLASHER

The flasher shall be solid state and have two (2) output circuits. It shall be rated at fifteen (15) amps per circuit and conform to NEMA Publication No. TS2-1992 Section 6.3 or its latest revision.

711.02.26 – FLASH TRANSFER RELAYS

The flash transfer relay shall meet the requirements of NEMA Publication TS2-1992 Section 6.4 or its latest revision.

711.02.27 – MALFUNCTION MANAGEMENT UNIT (CONFLICT MONITOR)

The Malfunction Management Unit (MMU) shall meet the requirements of NEMA Publication No. TS2-1992 Section 4 or its latest revision. In the event of conflicting signals, it shall place the intersection in flash and the controller in stop timing. The monitor shall have conflict memory indicators to aid in tracing the cause of a conflicting signal indication or loss of signal condition.

711.02.28 – BUS INTERFACE UNIT

The Bus Interface Unit shall meet the requirements of NEMA Publication TS2-1992 Section 8 or its latest revision.

711.05 – TESTING

711.05.01 – DOCUMENTATION

The cabinet shall be supplied with three (3) copies of the cabinet wiring and schematic diagrams. Each termination point shall indicate all connections to and from that point.

711.05.02 – REFERENCES

The vendor shall provide references from three (3) cities where the traffic controller has been in use for two (2) or more years.

711.07 – BASIS OF PAYMENT

Vehicle actuated traffic signal controller units, complete with the cabinet and all auxiliary equipment described in this section, shall be measured by the unit complete and in place. Vehicle actuated traffic signal controllers shall be paid for at the contract unit price for :

VEHICLE ACTUATED TRAFFIC SIGNAL CONTROLLER EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals, including concrete foundation and/or pedestal, necessary to complete the work as specified.

SECTION 712 – SOLID STATE DIGITAL INDUCTIVE LOOP VEHICLE DETECTOR

712.01 – DESCRIPTION

This section covers the minimum performance and design requirements of a card rack mounted digital inductive loop vehicle detector. Catalog sheets shall be provided to the Engineer on items bid after award of the Contract.

712.02 – MATERIALS

712.02.01 – GENERAL REQUIREMENTS

Physical and functional standards shall conform to this Specification and to NEMA Publication No. TS2-1992 Section 6.5 or its latest revision. The detector shall be completely self tuning with automatic tracking. The loop inductance range shall be 30 to 2000 microhenries. The loop input terminals shall be buffered by an isolation transformer. The detector shall have internal lightning protection devices to provide total circuit protection. There shall be three selectable frequencies to provide frequency separation to eliminate crosstalk. Three sensitivity selections shall be provided, with a high sensitivity of 0.02 percent change in loop inductance. There shall be a presence time control to select the rate at which detector tracking circuits cause the unit to tune out a stationary vehicle over the loop. The output indicator shall be a high intensity light emitting diode. The detector shall provide a continuous call output whenever power is removed. The operating temperature range shall be -30 degrees Fahrenheit (°F) to +180° F. The operating power range shall be 95 - 135 VAC 60 hz.

712.02.02 – DELAY AND EXTENSION TIMING

When specified on the plans, the detector shall be supplied with programmable delay and extension timing features. The call delay time shall be adjustable from 0 to 31 seconds in one second steps. The call extension time shall be adjustable from 0 to 15 seconds in 0.25 second steps. Activation of the Delay/Extension Feature shall meet the requirements of NEMA Publication TS2-1992 Section 6.5.2.9.7, or its latest revision.

712.02.03 – REFERENCES

The supplier shall provide references from three (3) cities where the detector has been in use for two (2) or more years.

712.07 – BASIS OF PAYMENT

Solid state digital inductive loop vehicle detectors installed shall be measured by the unit complete and in place, wired and connected to the controller. Solid state digital inductive loop vehicle detectors shall be paid for at the contract unit price for :

SOLID STATE DIGITAL INDUCTIVE LOOP VEHICLE DETECTOR EA.

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

SECTION 713 – TRAFFIC SIGNAL CONDUIT

713.01 – DESCRIPTION

This section covers the minimum construction and materials requirements for conduit used to enclose traffic signal conductors. All traffic signal conduit shall conform to Section 739 of the Oklahoma Department of Transportation Standard Specifications for Highway Construction 1999 or latest revision thereof unless otherwise noted in these Specifications.

713.02 – MATERIALS

713.02.01 – GENERAL

Traffic signal conduit shall be of the types given below. All fittings, entrance caps, and cements used shall be compatible with the conduit material for which they are used and comply with current traffic signal industry standards.

A) GALVANIZED STEEL - Rigid galvanized steel conduit shall comply with the requirements AASHTO M 272.

B) RIGID PLASTIC - Rigid plastic conduit shall comply with the requirements of AASHTO M 272. Rigid plastic conduit shall be schedule 40 polyvinyl chloride (PVC) plastic conduit, unless otherwise specified on the Plans.

C) 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 on the Plans.

D) CABLE-IN-DUCT - Cable-in-duct conduit shall be factory assembled. The duct shall be HDPE and comply with paragraph (C) above and be the size shown on the Plans. The conductors shall be the type, size, and number shown on the Plans. Identification of the conductors shall be accomplished by color coding the insulation by means of a continuous longitudinal colored stripe or various solid colors of insulation, in addition to the standard color markings.

713.02.02 – MATERIALS CERTIFICATION

Traffic signal conduit shall be accepted if all pieces are clearly marked with the UL label or a type D certification is provided by the manufacturer.

713.07 – BASIS OF PAYMENT

Traffic signal conduit of the size, type and method of installation specified shall be measured by the linear foot and shall include all fittings, outlets, entrance caps, pull wires, expansion devices and any other hardware necessary to complete the conduit system.

Accepted traffic signal conduit will be paid for at the contract unit price for :

(SIZE) GALVANIZED STEEL CONDUIT (INSTALLATION METHOD)	L.F.
(SIZE) RIGID PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
(SIZE) FLEXIBLE PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
(SIZE) CABLE-IN-DUCT	L.F.

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

SECTION 714 - ELECTRICAL CONDUCTORS

714.01 – DESCRIPTION

This section covers the materials and installation requirements for electrical conductors used for traffic lighting and signal electric cable, shielded loop detector lead-in cable, loop detector wire and communications cable.

714.02 – MATERIALS

Conductor shall meet the requirements listed below:

A) Traffic and Signal Electrical Cable. Traffic and signal electrical cable shall be straight conductor 600 volt cable with a polyethylene outer jacket for aerial and duct installation, and shall meet International Municipal Signal Association (IMSA) Specification No. 20-1. The conductors shall be solid copper No. 14 AWG. Electrical conductors for lighting shall be of the type shown on the Plans.

B) Shielded Loop Detector Lead-In Cable. Shielded loop detector lead-in cable shall comply with the requirements of IMSA No. 50-2. The conductors shall be stranded copper No. 14 AWG with a polyethylene outer jacket.

C) Standard Loop Detector Wire. Loop detector wire shall comply with requirements of IMSA No. 51-3. The conductors shall be No. 14 AWG stranded copper wire in a polyethylene outer jacket.

D) Loop-In-Duct Detector Wire. When Loop-In-Duct detector wire is specified on the Plans, it shall comply with the requirements of IMSA No. 51-5. The conductors shall be ducted No. 14 AWG stranded copper wire.

E) Signal and control Cable. Control cable for communications shall comply with the requirements of IMSA specification 20/6.

714.04 – CONSTRUCTION METHODS

A) Traffic and Signal Electrical Cable. Traffic and signal electrical cable shall be installed from the heads and luminaries on each traffic signal pole to the traffic signal controller or power source. 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 and signal and control cable. Shielded loop detector lead-in cables shall be placed in conduit from each loop detector pull box location to the traffic signal controller. 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. Signal and control cable shall be placed in conduit between traffic signal controllers as shown on the plans.

C) Loop Detector Wire. Loop detectors shall be located as shown on the Plans, the exact location being marked by chalk, spray paint or some other suitable marking device for inspection by the Engineer prior to being cut. The loop slots, including corner cuts, shall be cut in the pavement a minimum of two (2) inches deep and one-quarter (1/4) inch wide unless otherwise specified 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 slot shall be wound in the same direction a minimum of two (2) turns and a maximum of three (3) turns per loop. All loop wire shall be one continuous length to the pull box where it shall be connected to the lead-in cable. The run of loop wire between the loop and the pull box shall be twisted a minimum of five (5) turns per foot. A blunt instrument shall be used for placing the wire into the slot to prevent damage to the wires insulation. All loops connected to the same detector channel shall have their polarity reversed with respect to their adjacent loop. Loop wires shall be identified in the pull box as to loop number and the direction the loop is wound (i.e. clockwise, counter-clockwise). All connections that are made from loop wire to the lead-in cable shall be made only in the pull box. The connection shall be soldered with a 60/40 alloy, rosin core solder. A grease filled connector sealing pack shall be placed over the connection after soldering is completed. After the loop wire has been carefully placed in the slot and the circuitry checked by the Contractor, the slot shall be sealed with a sealer as shown on the Plans. A minimum of one (1) inch of sealer shall be over the top most wire in the slot. Loop sealant shall encapsulate loop wires in the saw cut. The process of cleaning the slot, installing the loop wire, checking the circuit, and sealing the slot shall be completed within the same working day to prevent the buildup of foreign matter in the slot after cleaning and prior to sealing.

714.07 – BASIS OF PAYMENT

Electrical conductor shall be measured by the linear foot for the various types specified and installed including all connectors, splices and incidentals necessary to complete the traffic signal and lighting system as provided on the Plans.

Accepted electrical conductors will be paid for at the contract unit price for :

(No. of conductors) CONDUCTOR TRAFFIC SIGNAL ELECTRICAL CABLE	L.F.
TWO CONDUCTOR SHIELDED LOOP DETECTOR LEAD-IN CABLE	L.F.
LOOP DETECTOR WIRE(AWG No.)(Wire Type)	L.F.
(No. of conductors)(AWG No.) ELECTRICAL CONDUCTOR	L.F.

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

SECTION 715 – POLYCARBONATE TWELVE (12) INCH TRAFFIC SIGNAL HEAD

715.01 – DESCRIPTION

This section covers the minimum design and operating requirements for adjustable face polycarbonate traffic signal heads that can be arranged in different combinations to provide vehicle signal displays in accordance with the Manual On Uniform Traffic Control Devices (MUTCD). Catalog sheets shall be provided on items bid.

715.02 – MATERIALS

715.02.01 – GENERAL REQUIREMENTS

Traffic signal heads shall conform to the ITE standard for Adjustable Face Vehicular Traffic Control Signal Heads. All traffic signal heads shall be mounted vertically, rigid, and not free swinging. Traffic signal placement shall conform to the requirements of the MUTCD.

715.02.02 – PHYSICAL AND MECHANICAL REQUIREMENTS

The housing of each signal section shall be one piece polycarbonate resin of the specified color, especially stabilized for atmospheric ultra-violet exposure, injection molded complete with integral top, bottom, and sides, having a minimum thickness of 0.1 inches.

One (1) section of each signal head shall be equipped with a five (5) position terminal block for termination of field wiring.

The top and bottom of each housing shall have an opening to accommodate standard one and one-half

(1 1/2) inch pipe fittings and brackets.

Signal sections shall be joined together in a manner that provides both mechanical integrity and prevents intrusion of dust and weather.

Each signal section shall be capable of being rotated 360 degrees about its axis and shall be capable of being locked at five (5) degree intervals. Serrations shall be integral with the signal section and designed to permit interlocking of adjacent sections.

715.02.03 – HOUSING, DOOR AND VISOR

Each signal section shall be constructed to accommodate a twelve (12) inch nominal dimension optical unit. The door of each signal section shall be hinged to the housing to permit access to the section for relamping. Each signal section shall be provided with a tunnel visor. The visor shall be a minimum of nine and one-half (9 1/2) inches in length with a minimum downward tilt of three and one-half (3 1/2) degrees. Each visor shall be secured to its door in a manner that will prevent its removal by wind. All exterior metal fasteners, including hinge pins, shall be made from stainless steel. Gasket material for the optical unit shall withstand temperatures up to 250° F without permanent deformation and discoloration, without adversely affecting the lens, reflector or lamp.

715.02.05 – COLOR

Nonmetallic materials shall have the color completely impregnated in the material. The exterior color of the entire signal head, including the outside of visors, shall be yellow. The inside of visors shall be flat black in color.

715.02.06 LIGHT EMITTING DIODE (LED) TRAFFIC SIGNAL LENSES

Light emitting diode (LED) lamp modules with spade tab connections shall meet the requirements in the Institute of Traffic Engineers (I.T.E.) standard entitled “Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement” (VTCSH-LED). LED lenses shall be Dialight, GelCore, Duralight or an approved equal.

When lit, all LED modules shall appear to drivers to be incandescent bulb type signals. Incandescent bulb type traffic signals are not acceptable.

The warranty from defective workmanship and materials shall be five (5) years from the date of the project’s final acceptance by the Oklahoma City Council. During the project's maintenance bond period, the contractor shall remove and replace defective LED modules within two (2) working days of receiving notice from the City’s Street and Drainage Maintenance Division. For reasons of immediate public safety, the City may remove and replace the module(s) and the contractor will be notified to furnish the city with replacement unit(s) meeting current ITE requirements. After the end of the maintenance bond period, all failed modules will be removed and replaced by the City and the contractor will be required to furnish the city with direct replacement unit(s) meeting current ITE requirements.

715.07 – BASIS OF PAYMENT

Polycarbonate 12-inch traffic signal heads shall be measured by the unit complete and in place including wiring. The contract unit price includes backplates, signal mounting brackets and geometrically programmed louvers (if specified), as described in sections 719, 720 and 721, of these specifications, respectively. Traffic signal heads shall be paid for at the contract unit price for :

ONE (1) SECTION TRAFFIC SIGNAL HEAD	EA.
THREE (3) SECTION TRAFFIC SIGNAL HEAD	EA.
FOUR (4) SECTION TRAFFIC SIGNAL HEAD	EA.
FIVE (5) SECTION TRAFFIC SIGNAL HEAD	EA.

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

SECTION 716 – RESERVED

SECTION 717 - PEDESTRIAN SIGNAL HEAD

717.01 – DESCRIPTION

This section covers the minimum design and materials requirements for an adjustable face pedestrian signal head. The pedestrian signal head shall conform to the latest Institute of Transportation Engineers Standard.

717.02 – MATERIALS

717.02.01 – GENERAL PHYSICAL AND MECHANICAL REQUIREMENTS

Signal sections shall be joined together in a manner that provides both mechanical integrity and maximum protection against intrusion of dust and weather.

Each signal face shall be capable of being rotated 360 degrees about its axis and shall be capable of being locked at five (5) degree intervals. Serration's shall be integral with the signal section and designed to permit interlocking of adjacent sections.

717.02.02 – HOUSING, DOOR AND VISOR

Each signal section shall be constructed to accommodate a 12-inch nominal dimension optical unit. The door of each signal section shall be hinged to the housing to permit access to the section for relamping. Each signal section shall be provided with a tunnel visor. Each housing and door shall be made of polycarbonate resin and shall be ultraviolet and heat stabilized. The housing and door shall conform to ASTM Specifications. All exterior metal fasteners, including hinge pins, shall be made from stainless steel. Gasketing material for the optical unit shall withstand temperatures up to 250° F without permanent deformation and discoloration, and without adversely affecting the lens, reflector or lamp.

717.02.03 – COLOR

All nonmetallic materials shall have the color completely impregnated in the material. The exterior color of the entire signal head, including the outside of visors, shall be yellow. The inside of visors shall be a flat black in color.

717.02.04 – LENSES

Lenses shall be made of glass and shall conform to the latest ITE specifications. The "Upraised Hand" lens shall be Portland orange and the "Walking Person" lens shall be lunar white. The letter height shall be four and one-half (4 1/2) inches and the stroke width shall be a minimum of 7/16 inches.

717.02.05 – REFLECTORS

Reflectors shall be specular aluminum with a protective anodic coating.

717.02.06 – ELECTRICAL

Traffic signal lamps shall be 67 watt, 120 volt lamps, and have a minimum rated life of 8000 hours. The lamp receptacles shall be of heat resisting material designed to properly position a traffic signal lamp with means for correct filament positioning. The receptacle shall be provided with a lamp grip to prevent the lamp from working loose due to vibration. Provision shall be made on either the lamp receptacle or the reflector holder to permit rotation of the lamp so that the opening between filament ends is up.

Each lamp receptacle shall be provided with two (2) color-coded No. 18 or larger lead wires with sufficient length to reach the terminal block with the reflector fully open. Each lead shall have a terminal attached to its end. Connection of the lead to the terminal block in the signal shall not require any tools other than a screwdriver. A suitable terminal block for connection of the wires from the signal circuits shall be provided in the signal housing.

717.04 – CONSTRUCTION METHODS

Pedestrian signal heads shall be installed at a height of eight (8) feet measured from the pole base plate to the bottom of the lower pedestrian signal section. Pedestrian signal heads shall be installed on the corner of the pole that most nearly aligns them with the crosswalk or as specified on the Plans.

717.07 – BASIS OF PAYMENT

Pedestrian signal heads shall be measured by the unit, complete and in place including wiring and all mounting hardware, as described in SECTION 720 - Signal Mounting Bracket. The number of ways (separate signal displays within a single unit) and mounting configuration for all signal heads shall be as shown on the Plan. Pedestrian signal heads shall be paid for at the contract unit price for :

PEDESTRIAN SIGNAL HEAD EA.

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

SECTION 718 – MODULAR PEDESTRIAN SIGNAL HEAD

718.01 – DESCRIPTION

This section covers the minimum design and materials requirements for an adjustable face modular (i.e. clamshell) pedestrian signal head. The pedestrian signal head shall conform to the latest Institute of Transportation Engineers Standard.

718.02 – MATERIALS

718.02.01 – GENERAL PHYSICAL REQUIREMENTS

The modular pedestrian signal shall be manufactured from a one piece die cast housing with a single face. It shall display the “Upraised Hand” message in the top portion of its face and the “Walking Person” message in the bottom portion. Its visor shall be a flat grid type. The assembled unit shall provide a completely dust tight and weather tight unit when installed.

718.02.02 – HOUSING, DOOR AND VISOR

The housing of the unit shall be a one piece corrosion resistant aluminum alloy die casting. It shall have an integrally cast top, bottom, sides, and back. It shall provide four integrally cast hinge lug pairs, two at the top and two at the bottom. These shall be provided for operation of the swing door unit.

The door frame shall be a one piece corrosion resistant aluminum alloy die casting. It shall have two hinge lugs cast at the bottom and two latch slots cast at the top of the door frame. The door shall be attached to the case with two stainless steel spring pins. Two stainless steel hinged bolts with captive stainless steel wingnuts and washers shall be attached to the case by stainless steel spring pins to complete the latching system. The visor for the unit shall be a flat grid type designed to eliminate glare from ambient light. The visor grid shall be installed parallel to the face of the "DONT WALK - WALK" message. The visor shall be attached by means of stainless steel screws. The visor shall be made of black polycarbonate with a flat finish on both sides.

718.02.03 – COLOR

The exterior color of the entire signal head except for the visor shall be Federal yellow. The entire visors including the outside shall be flat black.

718.02.04 – LENSES

Light emitting diode (LED) lamp modules with spade tab connections shall meet the requirements in the Institute of Traffic Engineers (I.T.E.) standard entitled “Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement” (VTCSH-LED). LED lenses shall be Dialight, GelCore, Duralight or an approved equal. The “Upraised Hand” lens shall be Portland orange and the “Walking Person” lens shall be lunar white. The letter height shall be four and one-half (4 1/2) inches

and the stroke width shall be a minimum of 7/16 inches.

718.04 – CONSTRUCTION METHODS

Pedestrian signal heads shall be installed at a height of eight (8) feet measured from the pole base plate to the bottom of the lower pedestrian signal section. Pedestrian signal heads shall be installed on the corner of the pole that most nearly aligns them with the crosswalk or as specified on the Plans.

718.07 – BASIS OF PAYMENT

Modular pedestrian signal heads shall be measured by the unit, complete and in place including wiring and all mounting hardware, as described in SECTION 720 - Signal Mounting Bracket. The number of ways (separate signal displays within a single unit) and mounting configuration for all signal heads shall be as shown on the Plan. Modular pedestrian signal heads shall be paid for at the contract unit price for :

MODULAR PEDESTRIAN SIGNAL HEAD EA.

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

SECTION 719 – TRAFFIC SIGNAL BACKPLATE

719.01 – DESCRIPTION

This section covers the material requirements for Type I and Type II traffic signal backplates.

719.02 – MATERIALS

719.02.01 – GENERAL REQUIREMENTS

Traffic signal backplates shall be premanufactured, one piece construction units specifically profiled to fit the signal head(s) furnished under this contract. Backplates shall extend outward from all parts of the signal face assembly a minimum distance of five (5) inches. All corners shall be rounded to have a one and one-half (1 1/2) inch radius. Backplates shall be secured to the traffic signal heads with stainless steel machine screws and lock nuts.

Type I backplates shall be constructed from polycarbonate sheet material and shall conform to the requirements of ASTM D 638, D 695, D 790, and D 1822.

Type II backplates shall be vacuum formed from acrylonitrile-butadiene-styrene (ABS) material conforming to ASTM D 1788.

719.02.02 – FINISH

Backplates shall be black in color with a haircell finish on the front side and smooth finish on the back side. The backplate shall be treated for ultra-violet retardation.

719.07 – BASIS OF PAYMENT

Payment for backplates shall be included in the contract price for traffic signal heads.

SECTION 720 - SIGNAL MOUNTING BRACKET

720.01 – DESCRIPTION

This section covers the minimum design and material requirements for traffic and pedestrian signal mounting brackets. Signal brackets shall be designed to hold signal heads in a vertical arrangement.

720.02 – MATERIALS

Traffic signal mounting brackets shall be of the type and construction as listed below :

A) MAST ARM MOUNTING BRACKETS

Mast arm mounting brackets shall attach to both the top and bottom of the signal head. The bracket shall be capable of adjusting the signal head in both the horizontal and vertical planes relative to the bracket. The bracket shall be adjustable about the mast arm. The mounting bracket shall be constructed with aluminum pipe and fittings (plastic fittings are not acceptable).

B) SIDE POLE MOUNTING BRACKET

The side pole mounting bracket shall consist of an upper and lower arm assembly with standard band-on mounting hub plates for banding on a tubular pole. The upper arm assembly shall include one and one-half (1 1/2) by ten (10) inch nipple, serrated ell, neoprene gasket, and cast nipple. The lower arm assembly shall include one and one-half (1 1/2) by ten (10) inch nipple, serrated tee and cast nipple. The mounting bracket shall be constructed with aluminum pipe and fittings (plastic fittings are not acceptable) and shall have a spun aluminum alodine finish.

C) POST TOP MOUNTING BRACKETS

One-way post top mounting brackets shall consist of a vertical terminal compartment, upper and lower arm assemblies, and a one and one-half (1 1/2) by thirty-seven (37) inch center support tube for mounting three (3) section twelve (12) inch traffic signal heads on a four and one-half (4 1/2) inch outside diameter pedestal pole. The upper arm assembly shall include a standard upper arm which will slide over the support tube and a tri-bolt arrangement for attaching to the signal housing. The lower arm assembly shall include a one and one-half (1 1/2) inch by five (5) inch nipple, serrated tee and cast nipple. The mounting bracket shall be constructed entirely of aluminum (plastic fittings are not acceptable) and shall be painted Federal yellow.

720.06 – METHOD OF MEASUREMENT

Payment for signal brackets shall be included in the contract price for traffic signal heads and pedestrian signal heads.

SECTION 721 – GEOMETRICALLY PROGRAMMED LOUVER

721.01 – DESCRIPTION

This section covers the minimum design and materials requirements for a twelve (12) inch louver assembly designed to direct the light beam from a traffic signal section to a predetermined viewing range. The physical and functional standards of the louver shall conform to the latest Institute of Transportation Engineers Standards.

721.02 – MATERIALS

721.02.01 – GENERAL REQUIREMENTS

The louver shall be designed to fit into a twelve (12) inch nominal dimension signal. The louver shall provide an absolute exact visual cut-off, and a full round ball display with minimum sat effect throughout the selected view range. In addition, the louver shall have a minimum glow outside the view range. The louver shall allow the view angle within each signal section to be adjusted to a designated area. The louver shall allow for controlling either the horizontal or vertical view range within the signal visor. The louver shall be of lightweight material, easily installed with minimum labor, and maintenance free.

721.02.02 – HOUSING

The housing shall be consist of a two-piece assembly injection molded from black UV inhibited ABS plastic. Two brass inserts shall be molded into the bottom half allowing the assembly to be fastened together with two stainless steel screws.

The housing's outside diameter shall be eleven and one-half (11 1/2) inches and have spherical contour which allows the light beam from the signal section to be directed up to ten (10) degrees in all

directions from the centerline of the visor/lens system.

The inside surface shall have a multiplicity of grooves for positioning light directing baffles. The remaining inside surface shall be grooved to prevent surface reflections of light.

Two (2) sponge neoprene o-rings shall be positioned in grooves on the outside surface to prevent light leakage between the housing and the visor.

The housing design shall allow the baffle positions to be changed in order to adjust the view angle.

721.02.03 – BAFFLES

Baffles shall be injected molded from flat black, ten (10) percent glass filled UV inhibited virgin polycarbonate. Each baffle shall be a thin opaque disc with a multiple of parallel evenly spaced apertures (openings). Each structural member forming the aperture shall have a cross section which allows for good stiffness and structural integrity, but shall have a thin edge to prevent reflection outside the desired viewing range. All baffles shall be identical in design and interchangeable within the housing. The plane of each baffle shall be 90 degrees to the centerline axis of the housing.

721.06 – METHOD OF MEASUREMENT

Payment for geometrically programmed louvers shall be included in the contract price for traffic signal heads.

SECTION 722 - PEDESTRIAN PUSH BUTTON

722.01 – DESCRIPTION

This section covers the material and installation requirements for pedestrian push buttons.

722.02 – MATERIALS

The pedestrian push button housing shall be cast aluminum and shall be suitable for mounting on a rounded surface. The body shall have a wire entrance hole at the back. A neoprene gasket shall provide a weather tight fit between the cover and body. The push button switch shall be waterproof. The cover shall be attached with recess hex head stainless steel screws. The push button housing shall be painted Federal yellow.

The pedestrian push button shall be constructed to be tamper proof. It shall be designed such that it will be virtually impossible to receive any electrical shock under any weather condition.

722.04 – CONSTRUCTION METHODS

The pedestrian push button and sign shall be attached to the traffic signal pole or pipe in the location shown on the Plans and at a height of 40 inches measured from the bottom of the unit to the pole base plate. It shall be attached to the pole or pipe in a rigid and secure manner. Holes which are drilled in the field during installation shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

722.07 – BASIS OF PAYMENT

Pedestrian push buttons shall be measured by the unit complete and in place, including an MUTCD designation R10-4 or R10-4b sign and all hardware.

Accepted pedestrian push buttons will be paid for at the contract unit price for:

PEDESTRIAN PUSH BUTTON AND SIGN EA.

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

SECTION 723 – ACCESSIBLE PEDESTRIAN PUSH BUTTON STATION

723.01 – DESCRIPTION

This section covers the material and installation requirements for accessible pedestrian push button stations. Push button stations shall consist of a modular unit containing both the push button and an MUTCD designation R10-3b sign.

Accessible pedestrian push button stations shall provide users with visual, tactile and audible information at the intersection crossing where installed. Each station shall include the following features:

Audible locating tone to guide pedestrians to accessible pedestrian push button stations. Automatically adjusting audible output to compensate for ambient sound levels.

Light emitting diode (LED) visual indicator showing the user that the service call from the push button station has been sent to the traffic signal controller.

Audible and vibrotactile confirmation to the user that the service call from the push button station has been sent to the traffic signal controller. The push button station shall vibrate at the start of the walk interval.

Audible message played for the user indicating the direction of travel.

Audible voice message indicating when a street can be crossed and identifying the street by name. The message shall play at the start of the walk interval and countdown the number of seconds remaining to cross the street during the pedestrian clearance phase.

The accessible push button stations shall meet the following minimum requirements:

723.02 – MATERIALS

The accessible pedestrian push button station housing shall be cast aluminum and shall be suitable for mounting on a rounded surface. The body shall have a wire entrance hole at the back. A neoprene gasket shall provide a weather tight fit between the cover and body. The push button switch shall be waterproof. The cover shall be attached with recess hex head stainless steel screws. The push button station housing shall be painted Federal yellow.

The pedestrian push button and sign shall be constructed to be tamper proof. It shall be designed such that it will be virtually impossible to receive any electrical shock under any weather condition.

723.04 – CONSTRUCTION METHODS

Accessible pedestrian push button stations and sign shall be attached to the traffic signal pole or pipe in the location shown on the Plans. Push buttons attached to the signal pole at points no lower than 15 inches nor higher than 40 inches as measured from the center of the push button to the grade adjacent to the pole where the user activating the push button would be positioned. It shall be attached to the pole or pipe in a rigid and secure manner. Holes, which are drilled in the field during installation, shall be regalvanized, metalized, or painted with approved zinc dust-oxide paint.

723.07 – BASIS OF PAYMENT

Accessible pedestrian push button stations shall be measured by the unit complete in place, connected, including signs and all hardware. Accepted accessible pedestrian push button stations will be paid for at the contract unit price for:

ACCESSIBLE PEDESTRIAN PUSH BUTTON STATION EA.

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

SECTION 724 – POLES AND MAST ARMS

724.01 – DESCRIPTION

This section covers the minimum requirements for traffic signal poles, mast arms and pedestal poles.

724.02 – MATERIALS

The design of traffic signal poles and mast arms shall be the responsibility of the manufacturer. Materials used shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs, Luminaires, and Traffic Signals.

Poles and mast arms shall be designed for a minimum of 80 mile per hour winds with a gust factor of 1.2 and shall meet all other design requirements of AASHTO Standard Specifications for Structural Supports of Highway Sign, Luminaires, and Traffic Signal Poles.

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 nonshrink grout.

Each pole shall be furnished with a reinforced handhole and weatherproof cover, unless otherwise specified on the Plans. Handholds shall be oval in shape, four (4) inches wide, at least six (6) inches long, with the bottom of the hole eight (8) inches from the pole base, unless otherwise specified on the Plans. Handhole covers shall be one piece formed from ABS plastic, shall be a pearl gray color, and shall be suitable for exposure to harsh sunlight and extreme weather. Cover shall latch with two screw thaches and shall fit tightly to the enclosure ring to create a rainproof seal. Latch screws shall be ¼ - 20 stainless flat socket head screws with tamper proof fetures. A removable pole cap shall be installed on each shaft. All metal poles shall be provided with a grounding connection inside the base of the shaft and shall be grounded as shown on the Plans. Mast arms and poles shall be selected from preapproved shop drawings of poles and mast arms which have been standardized for maximum loading. All mast arms shall provide for a seventeen (17) foot clearance measured from the bottom of the traffic signals heads. All luminaires mounted to signal poles shall provide a light fixture mounting height of 32 feet unless otherwise specified on the Plans.

Pedestal poles shall meet the following requirements:

Aluminum Alloy	6063-T6
Tensile Strength, KSI	30
Yield Strength, KSI	25
Elongation	10%
Minimum Wall Thickness	0.237 inches
Outside Diameter	4.05 inches

Threading and deburring of the pedestal pole shall be in accordance with the basic dimensions of the American National Standard Taper Pipe Threads, NPT(ANSI B2.1).

The threaded pedestal flange base shall be heavy-duty galvanized iron with a seven and one-quarter (7 1/4) inch bolt circle. Anchor bolts shall be provided with two (2) nuts and two (2) washers per bolt for double nut leveling of the pole.

All holes made in poles or mast arms after galvanizing shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

Traffic signal pole and mast arm sizes and locations shall be as shown on the Plans.

724.07 – BASIS OF PAYMENT

Traffic signal poles, mast arms, luminaire arms and pedestal poles, of various types, sizes, and lengths shall be measured by each unit installed.

The accepted poles, mast arms, luminaire arms and pedestal poles shall be paid for at the contract unit price for :

POLE AND SPECIFIED NO. OF MAST ARM(S)	EA.
POLE AND SPECIFIED NO. OF MAST ARM (S) AND LUMINAIRE ARM	EA.
PEDESTAL POLE WITH SPECIFIED MOUNTING HEIGHT	EA.

which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified, excluding reinforced concrete footings, which are classified separately for payment.

SECTION 725 – TRAFFIC SIGNAL POLE CONCRETE FOOTINGS

725.01 – DESCRIPTION

This section covers the construction material and installation requirements for reinforced p.c. concrete traffic signal pole footings. Footings shall be of the type(s) shown on the Plans. The footing dimensions and steel reinforcement requirements shall conform to the latest revision of the Oklahoma Department of Transportation Traffic Standard detail sheet CDF-1-05, Typical Conduit and Signal Pole Footing Details.

725.02 – MATERIALS

Concrete footings shall be placed in reasonably close conformity to the dimensions shown on the Plans and shall conform to the following material requirements:

A) Portland cement shall conform to the requirements of AASHTO M 85 and AASHTO M 240.
B) Aggregate shall conform to the requirements of ASTM C 330.
C) Reinforcement shall conform to the requirements of AASHTO M 55 or AASHTO M 221.p
D) Portland cement Concrete shall comply with the requirements of AASHTO T 23 and AASHTO T22. P.C. concrete shall have a minimum compressive strength of 3,000 pounds per square inch at 28 days.
E) Anchor bolts and nuts shall conform to AASHTO M 183.
F) Galvanizing (bolts, nuts and washers) shall conform to AASHTO M 233.
G) Electrical conduit shall conform to the requirements for Traffic Signal Conduit in SECTION 712 of these specifications.

725.04 – CONSTRUCTION METHODS

Concrete footings shall constructed in accordance with the most current revision of ODOT standard specifications section 509 – Structural Concrete, and shall be of the size(s) indicated and in the locations shown on the Plans. 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 design, number and layout of anchor bolts required shall be the responsibility of the manufacturer. Materials used shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs, Luminaires, and Traffic Signals. Anchor bolts and nuts shall be in accordance with the requirements of the preapproved shop drawings for poles and mast arms, which are standardized for maximum loading.

725.07 – BASIS OF PAYMENT

Concrete footings of the type(s) shown on the Plans shall be measured by the cubic yards of structural concrete and pounds of reinforcing steel required. The contract price for concrete footings includes anchor bolts, nuts, washers, ground rod, conduit, excavation and backfilling, necessary to construct the footings as shown on the Plans or as directed by the Engineer.

Accepted footings shall be paid for at the contract unit price for:

STRUCTURAL CONCRETE	C.Y.
REINFORCING STEEL	LBS.

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

SECTION 726 – PULL BOXES

726.01 – DESCRIPTION

This section covers the material and installation requirements for pull boxes. Pull boxes shall be size I or II as shown on the Plans. The dimensions of size I and II pull boxes shall conform to those given in the latest revision of the Oklahoma Department of Transportation Traffic Standards.

726.02 – MATERIALS

Portland Cement Concrete and polymer concrete pull boxes shall be placed in reasonably close conformity to the dimensions shown on the Plans and shall conform to the following material requirements:

A) Portland Cement shall conform to the requirements of AASHTO M 85 and AASHTO M 240.
B) Aggregate shall conform to the requirements of ASTM C 330.
C) Reinforcement shall conform to the requirements of AASHTO M 55 or AASHTO M 221.
D) Concrete shall comply with the requirements of AASHTO T 23 and AASHTO T22. Concrete shall have a minimum compressive strength of 3,000 pounds per square inch.
E) Gray Iron Casting Covers shall conform to AASHTO M 105.

726.03 - POLYMER CONCRETE PULL BOX REQUIREMENTS

Polymer concrete pull boxes have a polymer concrete cover, frame and body and a minimum load rating of 20,000 pounds. Polymer concrete pull boxes shall be Armorcast, Quazite or an approved equal. Fiberglass and/or plastic pull boxes or composites of same will not be accepted.

726.04 – CONSTRUCTION METHODS

Pull boxes shall be the sizes shown on the Plans. The general location of pull boxes shall be shown on the Plans. Field adjustment of pull box locations to fit existing conditions shall be permitted with approval of the Engineer.

The tops of pull boxes installed in sidewalks or other surfaced areas shall be flush with the finished surface. Pull boxes in unsurfaced areas shall be flush with the top of the ground or no more than one (1) inch above the top of the ground.

Pull boxes not installed in a surfaced area shall be installed with a concrete apron. The dimensions of the apron shall conform to those given in the latest revision of the Oklahoma Department of Transportation Traffic Standards.

Pull boxes shall be installed on a bed of crushed rock as shown on the Plans. Rock depth and size shall conform to the latest revision of the Oklahoma Department of Transportation Traffic Standards.

When called for on the Plans, pull box extensions shall be provided. The extensions shall be made of the same materials 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.

Pull box covers shall be marked with the legend "Highway Lighting" or "Street Lighting" when used for lighting conductors and "Traffic Signal" when used for traffic signal conductors with or without lighting conductors. The legend shall be cast into the cover face. 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 recessed hold down bolts. The

cover shall have a nonskid surface.

If called for on the Plans, a copperweld ground rod shall be installed as shown on the Plans.

726.07 – BASIS OF PAYMENT

Concrete pull boxes of the size and type shown on the Plans shall be measured by each unit installed and shall include cover, extension, ground rod, concrete apron, crushed rock, excavation, and backfilling, necessary to construct and install the pull boxes as shown on the Plans or as directed by the Engineer.

Accepted pull boxes will be paid for at the contract unit price for:

PULL BOX TYPE I	EA.
PULL BOX TYPE II	EA.

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

SECTION 727 – ROADWAY LUMINARIE

727.01 – DESCRIPTION

This section covers the minimum design and material requirements for high intensity discharge luminaries to provide roadway lighting.

The luminaire shall be a horizontal or vertical burning, high pressure sodium (HPS), outdoor luminaire complete with housing, appropriate mounting, built in ballast, adjustable mogul socket, lamp, gasketed reflector, and glass refractor.

727.02 – MATERIALS

A) HOUSING

The housing shall be precision die-cast aluminum and be of adequate size to contain the ballast components, reflector, lamp and socket, terminal board, and slip fitter allowing all the electrical components to operate within their designed temperature range.

B) REFRACTOR AND DOOR

The refractor shall be manufactured of pressed, heat resistant, crystal clear borosilicate glass, annealed, homogenous and free form imperfections and striations. Refracting prisms shall be incorporated in the refractor to assure maximum utilization of the light generated and provide the required photometric distribution.

The refractor door shall be precision die-cast aluminum with clips for proper positioning of the refractor. The door shall be easily detached from the housing by operating the spring loaded latch or latches and separating the hinges while wearing linemen's gloves.

C) MOUNTING

Luminaires for mast arm mounting shall be equipped with a slipfitter design to accept one and one-quarter (1 1/4) inch to two (2) inch schedule 40 pipe and provide a method of leveling the luminaire and vertical adjustment $\pm$ five (5) degrees using externally accessible bolts. The slipfitter shall be equipped with a pipe stop. Luminaires for post top mounting shall be equipped with a slipfitter designed to accept a two and three-eighths (2 3/8) inch to three (3) inch O.D. pole or tenon.

D) REFLECTOR

The reflector shall be of specular finished, hydro-formed, anodic coated aluminum with a minimum coat thickness of 0.00015 inches and weighing seven and one-half (7 1/2) milligrams per square inch to provide a minimum reflecting of 82 percent. The reflector shall have a reverse flange mounted within the housing to assure a firm surface for proper gasket sealing when the refractor

door is closed.

E) GASKETS

The gaskets between the refractor door and housing and at the socket entrance to the reflector shall be made of heat resistant, non-moisture absorbing, polyester, silicon rubber or dacron felt. The gasket shall be continuous or one piece and installed with no butt ends or gaps that will allow contaminants to enter the reflector cavity.

F) LAMP SOCKET AND SUPPORT

The lamp socket shall be a completely porcelain enclosed, mogul type with internal lamp grips to assure electrical contact under conditions of normal vibration. The socket shall have welded internal connections and be in compliance with the latest revisions of Edison Electric Institute (EEI) Publication No. TDJ-147. The socket support shall contain identifying marks so the socket may be easily adjusted, both horizontally and vertically to provide the specified IES light distribution.

G) BALLAST

The ballast shall be a high power factor bobbin wound, ISO-regulator constant wattage type, capable of operating the high intensity discharge lamp specified from a single phase, grounded, 120/240 Volt nominal, multiple system. The ballast shall regulate lamp watts within the following line voltage variations:

RATED WATTS	LINE VOLTAGE
High Pressure Sodium	
± 12%	± 10%

The ballast, capacitor, and starting aid module, if required, shall be prewired to the lamp socket and terminal board and be designed for easy removal and installation by using quick disconnect features. The ballast shall be designed to start the lamp at minus twenty (20) °F.

H) TERMINAL BOARD

The terminal board shall be of phenolic molded plastic or porcelain with protective barriers between terminals. The screw terminals shall be captive type, compatible with aluminum or copper conductors and capable of accepting up to a No. 6 AWG conductor.

I) HARDWARE

All nuts, bolts, screws, clips, washers, springs, and attaching hardware shall be fabricated from non-corrosive alloys. Cadmium plating will not be considered adequate weatherproofing. All threaded surfaces used in aluminum housing shall be lubricated with silicone grease.

727.02.01 – ELECTRICAL

All electrical components shall be insulated to a minimum of ten (10) KV BIL.

Termination connectors shall meet or exceed twice the rate current value for EEI-TDJ162 Class A Heat Cycle Test.

All wire shall be UL approved and the insulation capable of withstanding the designed operating temperatures of the luminaire, with a minimum insulation of 125 degrees Centigrade (°C) required.

727.02.02 – FINISH

The luminaire finish shall be Munsel #5BG-ASA#70 or an approved equal.

727.02.03 – PHOTO CELL AND RECEPTACLE

If required on the Plans, the luminaire shall be equipped with the following :

A) The photoelectric control shall be a detachable type cadmium sulfide photocell of 105-285 Volt,

50/60 Hertz AC, outdoor control complete, in accordance with EEI-NEMA Standard TDJ-146. It shall have a built in time delay of three (3) to five (5) seconds, relay load contacts rated 1000 Watts or 1800 Volt-Ampere reactive, a single-pole, single-throw, contact normally closed for "Fail Safe" operation, positive lightning and surge protection enclosed in a high impact acrylic housing which has a neoprene base plate gasket and 3-pole polarized twist-lock plug. Turn-on shall occur at approximately two (2) footcandles and turn-off at approximately five (5) footcandles. Turn-on and turn-off shall be adjustable.

B) The three pole locking receptacle shall be in accordance with the latest EEI and NEMA standards and shall be prewired to the terminal board.

727.02.04 – ADDITIONAL REQUIREMENTS

A) Each luminaire shall be supplied with a permanently attached name plate inside the housing and/or on the ballast. This label shall indicate the manufacturer, Catalog No., Lamp type, wattage, line voltage rating and connection diagram.

B) Each luminaire shall be marked in accordance with EEI-NEMA standards for "Field Identification of High-Intensity Discharge Lamps in Luminaries used in Roadway Lighting Equipment", EEI Publication No. TDJ-150 and NEMA Publication No. OD150.

C) If required on the Plans, each luminaire shall be equipped with a cut-off visor. Cut-off shall occur full circumference of the luminaire at approximately 75 degrees from the vertical axis. The visor shall be similar in color to the luminaire.

D) The contractor shall supply photometric data from the luminaire manufacturer for comparing light quality and quantity prior to receiving installation approval from the Engineer.

727.07 – BASIS OF PAYMENT

Luminaires will be measured by the unit, complete in place including wiring and all hardware. The accepted luminaires will be paid for at the contract unit price for:

ROADWAY LUMINAIRE (250 WATT HPS) EA.

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

SECTION 728 – SCHOOL FLASHERS

728.01 – DESCRIPTION

This section covers the material and construction requirements for school flashers used to supplement school speed limit signs.

728.02 – MATERIALS

728.02.01 – GENERAL

School flashers shall conform to the following requirements:

A) Signs. Signs used with school flashers shall be a M.U.T.C.D. designation S5-1, 24 inches by 48 inches and shall inform to the requirements of SECTION 729.

B) Flasher Assembly. The flasher assembly shall meet the requirements of SECTION 711.

C) Flasher Beacons. The flasher beacons shall utilize a yellow lens twelve (12) inches in diameter fitted with a cut-away visor. All other aspects of the flasher beacons shall conform to the requirements of SECTION 715.

D) Programmable Time Clock. The programmable time clock shall be a Paragon EC72D, or approved equal. It shall be completely solid state. Programming of time of day, day of week, date, and year, shall be accomplished through an integral keypad. The functions of the keypad keys shall be clearly

marked. Change over between daylight time and standard time shall be made automatically at the appropriate times as defined by United States Law. Timing shall be synchronous with the power line. In the absence of power, a backup power source shall be used to maintain timing accuracy within ± 3 seconds per 24 hours.

E) Pedestal Pole. The pedestal pole shall meet the requirements listed below:

Aluminum Alloy	6063-T6
Tensile Strength, KSI	30
Yield Strength, KSI	25
Elongation	10%
Minimum Wall Thickness	0.237 inches
Outside Diameter	4.05 inches
Length	13 feet

Threading and deburring of the pedestal pole shall be in accordance with the basic dimensions of the American National Standard Taper Pipe Threads, NPT(ANSI B2.1).

F) Flange Base. The threaded pedestal flange base shall be heavy-duty galvanized iron with a seven and one-quarter (7 1/4) inch bolt circle. Anchor bolts shall be provided with two (2) nuts and two (2) washers per bolt for double nut leveling of the pole.

728.02.02 – GROUNDING

On all school flasher assemblies, the AC neutral wire shall be bonded to the equipment grounding conductor.

728.04 – CONSTRUCTION METHODS

School flashers shall be located as shown on the Plans. However, the center of the flasher pole shall not be closer than five (5) feet from the face of curb or edge of the roadway shoulder.

The distance from the pole base to the top of the lower beacon shall be seven (7) feet. The distance from the pole base to the top of the upper flasher shall be thirteen (13) feet.

728.07 – BASIS OF PAYMENT

School flashers shall be measured by the unit, complete in place, wired and connected to the power supply as shown on the Plans and in accordance with these Specifications. Accepted school flashers will be paid for at the contract unit price for:

SCHOOL FLASHERS EA.

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

SECTION 729 – SIGNS

729.01 – GENERAL REQUIREMENTS

This section covers the minimum requirements for furnishing and erecting signs complete in place, 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 signs are 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. All signs shall be fabricated and installed in conformance with the latest edition of the MUTCD.

729.02 – MATERIALS

Materials used in the fabrication of signs shall meet the requirements of sections 730 and 731.

729.04 – CONSTRUCTION METHODS

Sign blanks shall be thoroughly cleaned prior to application of sheeting material in accordance with the manufacturers recommendations.

Signs shall be installed such that the sign face is vertical and at a horizontal angle of approximately 87 degrees toward the direction of travel or as shown on the Plans. Signs shall be installed so that the bottom of the sign is seven (7) feet above the roadway surface. Signs shall be placed five (5) feet behind curbed roadway sections or as shown on the Plans. Signs on roads with out curbs shall be placed six (6) feet from the edge of pavement on residential streets and eight (8) to fifteen (15) feet from the edge of pavement on other streets or as shown on the Plans. Signs shall be installed so as to minimize specular reflection. If it is found after inspection that specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor at his expense to eliminate or minimize this condition.

729.07 – BASIS OF PAYMENT

Signs shall be measured by the square foot of area of the vertical front face with no deduction for rounding off sign corners. Accepted signs will be paid for at the contract unit price for:

SHEET ALUMINUM SIGNS	S.F.
EXTRUDED ALUMINUM PANEL SIGNS	S.F.
MAST ARM MOUNTED SIGNS	S.F.

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

SECTION 730 – ALUMINUM SIGN BLANKS

730.01 – DESCRIPTION

This section covers the minimum requirements for aluminum sign blanks to be used for traffic control devices.

730.02 – MATERIALS

730.02.01 – GENERAL

All items bid under these specifications must be nationally advertised and must have been made available to the trade for not less than two (2) years.

All material furnished shall be guaranteed to be in accordance with the manufacturer's specifications and shall perform the function for which they were designed and manufactured. The Contractor shall obtain and assign to the City all manufacturer's warranties, guarantees, and/or exchange policies for defective items provided.

All sign blanks shall be free of buckles, warps, dents, cockles, burrs, or other defects.

All sign blanks shall be of stable flat sheet material, mill finished and furnished in domestic aluminum alloy 6061-T6, or 5052-H38, governed by A.S.T.M. specification B209-61, or latest revision thereof. Thickness, dimensions, hole sizes, and hole locations shall be shown on the Plans.

730.02.02 – METAL TREATMENT

All blanks shall be treated as follows:

A) Degreasing
   1) Vapor Degreasing - By total immersion of the sign blank in a saturated vapor, or trichloroethylene. Trademark printing shall be removed.
   2) Alkaline Degreasing - By total immersion of the sign blank in a tank containing alkaline solutions, controlled and titrated to the solution manufacturers specification. Rinse thoroughly with running water.

B) Etching
   1) Acid Etch - Etch well in 6-8% phosphoric acid solution at 100% F, or proprietary acid etching solution. Rinse thoroughly with running water.
   2) Alkaline Etch - Etch well in an alkaline etching material that is controlled by titration. Use time, temperature and concentration specified by the solution manufacturer. Rinse thoroughly and remove smut and rinse again.

C) Conversion Coating, or "Anodized" Finish
   1) Procedure - Treat with a light, tight amorphous type coating in accordance with the coating manufacturer's recommendations. Rinse thoroughly, then dry by use of forced hot air drier.

D) Contaminants

1) Condition - All metals shall be free of finger prints, grease, oils, or other contaminants.

A type A or type B certification is required for acceptance of aluminum sign materials.

SECTION 731 – REFLECTIVE SHEETING

731.01 – DESCRIPTION

This section covers the minimum requirements for sheeting used in the fabrication of sign faces. Types of sheeting shall be as described below. Reflective sheeting shall meet the requirements of Federal Specification FP-92 or its latest revision and the requirements further noted in this Specification.

All sheeting shall be type III unless otherwise specified on the Plans with the exception of sheeting used in construction traffic control. Sheeting used in construction traffic control shall be TYPE II-A.

731.02 – MATERIALS

The reflective sheeting used in the fabrication of reflectorized sign faces shall be of the types listed in Federal Publication FP-85 and are described below:

TYPE II - Type II is an enclosed lens type sheeting which consists of spherical lens elements embedded beneath the surface of a smooth, transparent, flexible plastic, resulting in a nonexposed lens, optical reflecting system.

TYPE II-A - Type II-A is the same system as Type II with the exception of a higher quantity and quality of lens elements being employed.

TYPE III - Type III is an encapsulated lens type sheeting which consists of spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, water proof, plastic having a smooth surface.

TYPE IV - Type IV is made of cubically shaped prismatic retroreflective elements integrally bonded to a transparent, flexible, smooth, tough, and weather resistant polymeric film.

A type A certification will be required for acceptance of sheeting material.

SECTION 732 – GALVANIZED STEEL SIGN POSTS

732.01 – DESCRIPTION

This section covers the minimum requirements for galvanized steel pipe sign posts. Sign posts shall be provided and constructed in accordance with these Specifications and in reasonably close conformity with the dimensions and locations shown on the plans or established by the Engineer.

732.02 – MATERIALS

Sign posts shall be made from new galvanized steel pipe conforming to the size and dimensions shown on the Plans and shall meet the requirements of ASTM A 53. All posts shall be standard weight schedule 40 steel pipe in twelve (12) foot lengths unless otherwise designated. Galvanizing shall be done after fabrication and punching and drilling of holes unless approved by the Engineer. Holes made after galvanizing shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

Sign posts shall be protected by a clear film, non-oil base chemical coating and shall provide conformity with the following requirements:

A) Meet ASTM Specifications D-522, B117, and D-1720.

B) Provide weathering resistance as follows: QUV weathering 50% gloss retention at 60% after 500 hours without loss of integrity or adhesion. Color shall be retained with a minimum of chalking.

C) Demonstrate a chemical resistance by having no effect on the coating when immersed in the following substances: Gasoline, motor oil, alcohol, 30 percent sodium hydroxide solution, 30 percent hydrochloric acid solution, 30 percent nitric acid solution, 30 percent sulfuric acid solution.

A type A certification will be required for acceptance of steel pipe sign posts.

732.04 – CONSTRUCTION METHODS

In the event it is necessary to cut a post in the field, the cut end shall be placed in the concrete foundation. Any part of the sign posts from which the galvanized and/or clear film protective coating is knocked, chipped or scratched off exposing bare metal during transit, installation or alteration shall be regalvanized, metalized or painted with an approved zinc dust-oxide paint and clear film coated.

732.07 – BASIS OF PAYMENT

Sign posts shall be measured by the linear foot for each size erected in place as shown on the Plans or as directed by the Engineer. Accepted sign posts will be paid for at the contract unit price for :

GALVANIZED STEEL SIGN POST L.F.

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

SECTION 733 – SQUARE STEEL SIGN POSTS

733.01 – DESCRIPTION

This section covers the minimum requirements for square steel sign posts. The sign posts shall be provided and constructed in accordance with these Specifications and in reasonably close conformity with the dimensions and locations shown on the Plans or established by the Engineer.

733.02 – MATERIALS

Square steel sign posts shall be made from hot-rolled strip steel (structural quality) and shall conform to ASTM Specification A446, Grade A.

The cross section of the post shall be square and formed into size required on the Plans. The finished posts shall be straight and have a smooth uniform finish. It shall be possible to telescope the post with each consecutive larger or smaller size of square tube, freely and for not less than ten feet of their length without the necessity of matching any particular face to any other face.

All holes and ends shall be free from burrs and shall be cut square. Hole diameter shall be 7/16 inch plus or minus 1/64 inch on one (1) inch centers, running on all four sides for the entire length of the post. Holes shall be on the center line of each side in true alignment and opposite to each other. Holes shall be pre-punched or quick punched.

All posts shall be weather protected by galvanizing conforming to ASTM Specification A525. Galvanizing shall be done after fabrication and punching of holes unless approved by the Engineer. Holes made after galvanizing shall be regalvanized, metalized, or painted with an approved zinc dust-oxide paint.

Square steel sign posts shall be protected by a clear film, non-oil base chemical coating and shall provide conformity with the following requirements:

A) Meet ASTM Specifications D-522, B117, and D-1720.

B) Provide weathering resistance as follows: QUV weathering 50% gloss retention at 60% after 500 hours without loss of integrity or adhesion. Color shall be retained with a minimum of chalking.

C) Demonstrate a chemical resistance by having no effect on the coating when immersed in the following substances: Gasoline, motor oil, alcohol, 30 percent sodium hydroxide solution, 30 percent hydrochloric acid solution, 30 percent nitric acid solution, 30 percent sulfuric acid solution.

A type A certification will be required for acceptance of square steel sign posts.

733.04 – CONSTRUCTION METHODS

Any parts of the square steel sign posts from which the galvanizing is knocked, chipped, or scratched off exposing bare metal in transit, installation, or alteration shall be regalvanized, metalized or painted with an approved zinc dust-oxide paint.

733.07 – BASIS OF PAYMENT

Square steel sign posts shall be measured by the linear foot for each size erected in place as shown on the Plans or as directed by the Engineer. Accepted sign posts will be paid for at the contract unit price for:

SQUARE STEEL SIGN POST L.F.

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

SECTION 734 – TRAFFIC STRIPE (PAINT)

734.01 – DESCRIPTION

This section covers the material and application requirements for placing white and yellow painted traffic stripes containing glass beads.

734.02 – MATERIALS

Painted traffic stripes shall be applied by the drop method and shall conform to these Specifications, The Uniform Manual on Traffic Control Devices for Streets and Highways, and be in reasonably close conformity with the locations, lines and dimensions shown on the Plans or established by the Engineer.

The white and yellow paint shall be formulated and manufactured from first-grade raw materials, and shall be free from defects and imperfections that might adversely affect the serviceability of the finished product. The paint shall be suitable for spray application and use as a reflecting traffic guide on concrete and bituminous roadway surfaces. Glass beads used to produce retroreflection shall conform to the requirements of SECTION 737 of these Specifications.

734.03 – EQUIPMENT

The paint machine shall be capable of applying an even clean-cut line without excessive drifting of paint and without dripping or stringing fine lines of paint on end sections. The paint machine shall have the automatic cutoff controls for the bead dispenser and the paint dispenser synchronized.

734.04 – CONSTRUCTION METHODS

The contractor shall be required to clean all dirt, grease, and other foreign materials off the road surface prior to application of traffic stripes to ensure maximum adhesion.

The paint shall be applied to the pavement surface at a wet film thickness of approximately 0.015 inch.

The glass beads shall be uniformly distributed over the wet paint at a reasonably accurate rate of six (6) pounds per gallon of paint, unless a different rate is specified by the Engineer. The glass beads shall be

dispensed immediately upon the completed line by means of an automatic bead dispenser working in synchronization with the paint dispenser.

The completed line shall be of a uniform cross section. The completed lines shall be of the dimensions and spacing as shown on the Plans or as specified by the Engineer.

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. Paint traffic stripe shall not be applied when the atmospheric temperature is at or below 40° F.

734.07 – BASIS OF PAYMENT

Traffic stripe (paint) shall be measured by the linear foot of four (4) inch wide traffic stripe placed or the equivalent four (4) inch stripe necessary when a wider or narrower stripe is specified of the Plans or approved by the Engineer. Accepted traffic stripe (paint) will be paid for at the contract unit price for :

TRAFFIC STRIPE (PAINT) L.F.

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

SECTION 735 – TRAFFIC STRIPE (THERMOPLASTIC)

735.01 – DESCRIPTION

This section covers the materials and application requirements for placing white and yellow reflectorized thermoplastic compound on roadway surfaces.

Thermoplastic traffic stripe shall be applied by extrusion die method and shall conform to these Specifications, The Uniform Manual on Traffic Control Devices for Streets and Highways, and be in reasonably close conformity with the locations, lines, and dimensions shown on the Plans or established by the Engineer.

735.02 – MATERIALS

The white and yellow thermoplastic traffic stripe shall be formulated and manufactured from first-grade raw materials, and shall be free from defects and imperfections that might adversely affect the serviceability of the finished product. The thermoplastic traffic stripe shall provide a durable, reflectorized, traffic guide on concrete and bituminous roadway surfaces. Glass beads used to produce retroreflection shall conform to SECTION 737 of these Specifications.

The hot applied thermoplastic compound shall meet the requirements of AASHTO M 249.

A type A certification will be required for acceptance of thermoplastic pavement marking materials.

735.03 – EQUIPMENT

The thermoplastic material shall be applied to the pavement surface by the extrusion die method where the pavement surface forms one side of the die. Extrusion of material above the pavement surface shall not be permitted.

All parts of the application equipment which mix, convey, or shape the thermoplastic material shall maintain the material at the plastic temperature, and assure the continuous uniformity in the dimensions of the stripe providing clean and sharp dimensions. The equipment shall be capable of applying a uniform film thickness between 3/32 inch and 3/16 inch.

The equipment shall apply the glass beads to the surface of the stripe at a rate of approximately one (1) pound per one hundred (100) feet of four (4) inch wide stripe. The beads shall be applied in such a manner that at least half the diameter of the larger gradations sizes are firmly embedded into the thermoplastic material.

735.04 – CONSTRUCTION METHODS

The contractor shall be required to clean all dirt, grease, curing compound, or other foreign materials from the pavement surface prior to application of thermoplastic materials.

On all asphalt surfaces in place over six (6) months and all Portland cement concrete surfaces of any age, a liquid seal coat shall be applied to the area that is to be striped. The seal coat shall be compatible with the thermoplastic material used and the pavement surface to which it is applied.

Thermoplastic shall not be applied over longitudinal joints unless approved by the Engineer.

Thermoplastic material shall be applied by the extrusion die method at a temperature between 400 and 450° F measured at the pavement surface and in accordance with manufacturer's recommendations. The application shall only take place on clean, dry pavement having a minimum surface temperature of 55° F. 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 traffic will leave no impression or imprint on the new stripe. The drying time shall be a maximum of two (2) minutes at 50° F and 70 percent relative humidity when applied at a thickness of 3/16 inch. The drying time shall be reduced to one (1) minute for these conditions when applied at a thickness of 3/32 inch.

Thermoplastic material used in accordance with these Specifications shall be compounded and applied such that the good reflectance, adhesion, durability, impact resistance, weather resistance, and discoloration resistance is retained for the life of the stripe.

735.07 – BASIS OF PAYMENT

Traffic stripe (thermoplastic) shall be measured by the linear foot of four (4) inch wide traffic stripe placed or the equivalent four (4) inch stripe necessary when a wider or narrower stripe is specified on the Plans or approved by the Engineer. Words, symbols, and arrows shall be measured by the unit. Accepted traffic stripe (thermoplastic) will be paid for at the contract unit price for:

TRAFFIC STRIPE (PLASTIC) (4 INCH WIDE)	L.F.
TRAFFIC STRIPE (PLASTIC) (ARROWS)(SINGLE)	EA.
TRAFFIC STRIPE (PLASTIC) (ARROW)(DOUBLE)	EA.
TRAFFIC STRIPE (PLASTIC) (WORDS)	EA.
TRAFFIC STRIPE (PLASTIC) (SYMBOLS)	EA.

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

SECTION 736 – TRAFFIC STRIPE (PLASTIC TAPE)

736.01 – DESCRIPTION

This section covers the material and application requirements for placing white and yellow preformed plastic traffic striping tape.

Preformed plastic traffic stripes shall conform to these Specifications, The Uniform Manual on Traffic Control Devices for Streets and Highways, and be in reasonably close conformity with the locations, lines and dimensions shown on the Plans or established by the Engineer.

736.02 – MATERIALS

The preformed plastic pavement marking material shall consist of white or yellow films with pigments, selected and blended to conform to standard highway colors through the expected life of the film. Glass beads shall be incorporated to provide immediate and continuing retroreflection. The material shall also conform to the items listed below.

A) Material: General purpose high durability retroreflective pliant polymer film for preformed longitudinal, transverse and words/symbol markings subjected to high traffic volumes and severe wear conditions such as repeated shear action from crossover or encroachment on edge and

channelization lines, and stop, start, or turn movements. The preformed plastic shall be capable of being adhered to asphalt concrete or Portland cement concrete by a precoated pressure sensitive adhesive.

B) Skid Resistance: The surface of the retroreflective pliant polymer film shall provide an initial minimum skid resistance value of 45 BPN when tested according to ASTM E 303.74.

C) Tensile Strength: The film shall have a minimum tensile strength of 150 pounds per square inch of cross-section when tested according to ASTM D 638-76 using a jaw speed of 10 to 12 inches per minute.

D) Elongation: A sample 6" x 1" shall be tested at a jaw speed of 10 to 12 inches per minute. The sample shall have a minimum elongation of 75% at break when tested by the method according to ASTM D 638-76.

E) Thickness: The film without adhesive shall have a minimum thickness of 60 mils.

F) Reflectance: The white and yellow films shall have the following initial minimum reflectance values at 0.2 degrees and 0.5 degrees observation angles and 86.0 degrees entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be used measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot-candle (mcd sf fc).

	White		Yellow	
Observation Angle (degrees)	0.2	0.5	0.2	0.5
SL (mcd sf fc)	550	380	410	250

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 six (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.

G) Glass Beads: Glass beads shall be uniformly distributed throughout the material and shall conform to SECTION 737 of these Specifications.

H) Reflectivity Retention: The following test shall be employed to measure reflectivity retention. Taber abrase simulation test. No more than 15% of the beads shall be lost due to popout and the predominate mode of failure shall be "wear down" of the beads.

I) Conformability and Re-Sealing: The performed marking shall be capable of being adhered to asphalt concrete or Portland cement concrete by a precoated pressure sensitive adhesive. The preformed marking film shall mold itself to pavement contours by the action of traffic. The film shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking material of the same composition.

J) Durability and Wear Resistance: The material, when properly applied, shall provide a neat, durable marking that will not flow or distort due to temperature provided the pavement surface remains stable. The material shall provide a cushioned resilient substrate that reduces bead crushing and loss. The material shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting, or shrinkage throughout the life of the markings, and shall show no significant tearing, roll back, or other signs of poor adhesion.

K) Pressure Sensitive Adhesive with a Removable Plastic Liner: The white or yellow sheeting shall be pre-coated on the reverse side with a pressure sensitive adhesive and be protected by an easily removable plastic liner to facilitate processing. The sheeting is intended for hand positioning of irregular shaped markings such as pre-cut symbols, arrows, and legends, etc.

A type A certification will be required for acceptance of plastic tape pavement marking materials.

736.04 – CONSTRUCTION METHODS

The contractor shall be required to clean all dirt, grease, curing compound, or other foreign materials from the pavement surface prior to application of preformed plastic pavement marking materials.

On all asphalt surfaces in place over six (6) months and all Portland cement concrete surfaces of any age, a liquid seal coat shall be applied to the area that is to be striped. The seal coat shall be compatible with the plastic pavement marking material used and the pavement surface to which it is applied.

Plastic pavement marking shall not be applied over longitudinal joints unless approved by the Engineer.

Preformed plastic pavement marking material shall be applied in accordance with the manufactures recommendations and procedures. Application shall be during weather conditions allowed by the manufacturer. However, the material shall not be applied when the surface temperature of the roadway is below 45° F and rising.

736.07 – BASIS OF PAYMENT

Traffic stripe (plastic tape) shall be measured by the linear foot of four (4) inch wide traffic stripe placed or the equivalent four (4) inch stripe necessary when a wider or narrower stripe is specified on the Plans or approved by the Engineer. Words, symbols, and arrows shall be measured by the unit. Accepted traffic stripe (plastic tape) will be paid for at the contract unit price for:

TRAFFIC STRIPE (PLASTIC TAPE) (4 INCH WIDE)	L.F.
TRAFFIC STRIPE (PLASTIC TAPE) (ARROW)(SINGLE)	EA.
TRAFFIC STRIPE (PLASTIC TAPE) (ARROWS)(DOUBLE)	EA.
TRAFFIC STRIPE (PLASTIC TAPE) (WORDS)	EA.
TRAFFIC STRIPE (PLASTIC TAPE) (SYMBOLS)	EA.

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

SECTION 737 – GLASS BEADS USED IN TRAFFIC PAVEMENT MARKING MATERIAL

737.01 – DESCRIPTION

This section covers transparent glass spheres (glass beads) applied to traffic paint, thermoplastic compound, and plastic pavement marking tape for the production of a reflective surface creating improved night visibility of the markings.

737.02 – MATERIALS

Glass beads used in traffic paint and thermoplastic compound shall be transparent, clean, colorless glass, smooth and spherically shaped, free from milkiness, pits, or excessive air bubbles. The glass beads shall conform to the requirements of AASHTO M 274, Type I unless specified differently below.

A) Gradation - The beads shall meet the gradation requirements for type as given in Table 737.03.01:

Table 737.03.01 Gradation of Glass Beads

Sieve Designation		
Standard (mm)	Alternate (Type 1 No.)	Mass Percent Passing
0.850	20	98-100
0.600	30	75-85
0.425	40	50-70
0.300	50	15-35
0.180	80	---
0.150	100	0-5

B) Shape - The glass beads shall have a minimum of 70% true spheres.

C) Crushing Resistance - The crushing resistance of beads retained on a No. 40 sieve (0.425 mm) shall be 30 pounds (133N) minimum.

C) Refractive Index - The glass beads shall have a minimum refractive index of 1.50.

D) Moisture Resistance - The glass beads shall be supplied with a moisture resistant coating.

A type A certification will be required for acceptance of glass beads.

SECTION 738 – PAVEMENT MARKERS

738.01 – REQUIREMENTS

Pavement markers shall meet the requirements of the Oklahoma Department of Transportation Standard Specifications for Highway Construction Sections 736 and 857, 1999 Edition or its latest revision.

Pavement markers shall be installed in the locations shown on the Plans.

738.07 – BASIS OF PAYMENT

Pavement markers shall be measured by the unit complete in place. Accepted pavement markers will be paid for at the contract unit price for:

PAVEMENT MARKERS, CLASS A TYPE 1	EA.
PAVEMENT MARKERS, CLASS A TYPE 2	EA.
PAVEMENT MARKERS, CLASS B (YELLOW)	EA.
PAVEMENT MARKERS, CLASS B (WHITE)	EA.
PAVEMENT MARKERS, CLASS C TYPE 1	EA.
PAVEMENT MARKERS, CLASS C TYPE 2	EA.

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

SECTION 790 – TRAFFIC CONSTRUCTION STANDARD BID ITEMS

790.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for construction. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
711	VEHICLE ACTUATED TRAFFIC SIGNAL CONTROLLER	EA.
712	SOLID STATE DIGITAL INDUCTIVE LOOP VEHICLE DETECTOR	EA.
713	(SIZE) GALVANIZED STEEL CONDUIT (INSTALLATION METHOD)	L.F.
713	(SIZE) RIGID PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
713	(SIZE) FLEXIBLE PLASTIC CONDUIT (INSTALLATION METHOD)	L.F.
713	(SIZE) CABLE-IN-DUCT	L.F.
714	(NO. OF CONDUCTORS) CONDUCTOR TRAFFIC SIGNAL ELECTRICAL CABLE	L.F.
714	TWO CONDUCTOR SHIELDED LOOP DETECTOR LEAD-IN CABLE	L.F.
714	LOOP DETECTOR WIRE(AWG NO.)(WIRE TYPE)	L.F.
714	(NO. OF CONDUCTORS)(AWG NO.) ELECTRICAL CONDUCTOR	L.F.
714	SIGNAL AND CONTROL CABLE	L.F.
715	ONE (1) SECTION TRAFFIC SIGNAL HEAD	EA.
715	THREE (3) SECTION TRAFFIC SIGNAL HEAD	EA.

715	FOUR (4) SECTION TRAFFIC SIGNAL HEAD	EA.
715	FIVE (5) SECTION TRAFFIC SIGNAL HEAD	EA.
716	THREE (3) SECTION OPTICALLY PROGRAMMED TRAFFIC SIGNAL HEAD	EA.
716	FOUR (4) SECTION OPTICALLY PROGRAMMED TRAFFIC SIGNAL HEAD	EA.
716	FIVE (5) SECTION OPTICALLY PROGRAMMED TRAFFIC SIGNAL HEAD	EA.
717	PEDESTRIAN SIGNAL HEAD	EA.
718	MODULAR PEDESTRIAN SIGNAL HEAD	EA.
722	PEDESTRIAN PUSH BUTTON AND SIGN	EA.
723	PEDESTRIAN PUSH BUTTON STATION	EA.
724	POLE AND SPECIFIED NO. OF MAST ARM(S)	EA.
724	POLE AND SPECIFIED NO. OF MAST ARM (S) AND LUMINAIRE ARM	EA.
724	PEDESTAL POLE WITH SPECIFIED MOUNTING HEIGHT	EA.
725	STRUCTURAL CONCRETE	C.Y.
725	REINFORCING STEEL	LBS.
726	PULL BOX TYPE I	EA.
726	PULL BOX TYPE II	EA.
727	ROADWAY LUMINAIRE (250 WATT HPS)	EA.
728	SCHOOL FLASHERS	EA.
729	SHEET ALUMINUM SIGNS	S.F.
729	EXTRUDED ALUMINUM PANEL SIGNS	S.F.
729	MAST ARM MOUNTED SIGNS	S.F.
732	GALVANIZED STEEL SIGN POST	L.F.
733	SQUARE STEEL SIGN POST	L.F.
734	TRAFFIC STRIPE (PAINT)	L.F.
735	TRAFFIC STRIPE (PLASTIC) (4 INCH WIDE)	L.F.
735	TRAFFIC STRIPE (PLASTIC) (ARROWS)(SINGLE)	EA.
735	TRAFFIC STRIPE (PLASTIC) (ARROW)(DOUBLE)	EA.
735	TRAFFIC STRIPE (PLASTIC) (WORDS)	EA.
735	TRAFFIC STRIPE (PLASTIC) (SYMBOLS)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (4 INCH WIDE)	L.F.
736	TRAFFIC STRIPE (PLASTIC TAPE) (ARROW)(SINGLE)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (ARROWS)(DOUBLE)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (WORDS)	EA.
736	TRAFFIC STRIPE (PLASTIC TAPE) (SYMBOLS)	EA.
738	PAVEMENT MARKERS, CLASS A TYPE 1	EA.
738	PAVEMENT MARKERS, CLASS A TYPE 2	EA.
738	PAVEMENT MARKERS, CLASS B (YELLOW)	EA.
738	PAVEMENT MARKERS, CLASS B (WHITE)	EA.
738	PAVEMENT MARKERS, CLASS C TYPE 1	EA.
738	PAVEMENT MARKERS, CLASS C TYPE 2	EA.

TABLE OF CONTENTS
SECTION 800

SECTION 800 – INCIDENTAL CONSTRUCTION

SECTION 801 – CONSTRUCTION STAKING (CONSTRUCTION SURVEY)

801.01 – DESCRIPTION

The Contractor is responsible for furnishing, placing and maintaining all construction stakes necessary for the proper prosecution and inspection of the Work.

801.04 – CONSTRUCTION METHODS

A) Prior to commencing Work, the City Engineer will furnish the Contractor permanent horizontal alignment and vertical control points throughout the Work and permanent benchmarks within two hundred feet (200') of the beginning and the end of the Work limits. The City Engineer will also provide bridge centerline horizontal and vertical control points if applicable to the project.

B) 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 of other structures and any other horizontal or vertical controls necessary to secure a correct layout of the work. The Contractor shall also perform all layout work and shall set stakes necessary for carrying out utility changes when such utility changes are required during the Work.

Stakes for line and grade shall be adequate to maintain the specified tolerances for the Work. The station number and distance from the centerline of construction shall be marked on all grade stakes. The City Engineer may at any time check for the correctness of the Contractor's staking by using a spot check method. When significant errors occur, the Contractor shall re-survey to the satisfaction of the City Engineer. Any inspection or checking of the Contractor's layout by the City Engineer and the acceptance of all or any part shall not relieve the Contractor of its responsibility for the Work.

When grading quantities are specified to be paid as plan quantity, the Contractor will be required to furnish original cross-sections. When the grading quantities are specified to be paid by field measurement, the Contractor shall furnish both original and final cross-section field notes.

The Contractor shall have the sole responsibility for the preservation of all horizontal alignment and vertical control stakes, benchmarks and construction stakes. The Contractor shall, at its own expense, replace any horizontal alignment, vertical control, construction stakes and benchmarks when damaged, lost, displaced or removed.

The Contractor shall furnish the original copy of all survey records to the City Engineer for calculation of quantities and permanent file. These records shall be furnished as they are completed during the Work. The records shall be permanently bound in field books and formatted in a manner commonly accepted by the surveying profession.

C) As-Built Survey – The Contractor shall perform an as-built survey. This survey shall be turned over to the Engineer of Record. This survey shall be used for final as-built record drawings and calculations of final quantities.

801.06 – METHOD OF MEASUREMENT

Measurement for all construction stakes will be made on a lump sum basis.

All construction staking Work performed shall be paid for at the Contract lump sum Bid price. The Bid price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals

necessary to complete the Work. Payments will be made on the following schedule:

A) up to 25% - First monthly claim for compensation
B) up to 50% - When 10% of the Work is complete
C) up to 75% - When 50% of the Work is complete
D) up to 95% - When 75% of the Work is complete
E) up to 100% - When 100% of the Work is complete

Payment for unauthorized Work will not be made.

801.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONSTRUCTION STAKING (CONSTRUCTION SURVEY) L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 802 – CONSTRUCTION SIGNING AND TRAFFIC CONTROL

802.01 – GENERAL

All signs, barricades, warning lights, and other traffic control devices used for construction traffic control shall meet the requirements of the latest edition of the Manual on Uniform Traffic Control Devices For Streets and Highways as pertains to shape, size, color, mounting height, and placement. All sign sheeting materials shall meet or exceed the requirements of SECTION 700.

802.04 – CONSTRUCTION METHODS

If not included in the Plans, the Contractor shall submit a Traffic Control Plan to the Traffic Management Division prior to the start of construction. The Traffic Control Plan shall include types and locations of all traffic control devices to be used for the construction zone, and detour plans when applicable. If construction involves more than one phase requiring relocation of traffic control devices, traffic control plans shall be submitted for each phase. Field adjustment of the Traffic Control Plan shall be permitted with approval of the Engineer.

802.06 – METHOD OF MEASUREMENT

All signs, barricades, warning lights, and other traffic control devices used for construction traffic control shall be measured as a lump sum. Accepted signs, barricades, warning lights, and other traffic control devices used for construction traffic control will be paid for at the contract price. Which shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified.

802.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONSTRUCTION SIGNING AND TRAFFIC CONTROL L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 809 - MOBILIZATION

809.01 - DESCRIPTON

This work shall consist of construction preparatory operations, including the movement of personnel and equipment to the project site and for the establishment of the Contractor’s offices, buildings, and

other facilities necessary to begin work on a substantial phase of the Contractor.

809.02 – METHOD OF MEASUREMENT

Measurement for mobilization will be made on a lump sum basis.

809.03 - BASIS OF PAYMENT

Mobilization, measured as provided above, will be paid for at the contract price as follows:

Mobilization	LUMP SUM

Such payment shall be full compensation for performing the work specified and the furnishing of all materials, labor, tools, equipment, and incidentals necessary to mobilize and subsequently demobilize the construction preparatory operations.

Payment for this item will be made in one installment on the first estimate following completion of substantial mobilization.

The lump sum price paid for mobilization shall not exceed five percent (5%) of the total contract amount.

In the event the lump sum bid for mobilization exceeds the amount stated herein, the difference (remainder) will not be paid.

SECTION 810 – CLEARING AND GRUBBING

810.01 – DESCRIPTION

This section covers the removal and disposal of trees, stumps, brush, roots, vegetation, logs, rubbish, and other objectionable matter from the designated area, except such objects as are designated to remain or to be removed in accordance with other sections of these specifications.

810.04 – CONSTRUCTION METHODS

The entire right-of-way shall be cleared of all trees, brush, logs, rubbish, except such trees and shrubs as may be designated by the Engineer for preservation. Trees and shrubs designated to be left in place shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations. The limbs shall be treated by painting the exposed ends with an approved asphaltic material. Areas required for embankment construction; for roadway, and structural excavations; and for borrow sites and material sources shall be cleared and grubbed. On areas required for roadway, channel, or structural excavation, all stumps, roots, etc., (except for designated trees and shrubs) shall be removed to a depth of at least two (2) feet below the lower elevation of the excavation. On areas required for embankment construction, all stumps, roots, etc., (except for designated trees and shrubs) shall be removed to a depth of at least two (2) feet below the existing ground surface. All holes remaining after clearing and grubbing shall be backfilled and tamped as directed by the Engineer and the entire area bladed to prevent ponding of water and to provide drainage; except in areas to be immediately excavated the Engineer may direct that the holes not be backfilled. When permitted by the plans, trees and stumps may be cut off as close to natural ground as practicable on areas which are to be covered by at least three feet (3') of embankment. Areas required for borrow sites and material sources, stumps, roots, etc., (except for designated trees and shrubs) shall be removed to the complete extent necessary to prevent objectionable matter to become mixed with the material to be used in construction.

All cleared and grubbed material shall be disposed of in a matter satisfactory to the Engineer.

810.06 – METHOD OF MEASUREMENT

Unless the plans and contract include the items of clearing and grubbing and provide for payment

therefore, the work prescribed under this item shall not be paid for directly but shall be considered subsidiary work pertaining to Unclassified Excavation; except that grubbing and clearing of trees six inches (6”) or greater in diameter, measured forty-eight inches (48”) above the natural ground level.

If the plans and contract include the item of clearing and grubbing and provide for payment therefore, this work shall be measured by the acre at the locations designated on the plans or directed by the Engineer. Measurement of large trees for payment shall be as defined above.

The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price bid per acre for "Clearing and Grubbing" if so designated on the plans and in the contract, and per each for "Tree Removal", which prices shall be full compensation for furnishing all labor, materials, equipment, tools, and incidentals necessary to complete the work.

810.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CLEARING AND GRUBBING L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 811 – REMOVAL OF EXISTING STRUCTURES

811.01 – DESCRIPTION

This section covers the removal and disposal of old structures or portions of old structures as noted on the plans and will include all excavation and backfilling necessary to complete the removal. The work shall be done in accordance with the provisions of these specifications.

811.04 – CONSTRUCTION METHODS

A) Culverts or Storm Sewers - Pipe shall be removed by careful excavation of all dirt on top and sides in such manner that the pipe will not be damaged. Those pipes which are deemed unsatisfactory for reuse by the Engineer may be removed in any manner the Contractor may select.

B) Concrete Structures - Concrete structures or concrete portions of structures may be removed by blasting, if approved by the Engineer.

Concrete portions of structures below the permanent groundline, which will not interfere in any manner with the proposed construction, may be left in place but removal shall be carried at least two (2) feet below the permanent groundline and neatly squared off. Reinforcement shall be cut off close to the concrete. The bottom of such structures shall be perforated or broken to prevent the entrapment of water.

C) Steel Structures - Steel structures or steel portions of structures shall be dismantled in sections as determined by the Engineer. The sections shall be of such weight and dimensions as will permit convenient handling, hauling, and storing. Rivets and bolts connecting steel railing members, steel beams or beam spans and steel stringers of truss spans shall be removed by cutting the heads with a "cold cut" and punching or drilling from the hole, or by such other method as will not injure the members for reuse and will meet the approval of the Engineer. The removal of rivets and bolts from connections of truss members, bracing members, and other similar members in the structure will not be required unless specifically called for on the plans or special provisions and the Contractor shall have the option of dismantling these members by flame cutting the members immediately adjacent to the connections. Flame cutting will not be permitted, however, when plans or special provisions call for the structure unit to be salvaged in such manner as to permit reerection. In such case, all members shall be carefully matchmarked with paint in accordance with diagram furnished by the Engineer prior to dismantling, and all rivets and bolts shall be removed from the connections

in the manner specified in the first portion of this paragraph.

D) Timber Structures - Timber structures or timber portions of structures shall be removed in such a manner that the damage to the timber will be minimum. All bolts and nails shall be removed from such lumber as deemed salvable by the Engineer.

   Unless specified otherwise on the plans, timber piles shall be either pulled or cut off at a point not less than two (2) feet below groundline, with the choice between these two methods resting with the Contractor.

E) Brick or Stone Structures - Brick or stone structures or stone portions of structures shall be removed by blasting, if approved by the Engineer, and/or sledging the masonry into sizes not larger than one (1) cubic foot.

   Portions of such structures below the permanent groundline which will not in any manner interfere with the proposed construction may be left in place, but removal shall be carried at least two (2) feet below the permanent groundline and neatly squared off.

811.02.01 – SALVAGE

All materials such as pipe, timbers, railings, etc., which the Engineer deems as salvable for reuse, and all structural steel shall be carefully placed in neat piles along the right-of-way at convenient loading points which will not interfere with traffic or construction. All of these materials shall be the property of the City.

The I-beams, stringers, etc., which are specified to be dismantled without damage for reuse, and all steel members when matchmarked and dismantled for reuse, shall be blocked off the ground in an upright position to protect the members against further damage.

Materials which are not deemed salvable by the Engineer shall become the property of the Contractor and shall be removed to suitable disposal sites off of the right-of-way and disposed of by the Contractor in a manner satisfactory to the Engineer.

Where temporary structures are necessary for a detour adjacent to the present structure, the Contractor will be permitted to use the material in the old structure for the detour structure, but he shall dismantle and stack or dispose of the material as required above as soon as the new structure is opened for traffic.

811.02.02 – BACKFILL

All excavation made in connection with this item and all openings below the natural groundline caused by the removal of old structures or portions thereof shall be backfilled to the level of the original groundline, unless provided otherwise on the plans.

The portion of the backfill which will support any portion of the roadbed or embankment shall be placed in layers of the same depth as those required for placing embankment. Material in each layer shall be wetted uniformly if required and shall be compacted to the density required in the adjoining embankment. In places inaccessible to blading and rolling equipment, mechanical or hand tamps, or rammers shall be used to obtain the required compaction.

That portion of the backfill which will not support any portion of the roadbed or embankment shall be placed as directed by the Engineer in such manner and to such state of compaction as will preclude objectionable amounts of settlement.

811.06 – METHOD OF MEASUREMENT

The work as provided for by this section shall be measured as each individual structure to be removed, except that storm sewers may be measured as each structure or may be measured by the linear foot. When measured by either method, removal shall include all appurtenances thereto.

The work as prescribed for in this section shall be paid for at the unit price bid each for the various types of structures as shown on the proposal or per linear foot when pipe is to be removed. This price shall be full compensation for all work, labor, tools, equipment, excavation, backfilling, materials, and incidentals necessary to complete the work.

811.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

STRUCTURE REMOVAL (TYPE) L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 812 – REMOVAL OF PAVING, SIDEWALKS, DRIVEWAYS, CURBS, ETC.

812.01 – DESCRIPTION

This section covers the removal of existing paving, sidewalks, driveways, curbs, or items of similar nature, composed of concrete, asphalt, brick, or any other material, and the disposal of same all in accordance with these specifications and as shown on the plans or as directed by the Engineer. For purpose of classification, all gutters, whether combined or separate from curb, shall be considered as paving.

812.04 – CONSTRUCTION METHODS

A) General - In removal of any paving, sidewalks, driveways, curbs, gutters, etc., care shall be taken to leave a straight, smooth edge, perpendicular to the surface of the portion left in place at the location given by the Engineer. Any breakage outside the lines given by the Engineer shall be replaced by the Contractor at his expense.

B) Disposal of Materials Removed - All materials designated by the Engineer as salvageable, including broken concrete bricks, manhole frames and grates, catch basin frames and grates, and all sewer and culvert pipe, shall be hauled and stored as directed by the Engineer. Gravel surfacing shall, as nearly as practicable, be removed separately from dirt or other materials, and where desired for use on other streets or alleys, shall be disposed of at sites designated by the Engineer.

812.06 – METHOD OF MEASUREMENT

The various items of this section when classified for payment as contract pay items, will be measured by the unit designated on the plans or as set out in the proposal.

The various items of this section when classified for payment will be measured as provided above and will be paid for at the contract unit price for:

A) Existing paving removed;
B) Existing asphalt wearing surface removed, variable thickness;
C) Concrete sidewalk removed;
D) Existing driveway removed;
E) Existing concrete or limestone curb removed;

as the case may be and such payment shall be full compensation for all materials, equipment, tools, labor and incidentals necessary for completing the removal and disposal of the item specified.

812.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE PAVEMENT (TYPE) (THICKNESS)	S.Y.
REMOVE SIDEWALK (WIDTH)	S.Y.
REMOVE CURB AND GUTTER	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 813 – REMOVE (AND REPLACE) DRIVEWAY

813.01 – DESCRIPTION

This section covers the reconstruction of driveways where called for on the plans.

813.04 – CONSTRUCTION METHODS

Unless otherwise specified this work shall include:

A) Concrete driveways - all construction shall be in accordance with the "Standard Details for Driveways". Driveways shall be constructed joint to joint unless otherwise called for.

B) Asphalt driveways - all construction shall be three inches (3”) of Type "A" mix laid on six inches (6”) of prepared subgrade as a minimum otherwise match existing.

C) Gravel driveways - all construction shall be four inches (4”) of crushed stone laid on six inches (6”) of prepared subgrade.

Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Crushed stone shall meet the gradation requirements Section 215.02 and ASTM C-33, No. 67, and be compacted in accordance with Section 212.04.04 B).

813.06 – METHOD OF MEASURMENT

Payment for "Removing and Replacing Driveway" shall be made at the unit price bid per square yard for each driveway type. The prices established shall be full compensation for the removal and replacement of driveways and per Section 813.04 where applicable, including saw cut, support of adjacent slabs, materials, labor, tools, equipment and all incidentals necessary to complete this item of work.

813.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE DRIVEWAY	S.Y.
REMOVE AND REPLACE DRIVEWAY	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 814 – PAVEMENT CUT AND PERMANENT REPAIR

814.01 – DESCRIPTION

This section covers the construction of a reinforced concrete slab over trench in paved areas, or where called for on the plans.

814.04 – CONSTRUCTION METHODS

All construction shall be in accordance with the "Standard Detail for Paving Cut and Permanent Repair". Where concrete repair is specified, the repair shall be from joint to joint.

814.06 – METHOD OF MEASUREMENT

Payment for "Paving Cut and Permanent Repair" shall be made at the unit price bid per square yard for each pavement type. The price established shall be full compensation for saw cut, removal of existing pavement, sand backfill, reinforced concrete slab, tools, labor, equipment, and incidentals necessary to complete this item of work. Curb and gutter shall be paid for separately.

814.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PAVEMENT CUT AND PERMENANT REPAIR (TYPE)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 815 – REMOVE (AND REPLACE) ALLEY PAVING

815.01 – DESCRIPTION

This section covers removing and replacing of alleys, and miscellaneous paved areas in which the item "Paving Cut and Permanent Repair" is not applicable.

815.04 – CONSTRUCTION METHODS

A) Concrete Alley - The affected area of concrete alley shall be replaced in accordance with the "Standard Details for Concrete Alley Paving". Alleys shall be constructed joint to joint unless otherwise called for.

B) Asphalt Alley - The affected area of Asphalt Alley shall be replaced with a minimum pavement section consisting of three inches (3”) of Type "A" Mix over six inches (6”) of prepared (compacted) subgrade.

C) Gravel Alley - The affected area of gravel alley shall be replaced with a minimum pavement section consisting of four inches (4”) of crushed stone over six inches (6”) of prepared (compacted) subgrade.

Each layer of the replacement section shall be equal to the existing section layer and not be less than the minimum section described above. Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Crushed stone shall meet the gradation requirements Section 215.02 and ASTM C-33, No. 67, and be compacted in accordance with Section 212.04.04 B).

815.06 – METHOD OF MEASUREMENT

Payment for "Removing and Replacing Alley Paving" shall be made at the unit price bid per square yard for each alley paving type. The price established shall be full compensation for removal and replacement of pavement, including excavation and backfill, compaction, and support of adjacent slab.

815.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE ALLEY PAVING (TYPE)	S.Y.
REMOVE AND REPLACE ALLEY PAVING (TYPE)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 816 – REMOVE (AND REPLACE) SIDEWALK PAVEMENT

816.01 – DESCRIPTION

This section covers removing and replacing sidewalks.

816.04 – CONSTRUCTION METHODS

The affected concrete sidewalks shall be replaced in accordance with the "Standard Details for Sidewalk Pavement". The removal and replacement of sidewalks shall be from joint to joint unless otherwise designated on the plans.

816.06 – METHOD OF MEASUREMENT

Payment for "Replacing Sidewalk Pavement" shall be made at the unit price bid per square yard. The price established shall be full compensation for replacement of sidewalk, excavation, backfill, compaction, support of adjacent slab, tools, labor, equipment, materials and incidentals necessary to complete this item of work.

816.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE SIDEWALK (WIDTH)	S.Y.
REMOVE AND REPLACE SIDEWALK (WIDTH)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 817 – REMOVE AND REPLACE PARKING LOT PAVING

817.01 – DESCRIPTION

This section covers removing and replacing of existing concrete, asphalt, and gravel parking lots.

817.04 – CONSTRUCTION METHODS

A) Concrete Parking Lots - The affected area of concrete parking lot shall be replaced with a minimum pavement section consisting of six inches (6”) of concrete pavement, over four inches (4”) of crushed stone base over six inches (6”) of prepared (compacted) subgrade. Removal and replacement of concrete parking lot pavement shall be from joint to joint unless otherwise designated on the plans.

B) Asphalt Parking Lots - The affected area of asphalt parking lot shall be replaced with a minimum pavement section consisting of one and one-fourth inches (1 ¼ “) of surface course Type "B" Mix and two and three-fourths inches (2 ¾”) of Type "A" Mix with four inches (4”) of crushed stone base over six inches (6”) of prepared (compacted) subgrade.

C) Gravel Parking Lots - The affected area of gravel parking lot shall be replaced with a minimum pavement section consisting of four inches (4”) of crushed stone over six inches (6”) of prepared (compacted) subgrade.

Each layer of the replacement section shall be equal to the existing parking lot pavement section layer and not be less than the minimum sections described above. Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Subgrade shall be prepared and compacted to a minimum of 95% Standard Proctor Test (ASTM D-698). Crushed stone shall meet the gradation requirements Section 215.02 and ASTM C-33, No. 67, and be compacted in accordance with Section 212.04.04 B).

817.06 – METHOD OF MEASUREMENT

Payment for "Removing and Replacing Parking Lot Paving" shall be made at the unit price bid per square yard for each pavement type. The price established shall be full compensation for complete repair and replacement of the parking lot, including the removal and proper disposal of spoil and the support of adjacent slabs.

Concrete parking lot paving shall also include curb and gutter if applicable. For other types, curb and

gutter shall be paid for separately.

817.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVE AND REPLACE PARKING LOT PAVEMENT (TYPE) S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 818 – INCIDENTAL PAVING REPAIR AND REPLACEMENT

818.01 – DESCRIPTION

This section covers the construction of edges or portions of pavement adjacent to new work; the repair and replacement of paving cuts required for sewer or other ditch construction including the construction of edges or portions for adjacent pavement; the repair and replacement of base failures in pavement including the reconstruction of edges of adjacent slab using Portland Cement Concrete; the repair and replacement of base failures in pavement including the reconstruction of edges of adjacent pavement using asphalt concrete; and preparation of pavement for resurfacing.

818.02 – MATERIALS

All materials shall conform to the requirements of Section 900 - Materials for the type or class of materials involved.

818.04 – CONSTRUCTION METHODS

A) Reconstruction of Edges of existing pavement adjacent to new Portland Cement Concrete paving construction shall be accomplished as follows:

Upon completion of the excavation or slab removal required by the new construction, the subgrade under the edge of the existing slab shall be undercut for a distance and depth as shown on the plans and the resulting void poured as a unit with the new slab. The edges of the new slab shall be vibrated sufficiently to insure flow of concrete into that undercut area.

B) Repair and Replacement of Paving Cut required for sewer or other ditch construction shall be accomplished as follows:

After backfilling operations are complete, the subgrade under the slab edges adjacent to the trench shall be undercut for a distance and depth as shown on the plans. Where reinforcement is required it shall conform to Section 941 of these specifications and be placed as shown on the plans. The cut shall then be filled with concrete to the depth indicated on the plans. The concrete shall conform to Section 932 of these specifications. The edges of the replacement slab shall be vibrated to insure flow of concrete into the undercut area.

C) Repair and Replacement of Base Failures in Pavement by the use of Portland Concrete shall be accomplished by removing the slab over and around the area of the failure as directed by the Engineer, or indicated by the plans.

When soft or spongy foundation material is encountered it shall be removed to a depth indicated by the Engineer and replaced with a soil having AASHTO Classification of A-2 or better. The backfill material shall be moistened and compacted in lifts not to exceed six inches (6”) to a density of ninety-five percent (95%) Standard Proctor.

When, in the opinion of the Engineer, the subgrade repair is of sufficient area to justify the use of a roller the subgrade shall be rolled with an approved power roller or sufficient weight and design to achieve the required density.

D) Repair and Replacement of Base Failures in Existing Pavement by use of Asphalt Concrete shall be accomplished in those areas as directed by the Engineer and as indicated on the plans.

The area to be patched shall be removed to a depth of the thickness of pavement currently existing except that the minimum depth for residential streets shall be six inches (6") and the minimum for all other streets shall be eight inches (8").

If soft and spongy material is encountered below the depth of patch such material shall be removed as directed by the Engineer. The material below the depth of the patch will be replaced with soil having an AASHTO Classification of A-2 or better (it shall be the option of the Contractor that the additional backfill material may be Hot Sand Asphalt meeting the requirements of these specifications).

When, in the opinion of the Engineer, the subgrade repair is of sufficient area to justify the use of a roller the subgrade shall be rolled with an approved power roller of sufficient weight and design to achieve the required density.

The area which is removed shall be in straight lines, either parallel or perpendicular, to the centerline of the road. The face of all sides of the patch shall be vertical.

The material to be used for patching shall be that material which is specified for the surface course mix used on the project.

E) Existing Pavement shall be prepared for resurfacing as follows:

The surface of the pavement shall be thoroughly cleaned of all dirt, dust or other loose, or inert materials by sweeping with approved brooms and flushing with water, using an approved hose and nozzle prior to resurfacing. The hose shall be of sufficient length to reach to entire width and length of the area to be cleaned. The cleaning shall be continued until the surface is in a condition satisfactory to the Engineer. Care shall be taken and the necessary arrangements made to prevent the water used in flushing the pavement from coming in contact with or interfering with any new work already in place or being placed. Where the existing paving is of two course construction and the surface course is removed, the area from which the surface course was removed shall be thoroughly cleaned of all particles of old surface course and, if directed by the Engineer, the area shall be flushed and broomed prior to resurfacing as indicated above.

818.06 – METHOD OF MEASUREMENT

A) Reconstruction - There will be no measurement of reconstruction of edges or portions of pavement adjacent to new work as such. Reconstruction of edges of existing paving adjacent to new paving construction will not be paid for as such, but the cost of reconstructing the edges of the existing pavement shall be included in the price bid for "Thickened Edge for Concrete Paving", including support for existing paving. The price bid per linear foot for thickened edge for concrete paving including support for existing paving in place shall be payment in full for all excavation, labor, material and equipment and performing all work required for the construction of the thickened edge and support for existing paving.

B) Repair and Replacement of Paving Cuts for sewer ditch or other ditch construction including the construction of edges or adjacent slab will be measured by the square yard. There will be no measurement of excavation or fine grading. Repair and Replacement of Paving Cuts required for sewer or ditch construction will be paid for by the unit price bid per square yard. Such compensation shall be payment in full for all labor, material, equipment, and excavation required to complete the repair and replacement of paving cuts for sewer or other ditch construction including support of adjacent slab.

C) Repair and Replacement of Base Failures in Portland Concrete pavement including the reconstruction of edges of adjacent slab will be measured by the square yard. Repair and Replacement of Base Failures in Portland Concrete pavement including the reconstruction of edges

of adjacent slab, will be paid for by the square yard and shall include the following items:

1) Existing paving removed;
2) Removal and disposal of unsatisfactory subgrade material;
3) Soil for replacing unsatisfactory subgrade materials;
4) Fine grading;
5) High Early Strength Portland Cement Concrete for base repair.

Such compensation as outlined above shall be payment in full for furnishing all materials, equipment, labor, excavation, and incidental items necessary to complete in accordance with the plans and specifications.

D) Repair and Replacement of Base Failure using Asphalt Concrete shall be measured by the square yard. Repair and Replacement of Base Failures using Asphalt Concrete, including the reconstruction of edges of adjacent slab, will be paid for at the unit price bid for "Base Repair" and shall include the following items:

1) Removal of existing flexible pavement;
2) Necessary earth excavation, if any, to obtain eight inch (8”) depth from the surface of the existing pavement;
3) Pavement shall be replaced as shown on Typical Sections. All asphalt concrete used in this repair shall conform to the job formula for Type "M" Asphalt Concrete;
4) Hot Sand Asphalt.

Existing paving removed will be paid for at the price bid per square yard as provided in these specifications. Removal and disposal of unsatisfactory subgrade material will be paid for at the price bid per cubic yard for this item. A-2 soil for replacing unsatisfactory subgrade material will be paid for at the price bid per cubic yard for this material in place, compacted and accepted.

Such compensation as outlined above shall be payment in full for furnishing all materials, equipment, labor, excavation, and incidental items necessary to complete in accordance with the plans and specifications the repair and replacement of base failures in pavement, including the reconstruction of edges of adjacent slab.

818.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

BASE REPAIR (PAVEMENT TYPE) S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 819 – ADJUSTMENT OF EXISTING STRUCTURES

819.01 – DESCRIPTION

This section will cover the necessary adjustment, alteration 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.

819.04 – CONSTRUCTION METHODS

General - The materials and workmanship necessary in raising, lowering and otherwise adjusting or resetting existing structures shall conform to the requirements of the City's standard specifications for the class of work involved, unless otherwise provided for in these specifications. Whole bricks,

salvaged in good condition from structures, may be used in rebuilding such structures provided the bricks are cleaned to the satisfaction of the Engineer. Existing structures shall be rebuilt accurately to correct grade and alignment and such work shall be completed in advance of the construction of new work abutting when required by the Engineer.

A) Waterlines, Valves, Meters, Fire Hydrants, etc. - The Contractor shall make complete arrangements with the City's Water Department for lowering or relocating of all waterlines and resetting of water valves and meters, and fire hydrants. Where the Contractor is to perform the actual work such work shall conform strictly to the requirements of the City's Water Department.

B) Electric Traffic Signals - The Contractor shall make proper arrangements with the City for the moving and resetting of any electric traffic signals, conduits, cables, etc. Where the Contractor is to perform the actual work, such work shall conform strictly to the requirements of the City.

C) Manholes and Inlets

1) Materials - Manholes or inlet rings, plates, grates and covers, and brick in good condition, removed from the manholes and inlets in the process of adjustment may be reused. All additional materials necessary for the completion of work (adjustment of existing structures) shall be included in price bid.

2) General - Utility manhole frames within the area to be paved or graded will be set by the City to finished surface grade at no cost to the Contractor. Sewer and storm drain manhole frames within the area to be paved or graded shall be set to finished grade by the Contractor.

Manholes or inlet rings, covers, plates, and grates shall be removed carefully and the contact areas shall be cleaned of all mortar and grease. Rings, covers, plates, or grates broken in the process of removal and cleaning shall be replaced in kind by the Contractor at his expense.

Where the tops of 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 four inches (4”) per foot.

Where manholes are to be built up a distance of one foot (1’) 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 (1’), 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 three feet (3’) six inches (6”). The manhole shall then be rebuilt in conformity with the size and shape of requirements for new manholes.

3) Manholes in HMAC Pavement - Except as otherwise authorized by the Engineer, manhole frames within the pavement area shall not be set to final grade until the pavement has been completed. The manhole frames and covers shall be removed and the manhole structure covered with a steel plate unless the existing cover is sufficiently below grade so as not to form an obstruction during the construction of the subgrade or base and the spreading and rolling of the asphalt concrete. The manhole openings shall be temporarily covered by suitable means. After the pavement has been completed, the necessary portions of the subgrade, base, and pavement shall be neatly cut away, the manhole built up, and the frames set to a grade flush with the surface of the adjacent pavement. The surrounding area from which the pavement, base or subgrade has been removed shall be backfilled to within two inches (2”) of the surface with PC Concrete. The remaining two inches (2”) shall be backfilled with asphalt concrete wearing surface and compacted. The work shall be so performed as to present a neat and thoroughly workmanlike appearance upon completion.

4) Manholes in Concrete Pavement - Existing manhole castings and covers shall be adjusted to the grade of the new pavement at least three (3) days before placement of the new pavement, using brick, mortar, and/or concrete for raising or lowering the manhole.

5) Inlets - Inlets which are to be adjusted shall be adjusted to the grade shown on the plans. All additional materials necessary for the completion of work (adjustment of existing structures) shall be included in price bid.

D) Parking Meters - Where parking meters are to be moved in areas where the sidewalk is to be removed, the concrete shall be carefully removed from around the base of the meter post and the parking meter then transported by the Contractor to a storage point designated by the Engineer.

Where parking meters are to be moved in areas where the existing sidewalk is to be left in place, the parking meter post shall be cut at a distance above the sidewalk to be designated by the Engineer and the meter then transported to a storage point to be designated by the Engineer. All parking meters will be reinstalled by the City and the cost of such installation will not be included in the contract.

819.06 – METHOD OF MEASUREMENT

Where payment is to be made on the unit price basis, vertical measurements of structures raised or lowered to grade will include only the actual net distance the structure is raised or lowered and will not include sections of wall removed and rebuilt. There will be no measurement of basement repair as such, however, the concrete used in the repair will be measured in cubic yards and the steel in pounds. Where adjustment of manholes exceeds one foot (1'), or manholes are to be offset, measurement will be made by L.F. for sections of wall removed and rebuilt.

Payment will be made at the contract price, or the unit price, or lump sum price basis, as the case may be, for the adjustment of the particular class of structure involved, other than repair of basements. Basement repair will not be paid for as such but the cost of the repair will be included in the price bid per cubic yard for "Formed Reinforced Concrete in Special Structures", and the price bid per pound for "Reinforcing Steel" used in the repair. Such price or prices shall be compensation in full for all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and these specifications.

819.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

ADJUST EXISTING STRUCTURE (TYPE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 820 – MACHINE SAW CUT

820.01 – DESCRIPTION

This section will cover the sawing of bituminous or concrete pavement, curb, gutter, sidewalk or driveways.

820.03 – EQUIPMENT

The saw shall be power driven, shall be manufactured especially for the purpose of sawing concrete, shall be suitable for the work to be performed, and shall be maintained in good operating condition.

Saw blades shall make a clean, smooth cut, producing a groove one-eighth inch (1/8") to one-fourth inch (1/4 ") wide and to the full depth required by these specifications or as shown on the plans.

The saw, with its control devices, shall be mounted on a sturdy frame supported on rubber tired wheels or portable handheld saws which can meet the requirements of this section.

820.04 – CONSTRUCTION METHODS

A) General - Sawing shall be in accordance with the requirements of this item unless shown otherwise on the plans or in the special provisions.

B) Removing Pavement, Curb, Gutter, Sidewalk and/or Driveways - Pavement and appurtenances shall be removed to neatly sawed edges. Saw cuts shall be made to a minimum depth of one and one-half inches (1/2”). The edges of pavement and appurtenances which are damaged subsequent to sawing shall again be saw cut to neat straight lines for the purpose of removing the damaged areas. Such saw cuts shall be either parallel to the original saw cuts or shall be cut on an angle which departs from the original saw cut not more than one inch (1”) in each six inches (6”).

   Concrete sidewalk or driveway to be removed shall be neatly sawed in straight lines either parallel to the curb or at right angles to the alignment of the sidewalk. No section to be replaced shall be smaller than thirty inches (30”) in either length or width unless otherwise approved by the Engineer.

   Curb and gutter shall be sawed on a neat line at right angles to the curb face.

C) Weakened Plane Joints (Contraction Joints) - Weakened plane joints shall be saw cut at the locations shown on the plans or as directed by the Engineer. The groove shall be cut to a minimum depth of one and one-half inches (1 ½”). Any portion of the membrane curing compound which has been disturbed by sawing operations shall be restored by spraying the areas with additional membrane curing compound.

820.06 – METHOD OF MEASUREMENT

Machine saw cut shall be measured for payment by the linear foot.

Such compensation as outlined above shall be payment in full for all labor, equipment, and materials necessary to complete the item of work.

820.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SAWCUT PAVEMENT (TYPE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 821 – PLANING PAVEMENT

821.01 – DESCRIPTION

This section covers planing and existing pavement surfaces with equipment meeting the requirements hereinafter specified which shall cold plane the surface irregularities such as to provide a smooth riding surface and, in some cases, remove the pavement to predetermined grades. The planed and finished surface shall be free from gouges, grooves, ridges, sooting, oil film and other imperfections of workmanship and shall have a mosaic appearance that clearly shows seventy-five (75) percent of the surface aggregate sheared by the cutting blades having a desirable bonding surface.

821.03 – EQUIPMENT

The planing work shall be performed with a pavement planing machine of the following type:

Cold Planing - This planing machine shall be designed and built for this type of work. The equipment shall be self-propelled with sufficient power, traction and stability to maintain accurate depth of cut and slope. The machine shall be equipped with automatic grade and slope controls capable of producing a finished profile within one-fourth inch (1/4”) of reference elevation.

The machine shall be equipped with an integral loading and reclaiming means to immediately remove

material being cut from the surface of the roadway and discharge the cuttings into a truck, all in one operation or adequate back-up equipment (sweepers, loaders, water truck, etc.) and personnel will be provided to insure that all cuttings are removed from street surface daily. Stock piling of planed material will not be permitted on the project site. The machine shall be capable of producing a minimum coverage of two thousand (2,000) square yards per hour while removing a minimum of one-fourth (1/4") to one-half (1/2") inch of the existing pavement per pass and shall be equipped with means to control dust created by the cutting action and be able to cut flush to all curbs, inlets, manholes or other obstructions within the paved area. In the case of producing a finished, textured surface, the speed of the machine shall be variable in order to leave the desired grid pattern. The texture produced for finished pavement shall be a grid surface with discontinuous longitudinal striations.

821.04 – CONSTRUCTION METHODS

The temperatures at which the work is performed, the nature and condition of the equipment, and the manner of performing the work shall be such that the pavement is not torn, gouged, shoved, broken, sooted, oil coated, burned or otherwise injured by the planing operation. Sufficient passes, or cuts shall be made such that all irregularities of high spots are eliminated and that one hundred percent (100%) of the surface area has been planed to the desired grade or to the satisfaction of the Engineer. Where the pavement is to be resurfaced, a one and one-half inch (1 ½") shoulder shall be cut along the gutter line to eliminate the necessity of feathering the edge of the new surface. As a general rule, an average cut over the street of one inch (1") will be required.

821.06 – METHOD OF MEASUREMENT

Pavement planing performed and provided above shall be measured by the square yard of variable depth up to a maximum of one and one-half inch (1 1/2") below the surface. An additional pay item will be provided for areas requiring extra depth in increments of one inch (1").

Payment for the planing of pavement shall be made at the unit price bid per square yard which shall include all labor, equipment, materials, supplies, mobilization, and traffic control.

821.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PLANE PAVEMENT (UPTO 1 ½ INCH)	S.Y.
PLANE PAVEMENT (GREATER THAN 1 ½ INCH)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 822 – PAVEMENT REINFORCING FABRIC

822.01 – DESCRIPTION

This section covers the application of pavement reinforcement fabric in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the plans or established by the Engineer.

822.02 – MATERIALS

Material shall meet the requirements of Section 988.

822.03 – EQUIPMENT

Equipment and tools necessary for performing all parts of the work shall be on the job site prior to commencement of work and shall be maintained in first class operating condition.

Distributors shall be designed, equipped, and maintained so that bituminous material at even heat may

be applied uniformly on variable widths of surface up to twenty-six (26) feet at readily determined and controlled rates from 0.1 - 1.0 gallons per square yard with uniform pressure and with an allowable variation from any specified rate not to exceed 0.03 gallon per square yard. A check of distribution rate and uniformity of distribution shall be made when directed by the Engineer.

Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a 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 and shall be equipped with a hand spray with single nozzle and positive shut off valve.

Fabric laydown equipment shall be capable of handling full or partial rolls of fabric and shall be capable of laying the fabric smoothly without wrinkles and/or folds. When manual laydown is required a length of standard one inch (1") pipe, together with suitable roll tension devices shall be used for proper roll handling.

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.

822.04 – 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 - The bituminous binder material shall be heated and uniformly spray applied over the area to be fabric covered. Double rate application shall be applied along an overlap area.

The minimum application temperature of the bituminous binder shall not be less than two hundred-ninety (290º) degrees F. If the fabric is oversprayed the maximum application temperature shall not exceed three hundred twenty-five (325°) degrees F. to avoid damage to the fabric.

The bituminous binder shall be applied at the rate of 0.20 to 0.35 gallons per square yard or 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 (2) to six inches (6") 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 smooth 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 two inches (2") and four inches (4"). Transverse joints shall be shingled in the direction of paving to prevent edge pickup by the paver. Additional binder shall be applied to joints at the rate specified by the Engineer by hand spraying or brushing.

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.

D) Weather Limitations - Asphalt binder shall not be applied for installation of the fabric when the air temperature is less than fifty (50°) degrees F.

E) Tack Coat - Tack coat, if required for the pavement overlay, shall be applied in accordance with Section 939. 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 laydown 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 three hundred twenty-five (325°) degrees 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.

822.06 – METHOD OF MEASUREMENT

Pavement reinforcing fabric will be measured by the square yard complete in place.

The pavement reinforcing fabric shall be paid for at the contract unit price bid per square yard. Measurement shall be made by the square yard of pavement so reinforced. Such payment shall be full compensation for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

822.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

PAVEMENT REINFORCING FABRIC S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 823 – CONCRETE SIDEWALKS AND DRIVEWAYS

823.01 – DESCRIPTION

This section covers concrete sidewalks and driveways constructed as herein specified and in conformity with the lines and grades as established by the Engineer and the details as shown on the plans.

823.02 – MATERIALS

All materials and requirements for concrete shall conform to the requirements of Section 305, "Concrete Curb and Gutter". Standard construction details shall also provide the requirements for expansion joints, forming, curing, and other incidental construction items related to the placing of concrete for sidewalks and driveways. Unless otherwise specified, High Early Strength Concrete shall be used for driveway construction to facilitate public access.

823.04 – CONSTRUCTION METHODS

A) General - Concrete sidewalks and driveways shall be constructed in accordance with the current Oklahoma City Engineering Department Construction Standards.

The Contractor shall furnish all materials, labor and equipment, and construct sidewalks and driveways, conforming to line, grade, location, and design as indicated on the plans and in these specifications, or as established by the Engineer.

B) Excavation - Excavation required for the construction of sidewalks and driveways shall be to the lines and grades as established by the Engineer, or as shown on the plans.

C) Fine Grading - The Contractor shall do all necessary filling, leveling, and fine grading required to bring the subgrade to the exact grades specified.

D) Forms - Construction methods and equipment for slip-form paving of sidewalks shall conform to the requirements of Section 305.

E) Finishing - Concrete sidewalks and driveways shall be finished to a true, even surface. They shall be troweled with a steel trowel and then brushed transversely to obtain a smooth uniform brush finish. Joint and sides shall be edged with suitable tools.

F) Joints - Expansion joints for sidewalks and driveways shall be formed using pre-molded expansion joint material of an approved type. Expansion joints shall be placed in the sidewalk at one hundred foot (100') intervals maximum distance or as otherwise specified by the Engineer. Expansion joints shall also be placed at all intersections or sidewalks with concrete driveways, poles, curbs, buildings, and other sidewalks. All expansion joints shall be three-fourths inch (3/4") in thickness, and shall be sealed.

The edges of all construction and expansion joints and the outer edges of all sidewalks shall be finished to approximately a one-half inch (1/2") radius with a suitable finishing tool. Contraction joints shall be saw cut in accordance with standard details.

G) Curing - Sidewalks and driveways shall be cured in accordance with the requirements of Section 305, "Concrete Curb and Gutter".

823.06 – METHOD OF MEASUREMENT

Measurement for sidewalks and/or driveways complete in place will be by the square yard.

Concrete sidewalks and driveways shall be paid for at the contract unit price bid, which price shall be full compensation for excavating and preparing the subgrade; furnishing and placing all materials, including expansion joint materials; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

823.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SIDEWALK (WIDTH)	S.Y.
DRIVEWAY (WIDTH)	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 824 – TEMPORARY SURFACING

824.01 – DESCRIPTION

This section covers the placing of temporary surfacing on areas to be used as temporary crossings and temporary routes of ingress and egress to residences and places of business adjacent to or near the

project.

824.02 – MATERIALS

Two types of temporary surfacing materials may be used as follows:

A) Asphalt - When called for, asphalt shall be type "A" mix placed a minimum of three inches (3”), and compacted on a prepared subgrade in accordance with the requirements of the Standard Specifications for asphalt paving.

B) Aggregate - When called for, aggregate shall be placed a minimum of four inches (4”), and compacted on a prepared subgrade and shall meet the requirements of one of the following gradations:

Type "A" - Type "A" material shall consist of hard durable particles of sand, gravel, mine chats, crushed rock or a combination of any of these materials.

Type "B" - Type "B" material shall consist of hard, durable particles of disintegrated granite with natural binder.

Type "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.

GRADATION REQUIREMENTS (Percent Passing)			
SIEVE SIZE	**TYPE "A"**	**TYPE "B"**	**TYPE "C"**
1 in.	100	100	100
¾ in.	95-100	95-100	...
½ in.	...	...	...
No. 4	5-75	0-85	40-75
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

824.04 – CONSTRUCTION METHODS

This work shall be constructed on a prepared subgrade in reasonable close conformity with the existing surfaces or established by the Engineer. Cross streets, side streets, approach streets, and temporary driveways to residences or places of business shall be shaped to a reasonable cross section to prevent ponding of water. Holes, waves and undulations which develop shall be corrected by blading and adding more material. The shaping of the surface material shall be continued until it is well compacted, free from ruts, waves, and undulations. Excess material not required for maintenance shall be removed from the construction site. The completed temporary surface shall be maintained in this condition until permanent repairs are constructed.

824.06 – METHOD OF MEASUREMENT

Payment for "Temporary Surfacing" shall be made at the unit price bid per ton for each material type. The

price established shall be full compensation for excavation, materials, labor, tools, equipment and incidentals necessary to complete this item of work.

824.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TEMPORARY SURFACING (TYPE)	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 825 – RIPRAP

825.01 – DESCRIPTION

This section covers the furnishing and placing of 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 II	Plain Riprap with Filter Blanket
Type III	Special Plain Riprap
Type IV	Special Plain Riprap with Filter Blanket
Type V	Laid Up Riprap
Type VI	Grouted Riprap

825.02 – MATERIALS

Materials shall meet the requirements specified in the following Subsection of Part VIII - Materials:

Portland Cement Concrete	932
Fine Aggregate	932
Stone for Riprap	981
Filter Blanket	981

825.04 – 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 V or Type VI construction is specified, the base shall be compacted in accordance with Section 302 before the riprap is placed.

B) Filter Blanket - Filter blanket, when specified, shall be placed on one (1) or two (2) layers as indicated on the plans.

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) Types I, II, III and IV - 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.

D) Type V - 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 or blocks 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.

E) Type VI - 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 or blocks 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. Care shall be taken during placing to keep earth or sand from filling the spaces between the stones.

After the stones or blocks are in place, the spaces between them 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 three (3) days after grouting.

Grout for grouted riprap shall consist of one (1) part of Portland Cement and three (3) parts of fine aggregate by volume thoroughly mixed with water to produce grout having the proper consistency. Retempering of grout will not be permitted.

825.06 – METHOD OF MEASUREMENT

Type I and Type II, Plain Riprap or Plain Riprap and Filter Blanket will be measured separately by the cubic yard determined by multiplying and 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 and Type IV, 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 V, 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 VI, Grouted 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.

Accepted Riprap, measured as provided above, will be paid for at the contract unit price which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

825.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(TYPE) PLAIN RIPRAP	C.Y.
(TYPE) PLAIN RIPRAP	TON
(TYPE) FILTER BLANKET	C.Y.
(TYPE) FILTER BLANKET	TON
(TYPE) FILTER BLANKET	S.Y.
(TYPE) SPECIAL PLAIN RIPRAP	C.Y.
(TYPE) SPECIAL PLAIN RIPRAP	TON
(TYPE) LAID-UP RIPRAP	S.Y.
(TYPE) GROUTED RIPRAP	S.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 826 – PIPE CONDUITS

826.01 – DESCRIPTION

This section covers 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 six inches (6”) in diameter or greater and all other pipe used in sanitary sewers, storm sewers, and pipe culverts.

826.02 – MATERIALS

Pipe conduit shall be of the kind specified on the plans and shall meet the requirements of Section 900. The class of reinforced aluminum pipe for various diameters and heights of fill above the top of pipes shall be shown on the standard drawings. When the class of reinforced concrete culvert pipe is not specified it shall be Class III.

When not specified on the plans the kind of approved 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.

Semicircular metal pipe will not be approved as optional for pipe underdrains when the pipe drain shown on the plans is eight inches (8”) in diameter or greater.

826.04 – CONSTRUCTION METHODS

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 submain pipe conduit having one or more laterals or tributaries, the construction of tributary lines will not be started until the main or submain pipe conduit has been completed to the point where the tributary or laterals discharge into it.

During construction adequate provisions for drainage of the system shall be made by the Contractor.

The connection of storm or sanitary sewers or sewer appurtenances to other storm or sanitary sewers or to sewer appurtenances shall be made in accordance with the plans or under the direction of the Engineer. 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 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 sewer. The centerline and grade line shall be accurately established in the trench at intervals of not more than twenty-five feet (25’).

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. When work is stopped temporarily on storm sewers twenty-four inches (24”) 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.

A) Excavation - Excavation, backfill and related items shall conform to Section 212, "Trench Excavation and Backfill".

B) 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.

   Paving or partially lined conduit shall be laid so that the longitudinal centerline of the paved segment coincides with the flow line. Elliptical and elliptically reinforced conduits shall be placed with the major axis within five (5°) degrees of a vertical plane through the longitudinal axis of the conduit.

   On underdrain pipe the pipe shall be embedded firmly in the bedding material. The pipe shall be laid reasonably true to the established line and grade. Perforated pipe shall be laid with perforation down. After the pipe has been inspected and approved it shall be covered with the cover and backfill material as shown on standard drawing with care being taken in placing backfill material so as to prevent displacement or damage of pipe.

C) Joining Pipe Conduit - Rigid conduits may be of bell and 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 oakum and mortar, cold applied mastic type, 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 coupling bands.

D) Shop Elongating - When required on the plans the pipe shall be shop elongated in accordance with AASHTO M36 to form an approximate ellipse with the vertical diameter approximately five (5) percent greater than the nominal diameter of the corresponding round pipe.

826.06 – METHOD OF MEASUREMENT

Measurement for pipe conduit shall be per unit price bid per linear foot. All work required to conform to these specifications shall be considered incidental to the price per linear foot, when additional pay items are not specified.

Accepted Pipe Conduit, measured as provided above, will be paid for at the contract unit price which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

826.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(TYPE) PIPE CONDUIT (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 827 – GUARDRAIL

827.01 – 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. The types of guard rail are designated as follows:

Beam Guard Rail-Steel-W-Beam-Single
Beam Guard Rail-Steel-W-Beam-Double
Transition Section
Guard Rail Anchor Unit
Guard Rail Extruder Terminal
Cable Guard Barrier
Wrought Iron Chain Guard Barrier

Guide posts with reflective bands shall be wood as specified.

827.02 – MATERIALS

Materials shall meet the requirements specified in the following Sections of these Specifications:

Guardrail Posts	983
Guide Posts (Wood)	983
Spacer Blocks	983
Zinc Rich Paint	984
Metal Plate (Beam Type Galvanized Steel)	982
Metal Plate (Beam Type Aluminum)	982
Fittings (Steel or Aluminum)	982
Wire Cable	982
Portland Cement Concrete	932

827.04 – CONSTRUCTION METHODS

A) Setting Posts for Guard Rail, Guide Posts, or Barrier Posts

a. Set posts for guardrail in accordance with the Plans.

b. When posts are to be set in the ground, set them in holes that have been dug in thoroughly compacted soil.

c. Keep the bottom of the holes free of loose material so that the post will have a stable foundation.

d. Space the posts as shown on the Plans, setting them 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.

e. Set the top of the post to the elevation shown on the Plans or as approved by the Engineer.

f. After the posts are placed, backfill the holes with approved material, thoroughly compacted in layers not to exceed six inches (6”) in depth and in such manner as not to

shift the posts from the correct alignment.

NOTE: Posts for guardrail may also be machine driven. Promptly fill any depression in the surface resulting from driving the posts, and tamp with like material.

All other requirements shall be as shown on the current guard rail standard drawings.

B) **Rail Elements**. Erect rail elements 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, correct any damage to the shop coat of paint by applying an approved rust-inhibitive primer prior to other painting. If any surfaces will be inaccessible to paint after erection, field paint them before they're erected. Give the railing components the specified number of coats of paint, uniformly applying them by thorough brushing or by approved pressure spray as specified.

Protect the following with two coats of an approved zinc rich paint:

a. galvanized surfaces which have been abraded so that the base metal is exposed;

b. threaded portions of all fittings;

c. fasteners and cut ends of bolts.

Where double-faced guard rail is specified, install it in accordance with the Plans.

C) **Placing Metal Plate Rails and Fittings.** Where metal plate rails are specified or used, fasten them 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, provide them with reflective sheeting when specified, fixed to the post with four 8d box nails as shown on the Plans.

E) **Guard Rail Anchor Units.** Construct guard rail anchor units 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.

a. For surface outcropping, drill four properly spaced and patterned 2 inches (50 mm) 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.

b. For rock with a soil overburden up to 18 inches (450 mm) deep, following these steps:

i. Drill the four, properly-spaced holes to receive the anchor bolts.

ii. Drill four additional holes at 2 1/2 inch (64 mm) diameter, spaced at 90° and 12 inches from center of concrete anchor.

iii. Half fill the outer holes with pourable epoxy grout; then insert and stabilize plumb one number 9 reinforcing steel bar per hole, cut to the proper length.

iv. 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

v. Tie the 6x6-W1.5xW1.5 wire mesh to the bars after grout is dry.

vi. Spread pourable epoxy grout on the mating surface between the rock and concrete for positive bond.

vii. Construct the upper portion with the same details as shown on the Plans.

c. For encountered rock at depths greater than eighteen inches (18”), omit the holes for the four anchor bolts and construct the anchor as covered in Section 827.02 above.

F) **Placing Wrought Iron Chains** - The chain shall be fed through the two inch (2”) holes in the posts and drawn up until the sag between posts is as shown on the plans. The chain shall be permanently secured in this position by placing one-half inch (1/2”) bolt through the post at right angles to the chain and through a link in the chain. All bolts projecting more than one inch (1”) through the nut shall be cut off one-half inch (1/2”) from the nut.

G) **Placing Reflective Sheeting on Guide Posts** - After the posts are set, they shall be provided with reflective sheeting.

827.06 – METHOD OF MEASUREMENT

Cable Guard Barrier, Beam Type Guardrail (Single), Beam Type Guardrail (Double Faced) and Wrought Iron Chain Guard Barrier will be measured by the linear foot between end section. Guardrail Anchor Units will be measured separately as unit 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.

827.07 – BASIS OF PAYMENT

The accepted quantities of the various items, measured as provided above, will be paid for at the contract unit price for:

BEAM-TYPE GUARDRAIL (SINGLE)	L.F.
BEAM-TYPE GUARDRAIL (SINGLE)(SHOP CURVED)	L.F.
GUARDRAIL ANCHOR UNIT, TYPE "A" (SEE STD. GRAU-1-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "B" (SEE STD. GRAU-1-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "C" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "D(BF)" (SEE STD. GRAU-1-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "E" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "F" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "G" (SEE STD. GRAU-2-1)	EA.
GUARDRAIL ANCHOR UNIT, TYPE "GE" (SEE STD. GRAU-2-1)	EA.
NEW GUARDRAIL EXTRUDER TERMINAL	EA.
ATTENUATOR (UP TO 42" WIDE)	EA.
ATTENUATOR (WIDE) (42" AND WIDER)	EA.
CABLE GUARD BARRIER	L.F.
WROUGHT IRON CHAIN GUARD BARRIER	L.F.
GUIDE POSTS	EA.

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

SECTION 828 – FENCES

828.01 – DESCRIPTION

This section covers 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 type of fence will be as shown on the plans. The types are designated as follows:

Fence	Type I
Standard Chain Link Fence	Type II
Fence	Type III
Glare Deflector Fence	Type IV

Fence gates shall be of the type and size as shown on the plans and shall be hung at locations shown on the plans or directed by the Engineer, and in accordance with the plans.

828.02 – MATERIALS

Materials shall meet the requirements of the following Section 900, Materials:

Fence Type I & II	982
Standard Chain Link Fence Type II	982
Glare Deflector Fence	982
Portland Cement Concrete	932

When not specified on the plans or in the proposal, the kind of posts, hardware and fittings meeting the requirements of Section 982 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.

828.04 – 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.

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 to conform to the requirements for the type of closure indicated.

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 the posts. Unless otherwise permitted, materials shall not be installed on posts or strain placed on guys and bracing set in concrete until five (5) days have lapsed from the time of placing of the concrete.

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 and under the conditions specified by him.

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 will be accomplished in accordance with the following:

A galvanized or copper coated steel ground rod eight feet (8') long having a minimum diameter of one-half inch (1/2") shall be installed directly below the point of crossing. The rod shall be driven vertically until the top is six inches (6") 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 power-line runs parallel or nearly parallel to and above the fence, the fence shall be grounded at each end or gate post or at intervals not to exceed fifteen hundred feet (1500').

When required 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 types of fences and gates that he constructs during his construction operations.

B) Fence Type I

1) Alignment - The plan sheets shall show the general alignment, angles, corners and attachment types at culverts. In general, fence shall be constructed one foot (1') inside and parallel to the permanent right-of-way line and wire usually will be attached to the property side of the fence posts. On curves, wire fabric shall be placed on that side of the post which will maintain the wire where the location of the fence is to be constructed and shall be cleared of obstructions and ground leveled of minor irregularities so the fence can be free of 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 a minimum of one foot (1') inside the permanent right-of-way or to a line shown on the plans or set by the Engineer, and in 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 the dimensions shown on the plans. Additional posts shall be set at each abrupt change in grade.

   Extra length posts will 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 barbed wire, stretched taut between posts, either on horizontal lines or fanned at six inch (6") maximum spacing, as shown on the plans or as directed 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 shall be stretched uniformly tight by means of an approved mechanical tensioning device and in conformity to the location of the posts as designated on the plans.

   Splicing or barbed 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 the wires shall be carried two inches (2") past the splicing tools and wrapped around both wires backward from the tool for at least five (5) turns.

   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 as designated on the plans. Parallel stays shall be straight and uniformly spaced as shown on the plans. Each woven fabric wire and barbed wire shall be stapled to wood posts or fastened with approved fittings to steel posts.

   Woven wire shall be cut and 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 end-walls 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) STANDARD CHAIN LINK FENCE TYPE II

Setting Posts and Placing Fencing - Post holes shall be dug to 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 (5) 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 wire full width and ties made in at least seven (7) 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 plan size of fabric is placed. Wire shall be placed on the outside of the posts with respect to the road except on curves where the wire shall be placed on the outside of the post with respect to the center of the curve.

D) Fence Type III - Fence Type III shall be a barbed wire fence constructed in the same manner as Fence Type I except the fencing fabric shall consist of the same number of strands as the existing fence unless otherwise shown on the plans and shall be set one foot (1') inside the right-of-way line.

E) Glare Deflector Fence - All line posts shall be spaced equal distance in the fence line or a maximum of twelve and one-half feet (12 ½') centers. Posts shall be plumb and the top of the posts properly aligned. Posts shall be attached to the guardrail posts by the use of clamps and/or bolts as shown on the plans.

Horizontal braces shall be provided at all terminal posts. Braces shall be securely fastened to the terminal posts and adjoining line posts by brace ends and brace bands.

Diagonal braces shall be trussed from the brace end of the line post back to the terminal post and fastened to it by a brace band.

Glare deflector fence fabric shall be installed as shown on the plans and securely fastened to the line posts with nine (9) gauge fabric ties spaced at approximately fourteen inch (14") intervals, and to the top and bottom tension wire with fabric ties or hog rings at a maximum of twelve inch (12") intervals. The chain link glare deflector fence shall be tightened to provide a smooth, uniform appearance.

Stretcher bar bands shall be installed at a maximum of eleven inch (1") intervals.

Terminal posts shall be spaced at maximum one hundred foot (100') intervals or as shown on the plans.

828.06 – METHOD 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.

828.07 – BASIS OF PAYMENT

The accepted quantities of fence, measured as provided above, will be paid for at the contract unit price per linear foot for fence and per each for gates of the types and sizes specified for:

FENCE - TYPE I	L.F.
GATES - TYPE I	EA.
FENCE - TYPE II	L.F.
GATES - TYPE II	EA.
FENCE - TYPE III	L.F.
GLARE DEFLECTOR FENCE - TYPE IV	EA.

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

SECTION 840 – SODDING AND SPRIGGING

840.01 – DESCRIPTION

This section covers the furnishing and planting of viable bermuda grass sod or sprigs in accordance with these specifications and in reasonably close conformity with the areas and locations shown on the plans or as established by the Engineer.

840.02 – MATERIALS

Materials shall meet the requirements specified in the following Sections of Part VIII - Materials.

Solid Slab Sod	985
Row Sprigging	985
Broadcast Sprigging	985

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.

840.03 – EQUIPMENT

The Contractor shall furnish equipment in accordance with the following requirements:

A) Rolling Equipment - Unless otherwise approved by the Engineer, the machine for compacting sodding or sprigging shall be equipped with a single or tandem axle corrugated roller. It shall weight not less than one hundred twenty-five pounds (125#) or more than three hundred (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.

C) Fertilizer and Lime Spreaders: 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.

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 disk spaced on two inch (2”) centers on tandem axles. The

rear disk wheels shall be placed so they trail between the front disks. They shall have an accurate and adjustable mechanism for adjusting the depth of sprig placement. The broadcasting and pressing operations 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.

840.04 – CONSTRUCTION METHODS

840.04.01 – SOLID SLAB SODDING OPERATIONS

Preparation of areas to be sodded shall include filling, reshaping of eroded areas, cleaning ditches, refinishing slopes and medians to the established grading section. The area shall be cleared of all litter and debris. The location, placement and seasonal requirements for areas to be solid slab sodded will be as described in these specifications or as shown on the plans. Sod shall be placed at the earliest time possible after soil disturbance and final placement of the subgrade.

Topsoil shall be placed where excavation and backfill operations have left soil unsuitable for sod establishment.

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 underneath.

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 thoroughly watered daily for a period of at least seven (7) days after placement. Remaining watering operations shall conform to Subsection 840.04 (F).

Fertilizer shall be applied in accordance with the appropriate sections of Section 840.

840.04.02 – ROW SPRIGGING OPERATIONS

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

B) Fertilizer shall be applied in accordance with Subsection 840.04.

C) The sprigs shall be planted with an automatic sprig planter conforming to Subsection 840.03 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 twenty inches (20”) on centers. The sprigs shall be placed approximately three inches (3”) deep at the rate of approximately thirty (30) bushels per acre with the ends of sprigs meeting or overlapping.

D) The sprig planter shall not be operated in excess of four miles per hour (4 mph).

E) 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.

F) The row sprigged areas shall be watered immediately after rolling. The remaining watering operation shall conform to Subsection 840.04.

840.04.03 – BROADCAST SPRIGGING OPERATIONS

A) Broadcast Sprigging Type A - Preparation of areas for broadcast sprigging, Type 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 six inches (6”). If rains or other conditions

should pack the soil before being planted, the tillage shall be repeated. At least eighty (80) bushels of sprigs shall be planted per acre unless shown otherwise 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 four inches (4") deep. Within two (2) hours after the sprigs have been planted the areas shall be disked to a depth of approximately three inches (3") with either a tandem or offset disk plow.

B) Broadcast Sprigging, Type B - At least twelve (12) bushels of sprigs shall be thoroughly incorporated into one hundred cubic yards (100 C.Y.) of stockpiled, Type B salvaged topsoil. A method approved by the Engineer shall be used to meter and distribute the sprigs into the stockpiled topsoil. During mixing operations both the soil and sprigs shall be kept moist. Preparation of areas for broadcast sprigging, Type 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 five inches (5") thick within four (4) hours of manipulation.

C) The following procedures shall be used for both methods of Broadcast Sprigging:

1) Fertilizer shall be applied in accordance with Subsection 840.04.

2) The planted areas shall be rolled and compacted with equipment conforming to Subsection 840.04. Rolling of slopes shall be along approximate contour lines and in a manner approved by the Engineer.

3) The sprigged areas shall be watered immediately after rolling. Remaining watering operations shall conform to Subsection 840.04(F).

840.04.04 – PLANTING SEASON AND WEATHER RESTRICTIONS

A) Time of sodding

1) Kentucky bluegrass sod may be planted during the periods of March 1 to June 15 and September 1 to November 15.

2) Buffalo grass sod may be established any time that the soil is workable with the exception of hot dry weather during July and August.

3) Bermuda grass sod strips or plugs and Bermuda grass sod retards shall be planted between April 1 and August 15. Divided Bermuda grass roots (rhizomes) shall be planted between April 15 and June 15.

B) Soil Moisture Requirements

1) Soil moisture shall exist throughout the zone from one inch (1") below the surface to at least five inches (5") 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 (2) pieces without crumbling and without leaving excess water on the hand after casting.

2) Sodded or sprigged areas shall be watered for thirty (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 (1").

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.

Fertilizer Operations - Fertilizer shall not be placed on hard or glazed surfaces. Fertilizer shall be applied in accordance with Section 842.

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.

4) 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 resodding or sprigging, refertilizing, and watering damaged areas which shall be performed during the specified planting season.

5) 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.

840.06 – METHOD OF MEASUREMENT

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

Sanitary sewer construction, the maximum width of solid slab sod replacement paid for shall be fifteen feet (15') measured from the centerline of the sanitary sewer pipe placement. Additional sodding beyond this limit shall be placed at the contractor's expense.

840.07 – BASIS OF PAYMENT

Accepted Sodding, measured as provided above will be paid for at the contract unit price for:

SOLID SLAB SODDING	S.Y.
ROW SPRIGGING	S.Y.
BROADCAST SPRIGGING, METHOD A	S.Y.
BROADCAST SPRIGGING, METHOD B	S.Y.

The contract unit price shall be the total compensation for furnishing and placing all sod; for all rolling and tamping; watering and fertilizer; for disposal of all surplus materials; and for all materials, labor, equipment, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

SECTION 841 – SEEDING

841.01 – DESCRIPTION

This section covers the furnishing and planting of seeds in accordance with these specifications and in reasonably close conformity with those areas and locations shown on the plans or established by the Engineer.

841.02 – MATERIALS

Materials shall meet the requirements specified in the following:

Seed	Section 985
Fertilizer	Section 985

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

841.03 – 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 one thousand (1,000) gallons and be equipped with a mechanical agitation system with operating capacity sufficient to suspend and homogeneously mix the seed and water. The distribution hoses shall be large enough to prevent clogging and 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 (2) 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 eight inch (8") or less centers with each disk having a depth regulating band one inch (1") 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 one-half (1/2) to three-fourths (3/4) 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 two inch (2") centers and shall place the seed at a depth of one-fourth (1/4) to one-half (1/2) inch. The seeder shall be equipped with two (2) separate planter boxes and planting mechanisms which will plant clean, fine seed and large, chaffy seed simultaneously. The seeder shall also be equipped with a mechanism for accurately adjusting the rate of seed flow. The seeder shall weigh approximately one hundred twenty-five (125) to two hundred fifty (250) pounds per linear foot of rolling width.

Rolling, fertilizing, and watering equipment shall meet the requirements of Subsection 840.03.

841.04 – CONSTRUCTION METHODS

A) Seedbed 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 section.

2) Seedbed preparation shall consist of eliminating all live plants by mowing and disking. 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 four inches (4"). All clods larger than one inch (1") 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 seedbed surface shall be left rough or made sufficiently rough before seeding.

B) Planting Methods - 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.

1) Seeding Method A - Hydraulic Seeder Method - The seed shall be placed in water in the spray tank of a hydraulic seeder conforming to Subsection 841.03(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 one thousand (1,000) gallons of water in the spray tank shall not exceed the quantity specified for two (2) acres. If less than one thousand (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.

2) Seeding Method B - Grass Seed Drill Method - The seed shall be planted with a grass seed drill conforming to Subsection 841.03(B). All drilling shall be carried out on the approximate contour lines.

3) Seeding Method C - Corrugated Roller Seeder Method - The seed shall be distributed with a corrugated roller seeder conforming to Subsection 841.03(C) that has been adjusted to accurately apply the specified quantities. Planting on slopes shall be along the approximate contour lines.

   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 - Permanent erosion control operations shall be in accordance with Subsection 840.04.04(A).

D) Soil Moisture and Watering Requirements

1) Soil moisture shall exist throughout the zone from one inch (1”) to at least five inches (5”) 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 (2) 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 - Fertilizer application shall be in accordance with Section 842.

F) Repairs and Maintenance - 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.

1) 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.

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.

841.06 – METHOD OF MEASUREMENT

A) Seeding - Seeding will be measured by the acre. Work and material used in repair of seeding will not be measured for payment.

B) Watering - Water used as a carrier for seed in hydraulic seeding operations is considered incidental to “seeding" and will not be measured for payment.

C) Fertilizer - Fertilizer will be measured and paid for in accordance with Section 842.

841.07 – BASIS OF PAYMENT

Accepted seeding measured as provided above will be paid for at the contract unit price bid for:

SEEDING AC

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

SECTION 842 – FERTILIZER

842.01 – DESCRIPTION

This section covers providing and distributing fertilizer over such areas as are designated on the plans and in accordance with these specifications.

842.02 – MATERIALS

All fertilizer used shall be delivered in bags or containers clearly labeled showing the analysis. The fertilizer is subject to the applicable requirements of the Oklahoma Department of Agriculture. A pelleted or granulated fertilizer shall be used with an analysis of 16-20-0 or 16-8-8 or having the analysis shown on the plans. The figures in the analysis represent the percent of nitrogen, phosphoric acid, and potash nutrients respectively as determined by the methods of the Association of Official Agricultural Chemists.

In the event it is necessary to substitute a fertilizer of a different analysis, it shall be a pelleted or granulated fertilizer with a lower concentration. Total amount of nutrients furnished and applied per acre shall equal or exceed that specified for each nutrient.

842.04 – CONSTRUCTION METHODS

When an item for fertilizer is included in the plans and proposal, pelleted or granulated fertilizer shall be applied uniformly over the area specified to be fertilized and in the manner directed for the particular item of work. Fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected. Distribution of fertilizer as a particular item of work shall meet the approval of the Engineer.

Unless otherwise indicated on the plans, fertilizer shall be applied uniformly at the average rate of three hundred (300) pounds per acre for all types of "Sodding" and four hundred (400) pounds per acre for all types of "Seeding".

842.06 – METHOD OF MEASUREMENT

Work and acceptable material for "fertilizer" shall be measured by the ton (2,000 pounds) as determined by approved scales or guaranteed weight of sacks shown by the manufacturer.

Work performed and materials furnished and measured as provided under Measurement will not be paid for directly but included in the price bid for "Sodding" or "Seeding".

SECTION 843 – TREE REPLACEMENT

843.01 – DESCRIPTION

This section covers replacement of trees one and one-half (1 1/2) to two and one-half (2 1/2) inches in diameter.

843.04 – CONSTRUCTION METHODS

Replaced trees shall be planted outside of public easements in accordance with good horticultural practices. The trees shall be replaced either in kind or by one of the following listed below:

London Plain Tree	Red Oak
Lace Bark Elm	Austrian Pine
Shademaster Honey Locust	Japanese Black Pine
Sweet Gum	Red Bud
Hackberry	Bradford Pear
Mulberry	Crabapple
Northern Oak	Russian Olive

The Engineer shall determine the type and location of the trees. The Contractor shall guarantee the trees for one (1) growing season.

843.06 – METHOD OF MEASUREMENT

Payment for "Tree Replacement" shall be made at the unit price bid per each tree. The price established shall be full compensation for removal and replacement of tree, including material, water, fertilizer, tools, equipment, labor and incidentals necessary to complete this item of work.

843.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TREE REPLACEMENT (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 844 – HEDGE REPLACEMENT

844.01 – DESCRIPTION

This section covers replacement of hedge with the same kind and in a location determined by the Engineer.

844.04 – CONSTRUCTION METHODS

Hedges replaced shall be planted outside of public easements in accordance with good horticultural practices. The Contractor shall guarantee the hedge for one (1) growing season.

844.06 – METHOD OF MEASUREMENT

Payment for "Hedge Replacement" shall be made at the unit price bid per lineal foot. The price established shall be full compensation for the complete replacement of hedges, including material, water, fertilizer, tools, equipment, labor and incidentals necessary to complete this item of work.

844.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

HEDGE REPLACEMENT L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 845 – SHRUB REPLACEMENT

845.01 – DESCRIPTION

This section covers replacement of shrubs with the same kind and in a location determined by the Engineer.

845.04 – CONSTRUCTION METHODS

Shrubs replaced shall be planted outside of public easements in accordance with good horticultural practices. The Contractor shall guarantee the shrub for one (1) growing season.

845.06 – METHOD OF MEASUREMENT

Payment for "Shrub Replacement" shall be made at the unit price bid per each.

The price established shall be full compensation for the replacement of shrubs, including material, water, fertilizer, tools, equipment, labor and incidentals necessary to complete this item of work.

845.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

SHRUB REPLACEMENT EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 850 – INCIDENTAL CONSTRUCTION STANDARD BID ITEMS

850.01 - DESCRIPTION

This section covers Standard Bid Items used in the contract documents for construction. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
801	CONSTRUCTION STAKING	L.S.
802	CONSTRUCTION TRAFFIC CONTROL	L.S.
810	CLEARING AND GRUBBING	L.S.
811	STRUCTURE REMOVAL (TYPE)	L.S.
812	REMOVE PAVEMENT (TYPE) (THICKNESS)	S.Y.
812	REMOVE SIDEWALK (WIDTH)	S.Y.
812	REMOVE CURB AND GUTTER	L.F.
813	REMOVE DRIVEWAY	S.Y.
813	REMOVE AND REPLACE DRIVEWAY	S.Y.
814	PAVEMENT CUT AND REPAIR	S.Y.
815	REMOVE ALLEY PAVING (TYPE)	S.Y.
815	REMOVE AND REPLACE ALLEY PAVING (TYPE)	S.Y.
816	REPLACE SIDEWALK (WIDTH)	S.Y.
817	REMOVE AND REPLACE PARKING LOT PAVEMENT (TYPE)	S.Y.
818	BASE REPAIR (PAVEMENT TYPE)	S.Y.
819	ADJUST EXISTING STRUCTURE (TYPE)	EA.
820	SAWCUT PAVEMENT (TYPE)	L.F.
821	PLANE PAVEMENT (UPTO 11/2 INCH)	S.Y.
821	PLANE PAVEMENT (GREATER THAN 1 1/2 INCH)	S.Y.
822	PAVEMENT REINFORCING FABRIC	S.Y.
823	SIDEWALK (WIDTH)	S.Y.

SECTION	DESCRIPTION	UNIT
823	DRIVEWAY (WIDTH)	S.Y.
824	TEMPORARY SURFACING (TYPE)	TON
825	(TYPE) PLAIN RIPRAP	C.Y.
825	(TYPE) PLAIN RIPRAP	TON
825	(TYPE) FILTER BLANKET	C.Y.
825	(TYPE) FILTER BLANKET	TON
825	(TYPE) FILTER BLANKET	S.Y.
825	(TYPE) SPECIAL PLAIN RIPRAP	C.Y.
825	(TYPE) SPECIAL PLAIN RIPRAP	TON
825	(TYPE) LAID-UP RIPRAP	S.Y.
825	(TYPE) GROUTED RIPRAP	S.Y.
826	(TYPE) PIPE CONDUIT (SIZE)	L.F.
827	BEAM-TYPE GUARDRAIL (SINGLE)	L.F.
827	BEAM-TYPE GUARDRAIL (SINGLE)(SHOP CURVED)	L.F.
827	GUARDRAIL ANCHOR UNIT, TYPE "A" (SEE STD. GRAU-1-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "B" (SEE STD. GRAU-1-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "C" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "D(BF)" (SEE STD. GRAU-1-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "E" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "F" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "G" (SEE STD. GRAU-2-1)	EA.
827	GUARDRAIL ANCHOR UNIT, TYPE "GE" (SEE STD. GRAU-2-1)	EA.
827	NEW GUARDRAIL EXTRUDER TERMINAL	EA.
827	ATTENUATOR (UP TO 42" WIDE)	EA.
827	ATTENUATOR (WIDE) (42" AND WIDER)	EA.
827	CABLE GUARD BARRIER	L.F.
827	WROUGHT IRON CHAIN GUARD BARRIER	L.F.
827	GUIDE POSTS	EA.
828	FENCE - TYPE I	L.F.
828	GATES - TYPE I	EA.
828	FENCE - TYPE II	L.F.
828	GATES - TYPE II	EA.
828	FENCE - TYPE III	L.F.
828	GLARE DEFLECTOR FENCE - TYPE IV	EA.
840	SOLID SLAB SODDING	S.Y.
840	ROW SPRIGGING	S.Y.
840	BROADCAST SPRIGGING, METHOD A	S.Y.
840	BROADCAST SPRIGGING, METHOD B	S.Y.
841	SEEDING	AC
843	TREE REPLACEMENT (SIZE)	EA.
844	HEDGE REPLACEMENT	L.F.
845	SHRUB REPLACEMENT	EA.

TABLE OF CONTENTS
SECTION 900

LIST OF TABLES

SECTION 900 – MATERIALS

SECTION 921 – LIME

921.01 – GENERAL

Lime will be applied either using pelletized lime or as a slurry. Lime dust will not be tolerated.

921.02 – HYDRATED LIME

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.

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.

Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

SIEVE SIZE PERCENT PASSING	
No. 20	99 - 100
No. 200	80 - 100

921.03 – QUICK LIME

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.

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.

Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

PROPERTY LIMITS
Slaking Temperature Rise, °C, minimum 40
Total active Slaking Time, minutes, maximum 20

When tested in accordance with method OHD L-28 the lime shall conform to the following requirements:

SIEVE SIZE PERCENT PASSING	
5/8 inch	95-100
No. 200	0-15

921.04 – 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)2 . Calculations will be based on the dry mass of the material. Sufficient by-product lime shall be required to provide an equivalent amount of available lime based on 90 percent availability per ton (metric ton) (dry mass) of

hydrated lime.

921.05 – AGRICULTURAL LIMESTONE

Agricultural limestone shall be a high calcic or dolomitic limestone having a neutralization value of at least 80 percent of calcium carbonate. 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.

The fineness shall conform to the following requirements:

SIEVE SIZE PERCENT PASSING	
No. 4	100
No. 8	90-100
No. 60	30-100

SECTION 922 – FLY ASH

922.01 – DESCRIPTION.

This section covers fly ash to be used to modify or stabilize soils and fly ash to be used as an admixture for concrete.

922.02 – GENERAL

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 above requirements except as modified by the Department' s acceptance policy published as: "Procedure for Sampling, Testing and Acceptance of Fly Ash." Copies of the procedure are available at the office of the Materials Engineer.

SECTION 923 – AGGREGATE, MISCELLANEOUS USES

923.01 – DESCRIPTION

This Section covers the requirements for aggregate intended for various uses not specifically covered in other sections of these Specifications.

A) Materials Covered - These Specifications cover the aggregate for use in the construction of aggregate base courses, backfill and surfacing.

B) General Requirements - Aggregate 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, or a combination thereof. Fine aggregate shall be sand, stone dust or other inert finely divided mineral matter.

C) 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 or more fractured faces resulting from the artificial crushing).

D) 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.

E) 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 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:

TABLE 923.01 – GRADATION OF MISCELLANEOUS AGGREGATE

Sieve Size	Percent Passing	
Square	Type A	Type B
3 in.		100
1 ½ 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	4-12	3-10

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.

F) 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.

G) 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 T 180 Method D

SECTION 931 – PLANT MIX BITUMINOUS BASES AND SURFACES

This Section covers the materials requirements, mix designs, proportioning, mix tolerances, and sampling and testing methods for plant- mixed bituminous bases and surfaces.

931.01 – APPROVAL OF MATERIALS.

Prior to use, aggregate sources and percentage of blends must be approved on a project basis by the Materials Engineer. The aggregate shall be stockpiled in accordance with Subsection 109.17.5 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 931.06.

931.02 – 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.

NOTE: 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.

TABLE 931.02 – PHYSICAL PROPERTIES OF AGGREGATES

Aggregates to be used in: Test	Asphalt Concrete	Open Graded Friction Course	Open Graded Bituminous Base	Hot Mix Cold Lay
L. A. Abrasion [a], % wear, max	40	30 b	40	40
Sand Equivalent [b], %,min				
Wearing Course	45	NA	NA	45
Base or Binder	40	NA	NA	40
Mechanically Fractured Faces [b], [c], %, min	75w/2	75w/2 [a]	75w/2	75w/2
Aggregate Durability Index [a], min	40	40	40	40
Insoluble Residue [d, e],%, min				
3000 Million ESAL' s or More	40	40	NA	NA
Less Than 3000 Million ESAL' s	30	30	NA	NA
Flat or Elongated Pieces [b, c, f], %, max	15	15	15	15
Natural Sand and Gravel [b], %, max				
1000 ADT or more	15 [h]	0	0	NA
Less Than 1000 ADT	25 [h]	0	0	NA
Clay Balls and Friable Particles g,%, max	1.0	0	0	1.0
Soft Particles a ,%, max	5	5	5	5
Sticks or Roots a ,%, max	0.5	0	0	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] Applies to the coarse aggregate used in the surface course. Does not apply to shoulders and temporary detours.
[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.
[h] Limited to 10 percent for Type E.

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.

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 as 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.

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.

Mineral Filler. Mineral filler, when required in addition to that naturally contained in the aggregate, shall conform to AASHTO M 17.

931.03 – ASPHALT MATERIALS.

General. Asphalt cement shall met the requirements of AASHTO MP1 for the grade specified. All other bituminous materials shall meet the requirements shown in Tables 2 through 3C for the type and grade of asphalt material specified.

TABLE 931.03.01 – ASPHALT MATERIALS 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.

GRADE	MC- 30		MC- 70		MC- 250		MC- 800		MC- 3000	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Kinematic Viscosity, 140° F	30	60	70	140	250	500	800	1600	3000	6000
Flash Point (Tag, open- cup), °	100	…	100	…	150	…	150	…	150	…
Water, %	…	0.2	…	0.2	…	0.2	…	0.2	…	0.2
Distillation Test: Distillate % by Vol. of total distillate to 680° F										
to 440° 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 680° F volume percentage of sample by difference	50	…	55	…	67	…	75	…	80	…
Tests on residue from distillation:										
Absolute Viscosity, 140° F	40	120	40	120	40	120	40	120	40	120
Ductility [a], 77° F	100	…	100	…	100	…	100	…	100	…
Solubility in Trichloroethylene, %	99.0	…	99.0	…	99.0	…	99.0	…	99.0	…
Spot test with Standard Naphtha Solvent		Neg		Neg		Neg		Neg		Neg

[a] If the ductility is less than 100, the material will be accepted if its ductility at 60° F is 100 or greater.

TABLE 931.03.02 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT RAPID SETTING, MEDIUM SETTING

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.

GRADE	RAPID- SETTING				MEDIUM- SETTING					
TYPE	RS- 1		RS- 2		MS- 1		MS- 2		MS- 2h	
TEST	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max

TABLE 931.03.02 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT RAPID SETTING, MEDIUM SETTING

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.

Tests on emulsion:										
Viscosity, Saybolt Furol, 77° F	20	100	…	…	20	100	100	…	100	…
Viscosity, Saybolt Furol, 122° F	…	…	150	400	…	…	…	…	…	…
Storage stability test, 24- h, %	…	1	…	1	…	1	…	1	…	1
Demulsibility [a] , 35 ml, 0.02 N CaCl 2 , %	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	40	120	40	120	40	120	40	120	160	480 [b]
Penetration, 77° F	100	200	100	200	100	200	100	200	40	90
Ductility, 77° F	40	…	40	…	40	…	40	…	40	…
Solubility in Trichloroethylene, %	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…

Typical applications [c] :
RS- 1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.
RS- 2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).
MS- 1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat.
MS- 2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.
MS- 2h: Cold plant mix, hot mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat.

TABLE 931.03.03 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT HIGH FLOAT, SLOW SETTING

TYPE	HIGH FLOAT								SLOW SETTING			
GRADE	HFMS- 1		HFMS- 2		HFMS- 2h		HFMS- 2s		SS- 1		SS- 1h	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Tests on emulsion:												
Viscosity, Saybolt Furol, 77° F,	20	100	100	…	100	…	50	…	20	100	20	100
Viscosity, Saybolt Furol, 122° F	…	…	…	…	…	…	…	…	…	…	…	…
Storage stability test, 24- h, %	…	1	…	1	…	1	…	1	…	1	…	1
Coating ability and water resistance:												
Coating	Good		Good		Good		Good		Good		Good	
Coating retention	Fair		Fair		Fair		Fair		Fair		Fair	
Cement mixing test, %	…	…	…	…	…	…	…	…	…	2	…	2
Sieve test, %	…	0.1	…	0.1	…	0.1	…	0.1	…	0.1	…	0.1

TABLE 931.03.03 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT HIGH FLOAT, SLOW SETTING

TYPE	HIGH FLOAT								SLOW SETTING			
GRADE	HFMS- 1		HFMS- 2		HFMS- 2h		HFMS- 2s		SS- 1		SS- 1h	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Residue by distillation, %	55	…	65	…	65	…	65	…	57	…	57	…
Tests on residue from distillation test:												
Viscosity, 140° F	40	120	40	120	160	480[b]	20	60	40	120	160	480[b]
Penetration, 77° F	100	200	100	200	40	90	200	…	100	200	40	90
Ductility, 25° C,	40	…	40	…	40	…	40	…	40	…	40	…
Solubility in Trichloroethylene, %	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…
Float test, 140° F	1200	…	1200	…	1200	…	1200	…	…	…	…	…

Typical applications c :

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 (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] Variability will be limited to ± 60 Pa· s from the target value established by the manufacturer.

[c] These typical applications are for use only as a guide for selecting and using emulsion for pavement construction and maintenance.

TABLE 931.03.04 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC 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	CRS - 1		CRS - 2		CMS-1		CMS- 2	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Tests on emulsions:								
Viscosity, Saybolt Furol, 77° F	…	…	…	…	…	…	…	…
Viscosity, Saybolt Furol, 122° F	20	100	150	400	50	500	50	450
Storage stability test [a], 24- h,	…	1	…	1	…	1	…	1
Demulsibility [a], 35ml 0.8%								
Sodium dioctyl sulfosucinate %	40	…	40	…	…	…	…	…
Classification test	Passes		Passes					
Coating ability and water resistance:								
Coating	…	…	…	…	Good		Good	
Coating retention	…	…	…	…	Fair		Fair	
Particle charge test	Pos		Pos		Pos		Pos	
Sieve test, %	…	0.1	…	0.1	…	0.1	…	0.1
Cement mixing test,	…	…	…	…	…	…	…	…
Distillation:								

TABLE 931.03.04 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC 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	CRS - 1		CRS - 2		CMS-1		CMS- 2	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Oil distillate, by vol of emulsion, %	…	0.1	…	0.1	…	8	…	12
Residue, %	60	…	65	…	65	…	65	…
Tests on residue from distillation test:								
Viscosity, 140° F	40	120	40	120	[c]	…	40	120
Penetration, 77° F	100	250	100	250	300	…	100	250
Ductility, 77° F	40	…	40	…	40	…	40	…
Solubility in Trichloroethylene, %	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] The Saybolt Furol viscosity of the residue shall be 200- 600 seconds when tested at180° F (82° C).

[d] Variability will be limited to ± 60 Pa· s from the target value established by the manufacturer.

[e] These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC 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	SLOW - SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX
Tests on emulsions				
Viscosity, Saybolt Furol, 77° F	20	100	20	100
Viscosity, Saybolt Furol, 122° F	…	…	…	…
Storage stability test [a], 24- h,	…	1	…	1
Sodium dioctyl sulfosucinate %	…	…	…	…
Classification test				
Coating ability and water resistance:				

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC 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	SLOW- SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX
Coating	Good		Good	
Coating retention	Fair		Fair	
Particle charge test	Pos[b]		Pos[b]	
Sieve test, %	…	0.1	…	0.1
Cement mixing test,	…	2	…	2
Distillation:				
Oil distillate, by volume of emulsion, %	…	…	…	…
Residue, %	57	…	57	…
Tests on residue from distillation test:				
Viscosity, 140° F	40	120	160	480[d]
Penetration, 77° F	100	250	40	90
Ductility, 77° F	40	…	40	…
Solubility in Trichloroethylene, %	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] The Saybolt Furol viscosity of the residue shall be 200- 600 seconds when tested at180° F (82° C).

[d] Variability will be limited to ± 60 Pa· s from the target value established by the manufacturer.

[e] These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 931.03.06 - REQUIREMENTS AND TYPICAL APPLICATIONS FOR POLYMER MODIFIED CATIONIC EMULSIFIED ASPHALT

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC 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	SLOW- SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX

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		SLOW-SETTING	
GRADE	PMCRS-2s [a]		PMCSS-1h	
TEST	MIN	MAX	MIN	MAX
Tests on emulsions				
Viscosity, Saybolt Furol, 77° F	…	…	20	100
Viscosity, Saybolt Furol, 122° F	125	400	…	…
Storage stability test [b], 24- h, %	…	…	…	1
Storage stability test [c], 5 day, %	…	5	…	…
Classification test	Passes			
Particle charge test	Positive		Positive	
Sieve test, %	…	0.1	…	0.1
Demulsibility	60	…	…	…
Distillation:				
Oil distillate, by volume of emulsion, %	…	2	…	0.5
Residue, %	65	…	62	…
Tests on residue from distillation test:				
Viscosity, 140° F	110	…	8000	…
Penetration, 77° F	100	200	40	90
Ductility, 77° F	…	…	70	…
Ductility, 40° F	30	…	…	…
Softening point, ring and ball ° F	112	…	135	…
Elastic Recovery, 50° F	58	…	…	…
Tensile Stress @ 800% elongation, 40° F, 50 cm/min, kPa	196	…	…	…
Solubility in Trichloroethylene, %	…	…	97	…
Ash Content, %	…	1	…	…

Typical applications [f] :

PMCRS-2s: Bituminous binder in bituminous surface treatments

PMCSS-1h: Bituminous binder in micro-surfacing

FOOTNOTES:

[a] A Type B certification shall be furnished for each lot for polymer modified asphalt

[b] The 24 hour storage stability test results do not necessarily predict satisfactory 5 day settlement test results.

[c] Upon examination of the test cylinder after standing undisturbed for 5 days, there shall be no milky colored substance anywhere within the test cylinder but a homogenous brown color throughout.

[d] The standard distillation procedure will be modified as follows:

TABLE 931.03.05 – REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC 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	SLOW - SETTING			
GRADE	CSS- 1		CSS- 1h	
TEST	MIN	MAX	MIN	MAX

Temperature of 350°F±5°F (177°C ± 3°C) will be maintained on lower thermometer for the last 20 minutes of test.

Test duration of 60 ± 10 minutes from the first application of heat. e The distillation residue of the modified emulsion shall contain a minimum of 3% polymer solids by mass of asphalt, as determined by an analytical method approved by the Department.

[f] These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 931.03.07 – TEMPERATURE RANGES FOR USE OF ASPHALT MATERIALS

Type or Grade of Asphalt	Asphalt Temperature		
	Mixture At Discharge Max. °F	For Mixing °F	For Spraying °F
PG76	350	275-350	285-350
PG70	350	275-350	285-350
PG64	350	275-350	285-350
PG58	350	275-350	285-350
PG52	325	275-350	285-350
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		70-185	70-185

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 Oklahoma Department of Transportation, Materials Division. Copies of these requirements may be obtained at the office of the Materials 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.

Application Temperature. The temperature to which asphalt materials shall be heated at the time of use shall be as shown in Table 4, unless otherwise specified.

Additional requirements for Asphalt Cement. PG 64-22 OK, PG 70-28 OK, PG 76-28 OK shall meet the requirements for PG 64-22, PG 70-28, and PG 76-28 as shown in AASHTO MP1. Additionally, they must meet the requirements as shown below.

- Elastic recovery, ASTM D6048, 25°C, run on RTFO residue.
  - 65% Minimum for PG 70-28 OK
  - 75% Minimum for PG 76-28 OK
- Separation, AST D5976, except test as original binder for G* value according to AASHTO
- TP5. (Separation is defined as 10% or greater difference in G* between top and bottom samples.)
- AASHTO TP5 - Test Method for Determining the Rheological Properties of Asphalt Binder
- Using a Dynamic Shear Rheometer (DSR)
- Original DSR G*/sin (d) limits 1.00 - 2.50.
- RTFO DSR G*/sin(d) limits 2.20 - 5.50
- PAV DSR (G*)*(sin(d)) -Run at 25°C for PG 64-22OK, PG 70-28 OK and PG 76-28 OK
- Spot test with standard Naphtha Solvent, AASHTO T102, Negative, PG 64-22 OK
- Flash Point, AASHTO T48, increase from 230°C to 288°C
- Solubility in Trichloroethylene, AASHTO T44 and AASHTO MP1 (99% Soluble Required)

Asphalt Binder Suppliers shall furnish recommended mixing and compaction temperatures for their product to the hot-mix producer. They shall also supply handling requirements.

931.04 – COMPOSITION OF MIXTURES.

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 Materials Engineer for review. The review of the proposed mix design will be to determine that the mix meets the design criteria. The Contractor shall furnish one mix design for each specific asphalt concrete mixture listed on the plans or in the Contract. The mix design shall be prepared in an approved laboratory of the Contractor' s choice. A request for laboratory approval may be made either by a Contractor or a Laboratory. Approval will be according to the Materials Division Policy for Asphalt Mix Design Laboratories.

The initial job-mix formula shall meet the requirements of Tables 5A or 5B and Tables 6A and 6B for the type mix specified on the Plans or in the Proposal. Prepare a trial mixture in accordance with Subsection 403. If the trial mixture, prepared at the initial job-mix formula proportions, fails to meet the requirements of Tables 6A and 6B, propose changes to the job-mix formula. If these changes do not result in a mixture meeting the requirements of Tables 931.04.01 or 931.04.02 and Tables 6A and 6B, 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. The job-mix formula with the allowable tolerances shown in Table 7 shall establish the Specification limits for each mixture. These limits may be outside the broad range in Tables 5A or 5B except for the following conditions:

Absolute maximum sieve size. Example, 1/2 inch (12.5 mm) sieve for type C.

Open graded friction surface. The job-mix formula with allowable tolerances shall be within the broad range given in Table 5A.

No tolerances are shown. The broad ranges in Table 5A are the Specification limits.

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 Tables 6A and 6B 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 Tables 5A or 5B. If test results indicate these adjustments will result in a mixture meeting the requirements of Tables 6A and 6B, 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 regardless of the allowable

tolerances. For temporary construction, such as crossovers and detours, the requirements given in Table 5A for minimum percent asphalt and Tables 6A and 6B for retained strength and V.M.A. will be waived.

Recycled Bituminous Pavements. Unless otherwise noted on the Plans, bituminous mixtures containing up to 25 percent reclaimed asphalt concrete pavement will be accepted provided that the mixture meets all the requirements of these Specifications. For roadways with 0.3 million ESALS or more, bituminous mixtures containing reclaimed asphalt concrete pavement will not be accepted in the wearing course. The reclaimed asphalt concrete pavement shall be crushed, screened or otherwise sized such that at least 95 percent passes the 2 inch (50 mm) sieve. The insoluble residue content for reclaimed asphalt concrete pavement will be considered to be zero unless it is from a known source and documentation of insoluble residue content is available. The total amount of natural sand and gravel permitted in the combined aggregate will be reduced by the amount of natural sand and gravel contained in the reclaimed asphalt concrete pavement.

TABLE 931.04.01 – MIXTURES (HOT MIX - HOT LAY)

ASPHALT CONCRETE MIXTURE TYPE:	A	B	C	D	E	OPEN GRADED BITUM. BASE	OPEN GRADED FRICTION SURFACE [a]
Sieve Size	**Percent Passing**						
1 ½ inch	100					100	
1 inch	90-100					95-100	
¾ inch		100					
½ inch	70-90	90-100	100		100	25-60	100
3/8 inch		70-90	90-100	100	80-95		90-100
No. 4	40-65	45-70	60-80	80-100	45-60	0-10	25-45
No. 10	25-45	25-50	35-60	50-90	20-35	0-5	0-10
No. 40	10-26[b]	12-30b	15-35b	20-50	9-19		
No. 80	6-18	7-20	8-22	10-30	6-14		
No. 200	…[c]	…[c]	…[c]	5-15	…[c]	0-3	0-5
Asphalt Cement [d], % of mix mass	3.8-6.5	4.7-7.5	5.1-7.5	5.5-7.5	4.8-7.5	…[e]	…[f]
Viscosity Grade Asphalt Cement	…[g]	…[g]	…[g]	…[g]	…[g]	…[g]	…[g]

TABLE 931.04.02 - TABLE OF MIXTURES (HOT MIX - COLD LAY)

TYPE:	HC1	HC2	HC3	HC4
Sieve Size	**Percent Passing [h,i,j]**			
1 ½ inch	100			
1 inch	90-100			
¾ inch	…	100		
½ inch	70-90	90-100	100	
3/8 inch	…	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 [k]	MC-800	MC-800	MC-800 or PG 52-22	MC-800 or CMS-1

FOOTNOTES FOR TABLES 931.04.01 AND 931.04.02

[a] A minimum of 55 percent of the aggregate shall be retained between the 3/8 inch (9.5 mm) and the No. 4 (4.75 mm). An approved anti-stripping agent shall be used at the rate of 5 gallon per 1000 gallons (5 liter per 1,000 lSiter) of asphalt cement.

[b] The upper limit for the No. 40 (425 µm) sieve shall be controlled by the gradation of the No. 10 (2.00 mm) sieve as follows:

Type A		**Type B**		**Type C**	
No. 10	No. 40 Max	No. 10	No. 40 Max	No. 10	No. 40 Max
25-32	19	25-43	24	35-49	27
33	20	44	25	50	28
34	21	45	26	51	29
35	22	46	27	52	30
36	23	47	28	53	31
37	24	48	29	54	32
38	25	49-50	30	55	33
39-45	26	…	…	56	34
…	…	…	…	57-60	35

[c] 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 the 1.2. This ratio will establish the master range for the job-mix formula on the No. 200 sieve.

[d] The lower limit may be adjusted if the effective specific gravity of the combined aggregates is greater than 2.65. This adjustment will be allowed if a theoretical lab molded specimen at the JMF asphalt content meets the VMA requirement at 4 percent air voids.

[e] The amount of binder shall be 2.5 ± 0.3 percent by mass of the mix. The amount of asphalt binder may be adjusted if the effective specific gravity of the combined aggregate is greater than 2.833 or less than 2.495.

[f] 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).

[g] Three grades of asphalt cement will be used as shown below unless otherwise specified on the plans. Use PG 64-22 OK in roadways with <3M ESALs and with all mixes more than 5 inches (125 mm) below the surface of the pavements in roadways with >3M ESALs and with all mixes used for shoulders and temporary detours. Use PG 70-28 OK with all mixes in the top 5 inches (125 mm) of pavements in roadways with >3M ESALs. Use PG 76-28 OK with all mixes in the top 5 inches (125mm) of pavements in readway >30M ESALs or in roadways with slow, standing, or turning traffic such as urban intersections with >3M ESALs.

[h] If emulsion or MC grade asphalt is used, the aggregate shall be surface dry and heated to a temperature above 160°F.

[i] AC Type Mixtures. The aggregate shall be thoroughly dried and delivered to the mixer at a temperature above 200°F (93.3°C) 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 mass, 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.

[j] The temperature of the aggregate shall not be heated in excess of the temperature of the liquid asphalt at time of mixing.

[k] MC-3000 may be substituted for MC-800 when specified or approved by the Engineer.

TABLE 931.04.03 – PROPERTIES OF LABORATORY MOLDED SPECIMENS		
Asphalt Mixture Property	**Hot Mix-Concrete Hot**	**Mix-Cold Lay**
Density, % of max. theo.sp.gr.		
3 million ESALs or more	94-96	93-97
0.3 million to 3.0 million ESALs	95-97	93
0.3 million ESALs or less	96-98	93
Hveem Stability, min,		
0.3 million ESALs or more [a]	40	35
Less than 0.3 million ESALs	35	35
% Retained Strength, min.	75	NA

TABLE 931.04.04 – PROPERTIES OF LABORATORY MOLDED SPECIMENS							
	ASPHALT CONCRETE						
	Type A	**Type AH**	**Type B**	**Type BH**	**Type C**	**Type D**	**Type E**
V.M.A. min % [b]	13	13	15	15	16	17	16

[a] Includes all city streets regardless of ESALs.

[b]V.M.A. (Voids in the Mineral Aggregate) is based on the effective specific gravity of the aggregates. V.M.A. shall be applicable when establishing the initial job-mix formula, when evaluating a pro-posed adjustment to the job-mix formula, and when transferring the mix design to another project.

NOTE: V.M.A. is an important mixture property and shall be calculated and reported for all asphalt concrete mixtures.

Acceptance of Combined Cold Feed Aggregate Gradation. Combined aggregate samples obtained by an approved sampling device may be tested for gradation in accordance with Subsection 931.06 (AASHTO T 27 & T 11) in lieu of testing extracted aggregate for gradation, provided the asphalt mixture does not contain reclaimed bituminous materials and the aggregate does not degrade appreciably during the drying and mixing process. The use of combined aggregate samples taken prior to asphalt coating for gradation acceptance of the mixture will be at the Engineer' s discretion. When approved or directed by the Engineer, acceptance of bituminous plant mix gradation results based on cold feed combined aggregate samples under this Contract will be contingent on the following conditions.

When the aggregate gradation test on extracted aggregates per AASHTO T 30 compares favorably with the results of cold feed aggregate gradation results.

When the Independent Assurance Samples test results of extracted gradation analysis compare favorably with Job Control Acceptance Samples.

When the results do not compare favorably, acceptance will be based on results of gradation tests performed in accordance with AASHTO T 30 on extracted aggregate.

Acceptance of Bitumen Content. Determination of the bitumen content of plant produced mixtures shall be determined by OHD L-26 method of test.

931.05 – TOLERANCES.

The tolerances shown in Table 7 shall be applied to the job-mix formula (JMF) as described in Subsection 931.04. The job average for gradation shall meet the stated 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 931.05 - RANGE OF TOLERANCES				
	Asphalt Concrete	Hot Mix Cold Lay	Open Graded Friction Course	Open Graded Bituminous Base
Sieve Size	Percent Passing			
No. 4 & larger	±7	±7	±7	--
No. 10	±4	±5	±4	--
No. 40	±4	±4	--	--
No. 80	±4	±4	--	--
No. 200	±2	±2	±2	--
Asphalt Cement	±0.4 a	±0.5 a	±0.3 b	±0.3 b
Temp. of mix as discharged from mixer °C	±10	±10	±10	±10

a The tolerances shown for asphalt content are for individual samples. The average asphalt content by OHD L-26 shall be within ±0.2 percent of the job-mix formula.

b The percent asphalt may be determined by the tank strap method of measurement or the printed batch weights from an approved automatic printer system or the counter on a drum-mix plant.

931.06 – SAMPLING AND TESTING.

Methods. Sampling and testing shall be done in accordance with AASHTO methods, except as noted below:

TABLE 931.06.01 – SAMPLING AND TESTING AGGREGATES:	
Sampling	T 2
Sieve Analysis	T 27
Material Passing No. 200 Sieve	T 11
Los Angeles Abrasion	T 96
Mud, Clay Balls, Sand Clusters, Sticks and Root Retained on No. 4	OHD L-9
Equivalent	T 176
Aggregate Durability Index	T 210
Insoluble Residue	OHD L-25
Soft Particles	OHD L-38

TABLE 931.06.02 – 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 Stabilometer Value	OHD L-8
Specific Gravity and Wt.per ft 3 (m 3) Compressed Bituminous Mixture	OHD L-14
Test for Stabilometer 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	

TABLE 931.06.02 – SAMPLING AND TESTING BITUMINOUS MIXTURES:
b OHD L-7 shall only be used when the results obtained from AASHTO T 209 are suspect.

TABLE 931.06.03 – 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

TABLE 931.06.04 – TESTING EMULSIFIED ASPHALT	
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
Elastic Recovery	OHD L-42
Ash in Bituminous Material	T 111
Creep Stiffness by Bending Beam Rheometer	TP1
Rhelogical Properties by Dynamic Shear Rheometer	TP5
Grading or Verifying Asphalt Binder	PP6
Accelerated Aging of Asphalt Binder by Pressure Aging Vessel	PP1
Fractured Faces Sand	OHD L-18

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 methods of sampling, testing and acceptance as specified may be modified for the bituminous materials under the Department' s acceptance policy. Copies of the procedure are available at the office of the Materials Engineer. 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 conditionally approved at the source by the Materials Division.

SECTION 932 – PORTLAND CEMENT CONCRETE

This Specification covers all materials, classification, mix designs, proportioning, and testing of portland cement concrete. All concrete 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 Section 403, with Sections 304 and 404 as specified for each use.

932.01 – MIX DESIGN AND PROPORTIONING.

932.01.01 - CLASSES OF CONCRETE.

The classes of concrete are shown in the following table:

CLASSES OF CONCRETE					
Class of Concrete	Maximum Cement Content[a]	Minimum 28-day Air Content	Water/Cement Ratio[b]	Slump [c]	Minimum 28-day Compressive Strength
	lb/y [3]	Percent	lb/lb	inches	psi
AA	611	6.5±1.5	0.44	2±1	4000
A	564	6±1.5	0.48	2±1	3000
AP	470	6±1.5	0.48	2±1	3000
C	395	6±1.5	0.62	3±1	2400
P	611	5±1.5	0.44	3±1	As specified

[a] Cement Substitution. Fly ash meeting the requirements of Section 922 may be substituted for up to 15% (20% from April through October) of the required cement. Ground granulated blast furnace slag meeting the requirements of AASHTO M 302 Grade 100 or Grade 120 may be substituted for up to 25% of the required cement. A combination of up to 25% ground granulated blast furnace slag and up to 15% fly ash may be substituted for up to 40% of the required cement. From April through October, a combination of up to 25% ground granulated blast furnace slag and up to 20% fly ash may be substituted for up to 45% of the required cement. Substitution shall be by weight: 1.0 pound (1 kg) for each 1.0 pound (1 kg) of cement. The concrete mix design shall be appropriately adjusted. These substitutions will not be allowed for high early strength concrete, Class P concrete or concrete containing Type IP, Type I (PM), or Type I (SM) cement. If the specified minimum cement content is satisfied, additional fly ash or ground granulated blast furnace slag, or silica fume complying with ASTM C 1240, may be added to the mix when approved as part of the mix design.

[b] Water Cement Ratio. Using the weight in pounds of each material, calculate the water-cement ratio (W/C) by the following equation: W/C = Water/ (Cement + Fly Ash + Blast Furnace Slag + Silica Fume) 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 plus water in any admixture solutions and shall not exceed the limit specified.

[c] Slump. The slump shall be as shown, or as specified in the contract documents, 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. If using a high-range water reducing admixture, limit the slump to a maximum of 9 inches (230 mm).

[d] Compressive Strength. Compressive strength is based on the average of three test cylinders. The compressive strength requirements of Class P concrete will be specified in the contract documents. When the class of concrete is not expressly indicated on the Plans, the following requirements shall govern:

- Class AA. Use Class AA concrete in superstructure items, such as bridge floors, approach slabs, reinforced concrete piles, drilled shaft foundations, parapet walls, concrete rail and handrails.
- Class A. Use Class A concrete for pavements and in substructures items, such as pier caps, columns, abutments, retaining walls, box culverts, and all reinforced concrete not requiring Class AA concrete.
- Class AP. Use Class AP concrete in shoulders, merge areas and gore areas for PCC pavements, unless otherwise directed by plan notes.
- Class C. Use Class C concrete for soil erosion control structures.

✍ Class P. Use Class P concrete for precast prestressed concrete members, such as PC beams, double tees, prestressed concrete piling, and stay-in-place precast concrete deck panels, and cast-in-place post-tensioned structures.

932.01.02 – PROPORTIONING

Base the mix design on absolute volume for the class of concrete specified and the consistency suitable for satisfactory placement of the concrete. Design and produce concrete mixtures that conform to the Class of Concrete table in this section and base the mix design on absolute volume. Proportion the coarse and fine aggregate in accordance with ACI 211.1. Use the least amount of sand and mixing water which will ensure concrete of the required workability for placement conditions. Meet the minimum strength within 72 hours of placement for high early strength concrete. Submit the mix design at least 14 days before production to the Engineer. Include at least the following information with each mix design:

A) Project identification

B) Name and address of contractor and producer

C) Mix design designation

D) Intended use of the mix design

E) Expected travel time from batch to placement

F) If the concrete will be pumped or not

G) Aggregate sources, gradation, moisture content, saturated surface dry batch mass, LA abrasion (AASHTO T 96-92), and freeze thaw durability (AASHTO T 103-91).

H) Fineness modulus of fine aggregate

I) Cement type and source

J) Type of cement replacement, if used, and source

K) Type of admixtures and sources

L) Material proportions

M) Air content

N) Slump

O) Water / cement ratio

P) Strengths at 7 and 28 days

Q) Strengths at 72 hours for high early strength concrete.

NOTE: Do not place any concrete until the mix design is approved.

Submit new mix designs if:

A) The mix design is rejected by the Engineer

B) The source of any material changes

C) The mix design produces unacceptable workability or production test results.

932.01.03 – TESTS AND SAMPLES.

Conduct fresh concrete sampling using AASHTO T141. If pumped, sample concrete after discharge from the pump. Determine the slump using AASHTO T119, and the air content using AASHTO T121, AASHTO T152 or AASHTO T196 as appropriate. Make and cure test specimens in accordance with AASHTO T23, except, after initial curing, specimens for acceptance testing will be cured in a medium maintained at 40°F (4°C) to 85°F (29°C) until tested. Test specimens for acceptance according to AASHTO T22 for cylinders.

932.02 – PORTLAND CEMENT

Portland cement shall conform to the requirements of AASHTO M 85 or AASHTO M 240. Type I, Type I(SM), Type I(PM), 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 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 may 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 any structure or adjacent structures. Provide suitable means of storing and protecting the cement against dampness.

NOTE: 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, except as modified by the Department' s acceptance policy: "Procedure for Sampling, Testing and Acceptance of Portland Cement." Copies of the procedure are available at the office of the Materials Engineer.

932.03 – ADMIXTURES

Use admixtures included in the approved mix design only, unless otherwise specified in the contract documents. This subsection does not specify requirements covering fly ash, ground granulated blast furnace slag, or silica fume. In addition, admixtures shall not be used to replace cement, and admixtures containing chlorides such as Cl - in excess of ten thousand ppm shall not be used in prestressed or reinforced concrete.

A) Accurately measure admixtures into each batch by methods approved by the Engineer.

B) Dispense admixtures 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 premeasured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. Do not allow the dosage to vary more than 5 percent from the dosage established by the mix design for the mix requirements. Make sure the measuring equipment allows for easy confirmation of the accuracy of measurement of the admixture dosage.

C) Store admixtures in a manner to prevent freezing and agitate them to prevent separation or sedimentation of solids. Do not use air agitation.

D) If more than one liquid admixture is used, be certain that they are compatible, and dispense each one by separate equipment.

NOTE: Any type of admixture shall be uniform in properties throughout its use in the work; if the furnished admixture is not uniform in properties, discontinue using it. Use only those admixtures which have been approved by the Materials Engineer. A list of approved commercial admixtures is maintained by the Materials Division.

NOTE: Admixtures not on the approved list may be accepted if the manufacturer presents a type A certification defined in Section 109.17 that the admixture meets all the requirements of AASHTO M 154 or AASHTO M 194 as appropriate. 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. Air entraining admixture shall be ADDED DURING BATCHING ONLY.

B) Chemical Admixtures. Chemical admixtures shall conform to AASHTO M 194 for the particular type specified.

C) High Range Water Reducer (HRWR) Concrete Mixture. The use of a Type F and G HRWR in concrete mixes will require written approval of the Engineer and meet the additional requirements of this Subsection for each specific project. If a high range water reducing chemical admixture is to be used, the concrete mixture shall meet the requirements of Subsection 932.01 or 509.01 prior to the addition of the admixture. When proposing the use of high range water reducer, provide a work plan with the mix design. Include the following in the work plan:

1) Purpose. Describe the purpose for using a high range water reducing admixture.

2) Sequence. Specify the batching sequence detailing when, where, and how HRWR is to be added to the mix.

3) Mixing Data. Specify the mixer capacity and the mixing time and revolutions before and after the addition of the HRWR.

4) Redose. Specify any condition that may require a redose include the redose dosage, permissible slump range for the redose, and the mixing time after redosing. Check air content after each redose.

5) Slump Loss. Provide an estimate of slump immediately before and after the addition of the HRWR, slump during placement and finishing, and the total length of time the HRWR is effective. Base the estimate upon trial batches or data from previous work using a similar mix design and consider the time required for delivery, placement, finishing, and temperature.

6) Air Content. For each slump estimate required above, provide a corresponding estimate of air content.

D) Corrosion-Inhibiting Admixtures. When an approved corrosion-inhibiting admixture is required by the contract documents, the admixture shall meet the following requirements. The admixture shall comply with the following characteristics when tested using the procedures described in AASHTO M194.

Physical Requirements for Corrosion-Inhibiting Admixture

Characteristic Value	
Calcium Nitrite Content	30%±2% (by weight)
Time of Setting	allowable deviation from control, (h:min)
Initial, not more than	1:00 earlier nor 3:30 later
Final, not more than	1:00 earlier nor 3:30 later
Compressive Strength	minimum percent of the control, any time: 90
Flexural Strength	minimum percent of the control, any time: 90
Length Change	maximum shrinkage, percent of the control: 135
Relative Durability Factor	minimum: 80

The average corrosion current of the corrosion inhibitor protected specimens shall be less than two microamps when tested according to ASTM G109 “Standard Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.” The test shall be run for three complete cycles after the control specimens have failed according to Section 8, Period of Testing. Protection potentials (Ep) shall be more positive than 280 mV versus SCE when tested according to ASTM G61 “Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements for Localized Corrosion Susceptibility of Iron, Nickel, or CobaltBased Alloys.” The test medium shall be modified to contain a calcium hydroxide

solution with a pH similar to concrete of 12.5, and sodium chloride content equivalent to approximately 5 lb/yd 3 (3kg/m 3) of concrete.

After five years of testing, the corrosion inhibitor protected test specimens shall have a corrosion current in microamps of less than 10% of the control when tested according to ASTM G109. The test specimens shall have a minimum 1 inch (25mm) of concrete cover over the reinforcement and a maximum water to cement ratio of 0.40.

Unless otherwise specified, the concrete shall contain 4.0 gallons of corrosion inhibiting admixture per cubic yard (19.8 l/m 3). Account for possible set acceleration effects from the use of calcium nitrite based admixture. Set retarding admixtures may be required.

932.04 – 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.

932.05 – FINE AGGREGATE

A) Materials Covered. These Specifications cover the quality and size of fine aggregates for portland cement concrete pavements or bases, highway bridges, and incidental structures. 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 it shall conform to these Specifications. Mix and store fine aggregate from different sources in separate stockpiles; in addition, do not use them alternately in the same class of construction or mix without permission from the Engineer or as provided herein for manufactured sand. Stockpile fine aggregate in accordance with Subsection 109.17.05. When manufactured sand is approved for use in combination with natural sand, at least 50 percent of the total fine aggregate by mass shall be natural sand. Store and batch the two materials 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	LIMITS:
Clay lumps and friable particles	%, maximum 3.0
Coal and Lignite	%, maximum 0.25

D) Organic Impurities. All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric 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.

NOTE: 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.

E) Gradation. Fine aggregate shall be well graded from coarse to fine, and when tested by means of

laboratory sieves, it shall conform to the following requirements:

SIEVE SIZE	PERCENT PASSING
3/8 inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
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, determine a fineness modulus (See Note). Determination shall be made from a representative sample obtained by the Engineer from the Contractor' s proposed source. Reject 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.

NOTE: The fineness modulus of an aggregate is determined by adding the total percentages of material in the sample that are coarser than each of the following sieves (cumulative percentages retained), and dividing the sum by 100; No. 100 (150 µm), No. 50 (300 µm), No. 30 (600 µm), No. 16 (1.18 mm), No. 8 (2.36 mm), No. 4 (4.75 mm), 3/8 inch (9.5 mm), 3/4 inch (19.0 mm), 1 1/2 inch (37.5 mm), and larger increasing at the ratio of 2 to 1.

F) 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

932.06 – COARSE AGGREGATE

A) Materials Covered. These Specifications cover the quality and size of coarse aggregate for use in portland cement concrete pavements or bases, highway bridges, and incidental structures.

B) General Requirements. Stockpile coarse aggregate in accordance with Subsection 109.17.05. 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. The sodium sulfate soundness require-ment shall not apply. Use only coarse aggregate shall consisting 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 stored and batched separately in recommended proportions, upon written permission of the Engineer. At least 70 percent of all

aggregate retained on the No. 4 (4.75 mm) 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:

Processed Aggregate Size Number

	357	57	67	7	8
SIEVE SIZE	**PERCENT PASSING**				
2 1/2 inch	100				
2 inch	95-100				
1 1/2 inch		100			
1 inch	35-70	95-100	100		
3/4 inch			90-100	100	
1/2 inch	10-30	25-60		90-100	100
3/8 inch			20-55	40-70	85-100
No. 4	0-5	0-10	0-10	0-15	10-30
No. 8		0-5	0-5	0-5	0-10
No. 16					0-5
No. 200	0-1.5	0-2.0	0-2.0	0-2.0	0-2.0

- Furnish coarse aggregate for Class A concrete in the No. 57 size only except as noted below.
- Furnish coarse aggregate for massive Class A concrete in the No. 357 size. Coarse aggregate for Class C concrete may be either No. 57 or No. 357.
- Furnish coarse aggregate for thin section concrete in the No. 7 size.
- Coarse aggregate for Class AA or P concrete shall be furnished in the No. 67 size. No. 7 or No. 8 coarse aggregate may be used in Class P concrete if either the specified 28-day compressive strength is in excess of 6000 psi (41.4 MPa) or permeability limits are specified.

932.07 – CURING AGENTS

Concrete curing agents shall consist of burlap, cotton mats, earth, white or red pigmented membrane curing compound, waterproof paper, polyethylene film, linseed oil emulsion, or water for ponding. Keep the curing agents 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 (600 mm) longer than the width of the pavement slab.

B) Cotton Mats. Cotton mats shall be either new, or they shall not have been used for any other purpose than curing concrete. Do not use mats with holes.

C) 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.

D) Liquid Membrane Curing Compounds. Liquid membrane curing compounds shall conform to AASHTO M 148 with these exceptions:

1) 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.

2) 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.

3) 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. Do not use sections of membrane which have lost their moisture- retaining qualities.

F) Linseed Oil Emulsion. Linseed oil emulsion shall comply with the following table of composition:

TABLE 937.05 – LINSEED OIL EMULSION

Composition	Weight Percent
Oil Phase (50% min. by volume)	
Boiled Linseed Oil	97.0 ± 0.1
Saturated Tallow Alcohol	3.0 ± 0.1
Total	100
Water Phase (50% max. by volume)	
Water	99.6 ± 0.01
Sodium Hydroxide	0.37 ± 0.01
Dipicolinic Acid	0.03 ± 0.001
Total	100

The emulsion shall be stable at the time of application.

Fugitive Dye. Linseed oil emulsion shall be colored by a red fugitive dye so that inspection may indicate complete coverage. The color must be maintained at least four (4) hours, after which it should gradually disappear within a couple of weeks.

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 1 gallon per 175 square feet(4.3 m 2 /l).

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.

G) 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.

932.08 – 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. Do not use this type filler in joints for which the Plan detail requires a sealer. Submit a type A certification from the manufacturer for each lot or shipment of materials.

B) Preformed Expansion Joint Fillers. (Nonextruding and Resilient Types). 1. Nonbituminous Joint

Filler. The nonbituminous joint filler shall conform to 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 psi (10.34 MPa). Compliance with the asphalt content requirement is waived providing the material meets all other physical requirements as specified. Submit a type A certification from the manufacturer for each lot or shipment of materials.

C) Preformed Elastomeric Compression Joint Sealer.

1) Description. These Specifications cover preformed elastomeric compression joint sealers for use in portland cement concrete pavements and concrete bridge floors.

2) Materials.

a) Preformed 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 preformed joint sealer.

b) 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 practical lengths for longitudinal joints. Elongation of the joint material of more than 2 percent during placement will require the preformed elastomeric compression joint sealer to be removed and replaced.

c) Samples. Two 2 foot (600 mm) long pieces of each size of sealer to be used shall be submitted to the Materials Division for tests as warranted.

d) 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.

e) 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.

f) Certification. A type A certification shall be submitted by the manufacturer 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. When recommended by the manufacturer, use a primer 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. Use the bond breaker recommended by the materials manufacturer as shown on the ODOT standard drawings.

a) Acceptance. Furnish a type A certification with each shipment or lot.

b) Packaging. Package the joint sealer in sealed containers identified by the name of the manufacturer, the manufacturer' s lot number, and the date of manufacture, and bearing 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. Give proper instructions for use of the primer on its container.

c) Tests. Tests shall be made in accordance with OHD L-21.

3) Machine Extruded Joint Sealer.

a) General. The joint sealer shall be a modified polysulfide or polyurethane polymer consisting of 2 components to be machine mixed and machine extruded directly into the joints. The polysulfide components shall be mixed at a 1:1 ratio by volume and the polyurethane components shall be mixed in accordance with the manufacturer's recommendations. Upon being opened, component B shall not exhibit more than a slight degree of skinning.

b) Properties of Laboratory Mixed Material.

Determination Requirements	
Penetration, 77°F, 0.1 mm (25°C)	50 to 120
Penetration, 158°F (70°C)	1.5 x Pen. at 25°C
Cold Flow, 3 minutes, mm, minimum	19.1
Cold Flow, 40 minutes, mm, maximum	12.7
Resilience, 77°F (25°C), %, minimum	70
	60 [a]
Resilience of oven aged sample, 7 days, %, minimum	70
	60 [a]
Resilience, 158°F (70°C), %, minimum	60
	50 [a]
Bond to concrete b , 100% extension, dry, -20°F	No failure
Bond to concrete b , 100% extension, wet, -20°F	No failure
Nonvolatile content, %, minimum	88

[a] Applies if penetration at 77°F is 90 to 120(0.1mm) (25°C is 90 to 120)
[b] Cure Sample for 24 hours at 77°F (25°C); then oven age for 7 days at 158°F±2°F (70 ± 1°C).

4) Pourable Joint Sealer.

a) General. The joint sealer shall be a polymeric material consisting of two components to be uniformly mixed and poured directly into the joints. The mass of component A in the mixture shall be not less than 10 percent of the mass used of component B. Upon being opened, neither component shall exhibit more than a slight degree of skinning.

b) Properties of Laboratory Mixed Material

Determination Requirements	
Viscosity, 5 minutes after mixing, Pa·s	2.00 to 3.50
Application time (Pot life or time to reach 20.00 Pa·s), 77°F , hr, minimum	1
Penetration, 77°F , 24 hours aging, maximum	150
Penetration [a] , 77°F (25°C)	50 to 120
Penetration [a] , 158°F (70°C)	1.5 x Pen @ 25°C
Resilience [a] , 77°F (25°C), %, minimum	70
	60 [b]
Resilience [a] , 158°F (70°C), %, minimum	60
	50 [b]
Resilience [a] , oven aged sample, 7 days, %, minimum	70
	60 [b]

Bond to Concrete [c] , 100% extension, dry, -20°F (-29°C)	No failure
Bond to Concrete [c] , 100% extension, wet, -20°F (-29°C)	No failure
Nonvolatile content, %, minimum	88

[a] After 96 hours aging at 77°F (25°C)
[b] This requirement applies if penetration at 77°F (25°C) after 96 hours at 77°F is 90 to 120(0.1mm) (25°C is 90 to 120).
[c] Cure sample for 24 hours at 77°F (25°C), then oven age at 158°F±2°F (70°C ± 1°C) for 7 days before testing.

E) Hot Poured Joint Sealer.

1) Description. Joint sealers furnished shall be of the hot poured type which readily bonds to concrete surfaces.

2) Materials.

a) 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.

(i) 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.

(ii) Acceptance. Hot poured joint sealer furnished under these Specifications will be accepted for use upon receipt of a type C certification in accordance with Section 109.17. Sealer materials damaged by excessive or prolonged heating will be rejected.

b) Backer Rod. When shown on the Plans, the use of a backer rod of the size and dimensions shown shall be required. The backer rod shall be compatible with the joint sealant. The backer rod shall be an approved product listed for use by the Materials Division.

F) Low Modulus Silicone Joint Sealant.

1) Description. These Specifications cover low modulus silicone joint sealant and expanded poly-ethylene backer 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.

a) Silicone Sealant. The silicone sealant shall meet the color, toxicity, stability, and durability requirements of the current Federal Specification TT-S-001543 for Class A sealants and the following test requirements:

Test	Limit	Test Method
Flow, inches , maximum	0.3	MIL S 8802
Extrusion Rate, g/minute	75-250	MIL S 8802
Tack Free Time, 77°F, 45-55% relative humidity, minutes	20-75	MIL S 8802
Specific Gravity	1.01 - 1.515	ASTM D 792 Method A [a]
Durometer, Shore A, 0°F (-17.8°C)	10-27	ASTM D 2240 [a]
Tensile Stress, 100% Elongation, psi (kPa), maximum	75 (517)	ASTM D 412 Die C [a]
Elongation, %, minimum	500	ASTM D 412 Die C [a]

[a] Cured 7 days at 77°F±4°F (25 ± 2°C) and 50 ± 5 percent relative humidity. Concrete primer may be used if specified by the sealant manufacturer.

(i) Acceptance. The sealant shall be accepted on the basis of manufacturer' s certification and approval by the Materials Engineer in accordance with Subsection 109. 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. Samples of the joint sealant shall be submitted by the manufacturer to the Materials Division for tests and approval prior to use.

(ii) Storage and Shelf Life. Storage and use of the joint sealant shall be in accordance with the manufacturer' s recommended practices.

b) Backer Rod. The backer rod shall be of the size and dimensions shown on the Plans. The backer rod shall be compatible with the joint sealant and no bond or reaction shall occur between the rod and sealant. The backer rod shall be an approved product listed for use by the Materials Division.

G) Low Modulus Silicone Joint Sealant (Self-Leveling).

1) Description. These Specifications cover self-leveling, low modulus silicone joint sealants and polyethylene backer rod for use in sealing portland cement concrete pavement joints and/or portland cement concrete to asphalt concrete pavement joints. The self-leveling silicone sealant shall be furnished in a one part silicone formulation. Acetic acid cure sealants are not accept-able.

2) Materials.

a) Silicone Sealant. The silicone sealant shall meet the color, toxicity, stability, and durability requirements of the current Federal Specification TT-S-001543 for Class A sealants and the following test requirements:

(i) 2.1.1.Acceptance. The sealant shall be accepted on the basis of the manufacturer' s certification and approval by the Materials Engineer in accordance with Subsection 109. Furnish a type A certification for the above listed test requirements. Furnish a type D certification to comply with current Federal Specification TT-S-001543 in accordance with Subsection 2 of these Specifications. Submit samples of the joint sealant to the Materials Division for tests and approval prior to use.

(ii) Storage and Shelf Life. Storage and use of the joint sealant shall be in accordance with the manufacturer' s recommended practices.

b) Backer Rod. The backer rod shall be of the size and dimensions shown on the Plans. The backer rod shall be compatible with the joint sealant, and no bond or reaction shall occur between the rod and the sealant. The backer rod shall be an approved product listed for use by the Materials Division.

Test	Limit	Test Method
Appearance	Smooth, non-grainy, homogeneous mixture	MIL S 8802
Extrusion Rate, g/minute, minimum	200	MIL S 8802
Tack Free Time, 77°F (25°C), 45-55% relative humidity, hr	5	MIL S 8802
Specific Gravity	1.26-1.34	ASTM D 792, Method A
Elongation, %, minimum	500	ASTM D 3583-85 Section 13, Modified [a]

Modulus @ 50%, psi, maximum	10	ASTM D 3583-85 Section 13, Modified [a]
Modulus @ 100%, psi, maximum	15	ASTM D 3583-85 Section 14, Modified [a]
Modulus @ 150%, psi, maximum	20	ASTM D 3583-85 Section 14, Modified [a]

[a] Clean two 1x1x3 inch concrete test blocks, hold under running tap water, and scrub with a brush for approximately 30 seconds. Allow blocks to dry for 24 hours at room temperature. Assemble blocks with 1x3 inch surface facing with 1/2 x 1/2 x 1 inch Teflon spacers. Hold in place with a clamp. Without touching the surface with your fingers, insert backer rod closed cell 1/2 inch diameter x 1 inch. Inject sealant to fill the cavity with no air entrapment. Allow the sealant to flow to a smooth surface, and do not strike off. Allow it to cure at 77°F and 45-55% relative humidity. After 21 days, remove the clamp and Teflon spacers and pull the test specimens at 2 inches per minute.

H) Rapid Cure Joint Sealant and Elastomeric Mortar.

1) Description. These Specifications cover rapid cure joint sealant and elastomeric mortar for use in expansion joints in bridge decks.

2) Materials.

a) Joint Sealant. Joint sealer shall be a self-leveling, rapid cure silicone joint sealant that cures to a low-modulus rubber upon exposure to atmospheric moisture. Rapid cure is defined as the development of sufficient integrity within the silicone in 8 hours or less to accommodate highway traffic and movements associated with bridges. Deliver each lot or batch of sealing compound to the job site in the manufacturer' s original sealed container. Each container shall be marked with the manufacturer' s name, and batch or lot number, and shall be accompanied by the manufacturer' s certification. Petroleum products shall not be deleterious to the sealant. Joint sealant shall meet the following requirements:

Test	Limit	Test Method
AS SUPPLIED:		
Extrusion Rate, g/minute, minimum	200	MIL S 8802
Specific Gravity	1.25 - 1.35	ASTM D 1475
AS INSTALLED - AT 77°F (25°C) AND 46-54% RH:		
Accelerated Weathering, No cracks, blisters	5,000 hours or bond loss	ASTM C 793-75
Skin-over time, minutes, maximum	20	OHD L-3
Non-volatile content, %, minimum	93	OHD L-4
Joint Elongation, %, minimum	600	ASTM D 3583-85
Joint Modulus at 100%, psi	3-12	ASTM D 3583-85 [a]

[a] Section 14, Modified: Clean six 1x1x3 inch concrete blocks; hold under running tap water and scrub with a brush for approximately 30 seconds. Allow blocks to dry for 24 hours at room temperature. Assemble blocks with 1x3 inch surfaces facing with 932.08, 1/2 x1/2 x 1 inch Teflon spacers; hold in place with a clamp. Insert backer rod, closed cell, 1/2 inch diameter by 2 inches; do not touch surface with fingers. Inject sealant to fill the cavity, with no air entrapment. Allow the sealant to flow to a smooth surface, do not strike off. Allow to cure at 77°F and 46-54% relative humidity. Cure for 160 hours, remove clamp and Teflon spacers, and pull the test specimens at 2 inches per minute.

b) Elastomeric Mortar. The binder material shall be a two-component, rapid curing liquid polymer that cures to a dense, semi-flexible polymer resistant to chemicals, weather, abrasion and impact. The binder material shall be compatible with the sealant, as

determined by the sealant manufacturer. The binder shall be cured in the “neat” to form the primer between the elastomeric mortar and the existing surfaces and shall be mixed with aggregate to form the polymer based mortar. Aggregate for the elastomeric mortar shall be compatible with the liquid polymer (binder material), as determined by the manufacturer. Properties for the binder material shall conform to the following requirements:

COMBINED LIQUID COMPONENTS (The mixing ratio shall be 1:1 by volume)		
Test	Limit	**Test Method**
Viscosity, Pa·s, 75°F±2°F (23.9°C ± 1.1°C) (Brookfield Model LVT) (Spindle No. 2, 30 RPM)	0.9 - 2.0	ASTM D 2393
Gel Time, minutes	25 - 60	AASHTO M-200
Elongation, %	40 - 55	ASTM D 638 [a]
Tensile Strength, psi (MPa), minimum	900 (6.21)	ASTM D 638 [a]
Shore D Hardness, 77°F (25°C), 7 day cure	45 - 75	ASTM D 2240
[a] Test Method Type 1, Molded Specimens, 1/4 inch (6.4 mm) thickness; speed of testing shall be 0.2±0.05 inch (5.1 ± 1.3 mm).		

Properties for the elastic mortar shall conform to the following:		
Test	**Limit**	**Test Method**
Absorption, %, maximum	1	ASTM D 570
Compressive Strength, 24 hr, psi (MPa), Method B, minimum	2500 (17.24)	ASTM C 579
Bond Shear Strength, psi (MPa), minimum	750 (5.17)	ASTM C 882
Abrasion Resistance Wear Index, Taber H-22, maximum	1.5 ASTM C 501	
Compressive Stress, psi (MPa), minimum	350 (2.41)	OHD L-6
Resilience, %, minimum	70	OHD L-6
Thermal Compatibility	Pass	ASTM C 884

c) General Use Procedure. Mixing and application time shall be as recommended by the manufacturer. No modification of the elastomeric mortar should be attempted without first consulting the manufacturer.

d) Acceptance and Sampling. The sealant and elastomeric mortar shall be accepted on the basis of the manufacturer’ s certification in accordance with Subsection 109 and acceptable performance on the project. A type A certification shall be furnished for the joint sealant, except a type B certification shall be furnished for the Accelerated Weathering test. A type B certification will be furnished for elastomeric mortar, except a type A certification will be furnished for the binder material. Samples of the rapid cure joint sealant, and the binder material and aggregate for the elastomeric mortar, shall be submitted by the manufacturers to the Materials Division for testing and evaluation.

e) Backer Rod. Backer rod shall be in accordance with Section 932.08 of the Standard Specifications.

f) Primer. Primer shall be applied as detailed in the plans prior to installation of the sealant or as specified by the sealant manufacturer.

g) Alternate Joint Products. When alternate expansion joint systems are specified on the plans, the Contractor may use the alternate joint system in place of the nosing and sealant specified above. Sealants and nosing material may be considered as an equal alternate to the above specified materials provided that they successfully complete a 3-year trial installation and evaluation in the State of Oklahoma as determined by the Bridge Engineer.

932.09 – 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. They 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 (915 mm) center to center. Sections of metal parting strips shall be not less than 10 feet (3.0 m) 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.

932.10 – HIGH DENSITY CONCRETE FOR BRIDGE DECK REPAIR AND OVERLAY

This Subsection covers the material requirements for high density concrete used for bridge deck repairs and/or overlays.

A) Aggregate.

1) Fine Aggregate. The fine aggregate shall meet all requirements of Subsection 932.05 except for gradation.

2) Coarse Aggregate. The coarse aggregate shall be a crushed stone containing no chert or shale and having a minimum durability of 50 as determined by AASHTO T 210. The coarse aggregate shall meet all other requirements of Subsection 932.06 and shall have an absorption of not more than 3 percent by mass.

3) Gradation. The combined aggregate shall meet the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
3/4 inch	100
1/2 inch	75 - 90
3/8 inch	62 - 80
No. 4	38 - 54
No. 16	16 - 32
No. 30	‘10 - 20
No. 50	‘4 - 12
No. 100	‘2 - 8
No. 200	‘0 - 4

B) Concrete. The concrete shall meet the following requirements:

Basic Absolute Volumes per Unit Volume of Concrete.

Combined Aggregate	0.6194
Air Content	0.0650
Water	0.1601
Cement	0.1555
	1.0000

A water-reducing admixture meeting the requirements of Subsection 932.03 shall be used. The slump, measured in accordance with AASHTO T 119, shall be 3/4 inch ± 1/4 inch (20 ± 5 mm). The air content of the freshly mixed concrete shall be 6.5 ± 1.0 percent when tested in accordance with AASHTO T 152 or T 196.

C) Grout. Grout for bonding new concrete to existing concrete shall consist of equal parts by mass of portland cement and sand, mixed with sufficient water to form a stiff slurry. The consistency of this slurry shall be such that it can be applied with a stiff brush or broom to the old concrete in a thin, even coating that will not run or puddle in low spots. For sealing vertical joints around repair or between adjacent lanes of overlay and at curbs, this grout shall be thinned to paint consistency.

932.11 – LATEX MODIFIED CONCRETE FOR BRIDGE DECK OVERLAYS

Description. This Subsection covers the material requirements for latex modified concrete for bridge deck overlays.

A) Aggregate.

1) Fine Aggregate. The fine aggregate shall meet all requirements of Subsection 932.05 except for gradation.

2) Coarse Aggregate. The coarse aggregate shall be a crushed stone containing no chert or shale and having a minimum durability factor of 50 as determined by AASHTO T 210 and have an absorption of not more than 3 percent. The coarse aggregate shall meet all other requirements of Subsection 932.06.

3) Gradation. The combined aggregate shall meet the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
3/4 inch	100
1/2 inch	68 - 83
3/8 inch	56 - 70
No. 4	36 - 46
No. 16	‘12 - 24
No. 30	‘7 - 17
No. 50	‘4 - 12
No. 100	‘2 - 8
No. 200	‘0 - 4

B) Latex Emulsion Admixture. Formulated latex admixture shall be nontoxic, film forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture and shall be homogenous and uniform in composition. Physical properties of the latex modifier shall conform to the following requirements:

Polymer Type Stabilizers	Styrene Butadiene
Latex	Nonionic Surfactant
Portland Cement Composition	Polydimethyl Siloxane
Percent Solids	46.0 - 49.0
Mass per Unit Volume, lbs/gallon, 77°F (kg/l, 25°C)	8.4 (1.007)
Color	White

A type D certification of materials will be required and shall be furnished to the Materials Engineer before acceptance of the product. Latex admixture to be stored shall be kept in suitable enclosures which will protect it from freezing and from prolonged exposure to temperatures in excess of 29°C. Containers of latex admixture may be stored at the bridge site for a period not to exceed 10 days. Such stored containers shall be covered completely with suitable insulating blanket material to avoid excessive temperatures

C) Latex Modified Concrete. The latex modified concrete for use in overlay shall be a workable mixture having the following properties or limits:

Material or Property	Concrete
Cement (Parts by Mass)	1

Fine Aggregate (Parts by Mass)	2.5
Coarse Aggregate (Parts by Mass)	2.0
Latex Emulsion Admixture, gallon/bag cement	3.5
Air Content, %	3-6
Slump [a,b] , inches	4-6

[a] Following sampling of the discharged, normally mixed material, the commencement of the slump test shall be delayed from 4 to 4-1/2 minutes.

[b] Water may be added to obtain slump within the prescribed limits, but the water-cement ratio produced should be between 0.35-0.40 by mass. All of the non solids in the latex admixture should be considered as a part of the water.

932.12 – 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 be 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 mass upon evaporation. The penetrating water-repellant treatment solution shall not permanently 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 Section 412.04. Treated concrete shall be surface dry within 30 minutes after application. The penetrating water repellent treatment solution shall be tinted with a fugitive dye to enable the solution to be visible on the treated concrete surface for at least four hours after the application. The fugitive dye shall not be conspicuous more than seven days after application when exposed to direct sunlight.

Certification. A type D certification shall be submitted for each lot or shipment of materials 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 D certification.

SECTION 933 - PORTLAND CEMENT MORTAR

933.01 - GENERAL

Portland Cement Mortar shall consist of Portland Cement, fine aggregate and water.

933.02 – MATERIALS

All materials for mortar shall conform to requirements of the following specifications:

PORTLAND CEMENT	Section 932
WATER	Section 932
SAND	Section 932

933.03 - EQUIPMENT

All equipment, tools and machinery used in mixing and handling mortar shall be approved by the Engineer.

933.04 - COMPOSITION

The proportions of Portland Cement, fine aggregate and water shall be such as to produce a plastic

mortar. The workability shall be consistent with the type of work for which it is used in order to secure the best results.

The classes of mortar as specified for the several types of work shall be proportioned in accordance with the following tabulation:

Class of Mortar	Portions of Cement	Parts by Volume Fine Aggregates
A	1	1
B	1	1.5
C	1	2
D	1	2.5
E	1	4

Proportioning of batches shall be by volume unless otherwise shown on the plans or specified in the special provisions. One (1) sack of cement weighing ninety-four (94) pounds shall be considered one (1) cubic foot. Correction for bulking of the fine aggregate shall be made as directed by the Engineer.

933.05 - ADMIXTURE

A) Lime which has been thoroughly air slacked may be added, up to ten (10) percent of the cement content of the mix, to increase the workability of the mortar upon approval of or at the direction of the Engineer. Lime shall conform to ASTM Specifications, Designation C-144-55.

B) Commercial Admixtures to increase the workability of mortar or concrete will not be used unless specifically approved in writing by the Engineer.

C) Lime Putty may be prepared from hydrated lime or quicklime. Hydrated lime shall be mixed with water to form a putty and stored with reasonable care to prevent evaporation for at least twenty-four (24) hours before use. Quicklime shall be slaked with enough water to make a cream, passed through a #10 sieve and then stored with reasonable care to prevent evaporation for at least seven (7) days before use.

SECTION 941 - REINFORCING STEEL

941.01 - BAR STEEL REINFORCEMENT - BILLET STEEL

This section 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.

A sample shall consist of two (2) bars, not less than twenty-four (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.

941.02 - AXLE STEEL

This section covers deformed and plain axle steel bars for concrete reinforcement and dowels which may be used in lieu of those as specified in Subsection 941.01.

Axle steel bars shall meet the specification requirements of AASHTO M-53, Grade 40.

Sampling shall conform to Subsection 941.01 above except that the carbon range for each lot will be required in lieu of a full chemical analysis.

941.03 - WELDED STEEL WIRE FABRIC

This section covers 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.

Two (2) samples, each twenty-four (24) inches in length, cut from the fabric shall be submitted for each different bar size in the fabric. Samples shall be submitted for each ten (10) tons or less of material.

941.04 - PRETENSIONING STEEL WIRE STRAND

Steel for pretensioning shall conform to the specifications for Uncoated Seven Wire Stress Relieved Strand for Prestressed Concrete, AASHTO M-203.

941.05 - BARS FOR POST TENSIONING

Bars shall be High Strength Alloy Steel Bars meeting the requirements of AASHTO M-215.

941.06 - POSTTENSIONING STEEL WIRE

Steel cable for posttensioning shall conform to the specifications for Uncoated Stress Relieved Wire for Prestressed Concrete, AASHTO M-204, Type BA or WA, as specified. Type A Certification shall be furnished for each coil or wire.

941.07 - ANCHORAGES FOR POSTTENSIONED TENDONS

A) Bars - Wedge type anchorages shall be used for bars. The wedge device shall develop the minimum ultimate stress specified for the nominal bar area. Wedge anchorages shall bear against anchorage plates fabricated of hot rolled steel having physical characteristics not less than as specified for No. 1040 of the American Iron and Steel Institute (AISI) Specifications. Type A Certification shall be furnished for each heat of anchorage plates.

B) Parallel Wire Assemblies - Wedge type anchorages of the sandwich plate or conical type shall generally be used. The anchorage device shall be capable of developing the ultimate strength of the total number of wires anchored. Conical type anchorages shall be embedded within the ends of the concrete members unless otherwise specified. Anchorages shall generally bear against embedded grids of reinforcing steel of approved type.

SECTION 942 - STRUCTURAL STEEL

942.01 - DESCRIPTION

This section covers the requirements for structural steel, bolts, nuts and washers, shear connector studs and filler material for welds.

942.02 - STRUCTURAL STEEL

Steel shall be furnished according to the following specifications:

A) 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. Test specimens of structural, rivet or eyebar steel shall show a fracture having a silky or fine granular structure throughout with a bluish gray or dove color and shall be entirely free from granular, black and brilliant specks.

B) Specific Requirements - Structural steel shall conform to the requirements of the current AASHTO specification as follows:

Structural Steel (A-36)	M-183
Structural Rivet Steel (A-502)	M-228

High Strength Low Alloy Structural Steel (A-242)	M-161
High Strength Structural Steel (A-440)	M-187
High Strength Low-Alloy Structural Manganese Vanadium Steel (A-441)	M-188
High Strength Low-Alloy Columbium-Vanadium Steels (A-572)	M-223
High Strength Low-Alloy Structural Steel (A-588)	M-222
High Yield Strength, Alloy Steel Plate (A-514)	M-244

Unless specified otherwise steel used in structures shall conform to the Current Specification for Structural Steel, AASHTO M-183 and rivets shall conform to the requirements of the current Specification for Structural Rivet Steel, AASHTO M-228.

Unless shown otherwise 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 the appropriate climatic service zone specified in the special 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 nonstress carrying members in unpainted structures shall conform to AASHTO M-222 or M-161, except that M-161 steel members shall be used only for riveted or bolted construction unless the weldability of the steel is established in accordance with AWS D1.1. Mil test reports shall be furnished for each heat of material.

942.03 - BOLTS, NUTS AND WASHERS

Except as provided in the next paragraph below bolts, nuts and circular washers if required, shall conform to requirements of AASHTO M-164.

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.

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, subpunched and reamed or drilled, as required by the applicable code or specification and shall be a nominal diameter not more than one-sixteenth (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 mil scale, and shall also be free of burrs, dirt and other foreign material that would prevent solid seating of the parts.

Contact surfaces within friction type joints shall be free of oil, paint, lacquer or galvanizing, except for inorganic ink primer.

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 provided atmospheric corrosion resistance similar to the structural steel being used.

942.04 - WELDING

All welding shall meet the appropriate section of the current specifications of AWS Structural Welding Code as modified by AASHTO.

942.05 - WELDED STUD SHEAR CONNECTORS

The materials, installation and inspection of end welded stud shear connectors where welded to steel beams, girders, or plates to connect the members to concrete in composite steel concrete construction

shall be in accordance with the AWS Structural Welding Code as modified by the AASHTO "Standard Specification for Welding of Structural Steel Highway Bridges" or as follows:

A) General Requirements - Before placing orders for studs the Contractor shall submit to the Engineer for approval the following information on the studs to be purchased:

1) The name of the manufacturer.
2) A detailed description of the stud and arc shield to be furnished.
3) A certification from the manufacturer that the stud base is qualified.
4) A copy of the qualification test report as certified by the testing laboratory.

For quality control purposes the Contractor shall furnish certification from the manufacturer that the studs as delivered are in accordance with the specification. Certified copies of in plant quality control test reports shall be furnished to the Engineer.

Construction Requirements - The first two studs welded on each beam or girder, after being allowed to cool, shall be bent forty-five (45) degrees by striking the stud with a hammer. If failure occurs in the weld of either stud, the procedure shall be corrected and two (2) successive studs successfully welded and tested before any more studs are welded to the beam or girder. The Engineer shall be promptly informed of any changes in the welding procedure at any time during construction. When the temperature of the base metal is below thirty-two (32) degrees F, one (1) stud in each one hundred (100) studs welded shall be bent forty-five (45) degrees in addition to the first two bent as specified above.

SECTION 943 - ELASTOMERIC MATERIALS

943.01 - DESCRIPTION

This section covers the materials, fabrication, and placement of elastomeric materials except as may otherwise be covered in other particular specifications or on the plans.

943.02 - MATERIALS

A) Elastomeric Bearings - When so specified on the plans concrete beams, steel beams, and other major structural members shall be seated on elastomeric bearings. These bearings may be either "plain" (consisting of elastomer only) or "laminated" (consisting of layers of elastomer interspersed with non-elastic laminates) as shown on the plans. Elastomeric bearings shall be specified on the plans by hardness (durometer), size and configuration and in the case of laminated bearings, by the thickness of individual layers of elastomer and the size and position of special connection members, if any, required to be vulcanized with the bearing.

1) General - Unless shown otherwise on the plans the elastomer for bearings shall be one hundred (100) percent virgin neoprene stock. Natural rubber, vulcanized rubber (natural or synthetic), or other synthetic rubber like materials will not be acceptable. Non-elastic laminates shall be one-sixteenth (1/16) inch thick (-0, +1/16") rolled mild steel plates or sheets conforming to ASTM Designation A-570. Metal for special connections shall conform to ASTM Designation A-36 unless shown otherwise on the plans.

2) Physical Properties of Elastomer - The elastomer shall meet the requirements shown in Table 943.02.01. Tests of the material shall be made in accordance with the test methods stipulated. Insofar as possible all tests shall be made on the finished product. A deviation of ten (10) percent from the values shown in Table 943.02.01 will be allowed where tests are performed on samples taken from the finished product. Special molded and/or prepared specimens where required shall conform to the preparation requirements of the particular test involved.

3) Formulation, Prequalification, and Certification - All bearings furnished by the Contractor shall be produced by a bearing manufacturer who has previously submitted the required prequalification test samples and certifications and whose elastomer formulation has been

initially approved for use by the Engineer. Each elastomer formulation produced by a manufacturer must be approved by the Engineer prior to its first use on City projects. For a bearing manufacturer to prequalify and obtain initial approval of a particular formulation he shall submit to the Engineer well in advance of anticipated use of his product certified test results indicating actual test values obtained when the physical properties of the elastomer to be furnished were tested for compliance with the specifications involved. In the case of laminated bearings, one finished laminated bearing typical of the size and type to be subsequently furnished on City projects shall be submitted for prequalification testing. In addition, a non-laminated bearing of the approximate size of one layer of elastomer in the laminated bearing shall be furnished. The bearing manufacturer shall certify that all of the samples submitted are of the same basic elastomer formulation and of the equivalent cure of that to be used subsequently in the finished products to be furnished on City projects.

The Engineer may require that the complete testing procedure for prequalification purposes be performed again by the producer during later production should the Engineer feel such action appropriate.

Table 943.02.01 Elastomeric Material Properties

Hardness (Durometer)	50	60	70	80	90
Original Physical Properties					
Hardness ASTM D-2240	50 ±5	60 ±5	70 ±5	80 ±5	90 ±5
Tensile Strength, min psi [1]	2500	2500	2500	2500	2500
Elongation at Break, min %	450	400	300	150	100
Accelerated tests to determine term aging characteristics, Oven aged at 70 hrs at 212º F, ASTM D573					
Hardness, points change max	0 to +15	0 to +15	0 to +15	0 to +15	0 to +15
Tensile Strength % change	-15	-15	-15	-15	-15
Elongation at Break, % change max	-40	-40	-40	-40	-40
Ozone: 100PPHM in Air by Volume, ASTM D395, Method B					
20% strain at 100º+2ºF 2	No Cracks	No Cracks	No Cracks	No Cracks	No Cracks
Compression Set 22 hrs, % max	25	25	25	25	25
Low Temperature Resistance ASTM D746, Procedure B					
Brittleness, at –26ºC	No Failure	No Failure	No Failure	No Failure	No Failure

ADHESION: For limited bearings, bond between the elastomer and laminates will be qualitatively evaluated by the procedure outlined in the THD Manual of Testing Procedures, Test Method TEX-601-J.

1ASTM D-412, 2ASTM D-1149

* Samples to be solvent wiped before test to remove traces of surface impurities.

4) Manufacturing Requirements - All components of a laminated bearing shall be molded together into an integral unit. All edges of the non-elastic laminations shall be covered by a minimum of one-eighth (1/8) inch of elastomer except that exposure of the laminates will be permitted at approved laminate restraining devices and around holes that will be entirely closed in the finished structure. Unless shown otherwise on the plans all laminates shall be parallel with the bottom surface of the bearing, subject to the tolerances that follow.

   Plain bearings may be molded individually, cut from previously molded strips or slabs or extruded and cut to length. The finish of cut surfaces shall be at least as smooth as ASA #250 finish. The batch or lot number shall be marked on one side of each bearing in such a manner as to remain legible until the structure is completed. A batch is defined as the quantity of compound produced from each separate mixture of ingredients. A lot is defined as the quantity of compound resulting from the mixture of two (2) or more batches.

5) Appearance and Dimensions - Flash tolerance, finish, and appearance shall meet the

requirements of the latest edition of the "Rubber Handbook" as published by the Rubber Manufacturers Association, Inc., RMA F3-T.063 for molded bearings and RMA F2 for extruded bearings. For both plain and laminated bearings the permissible variation from the dimensions and configuration required by the plans and these specifications shall be as follows:

a) Overall Vertical Dimensions
   (i) Average Total Thickness 1 1/4 Inch or Less -0, +1/8 Inch
b) Average Total Thickness 1 1/4 Inch -0, +1/4 Inch
   (i) Overall Horizontal Dimensions +1/4 Inch
   (ii) Thickness of Individual Layers of Elastomer +1/8 Inch
c) Laminated Bearings Only
   (i) Variation from a Plane Parallel to the
      1. Theoretical Surface, 1/8 Inch
      2. Top, 1/4 Inch
      3. Sides, 1/8 Inch
d) Individual Non-Elastic Laminated (As determined by measurements at edges of the bearing)
e) Position of Exposed Connection Members 1/8 Inch
f) Edge Cover of Embedded Laminates or Connection Members -0, +1/8 Inch
g) Size of Holes, Slots, or Inserts -0, +1/8 Inch
h) Position of Holes, Slots, or Inserts 1/8 Inch
i) Thickness of Non-Elastic Laminates -0, +1/16 Inch

6) Routine Inspection, Sampling and Testing - After prequalification approval, one plain bearing and/or one laminated bearing will be taken by the Engineer from each project or from each batch or lot of elastomer compound in case the same batch is used for more than one project. These bearings will not be returned for use in the project. For laminated bearings only, each bearing shall be subjected by the manufacturer to an average compression of one thousand (1000) pounds per square inch of bearing area. The performance of each bearing will be considered satisfactory provided there is no visible evidence of bond failure or other damage to the bearing because of this loading.

7) Waterstops - Waterstops shall be furnished and installed in accordance with the details shown on the plans. Except where otherwise indicated on the plans waterstops may be manufactured from either natural (plain) or synthetic rubber or from polyvinyl chloride (PVC) as specified below:

a) Materials

   (i) Natural (plain) rubber waterstops shall be manufactured from a stock composed of a high grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, antioxidants, and softeners. This compound shall contain not less than seventy-two (72) percent by volume of new plantation rubber.

   (ii) Synthetic rubber waterstops shall be manufactured from a compound made exclusively from neoprene or GRS, reinforcing carbon black, zinc oxide, polymerization agents, and softeners. This compound shall contain not less than seventy (70) percent by volume of neoprene or GRS.

   (iii) Physical properties of natural or synthetic rubbers for waterstops shall be as shown in Table 943.02.02.

   (iv) Unless specified otherwise on the plans the material for polyvinyl chloride (PVC) shall conform to the Corps of Engineers Specifications No. CRD-C-572-60.

Table 943.02.02 Physical Properties of Rubber for Waterstops		
	Natural (Plain) Rubber	Synthetic (Neoprene GRS) Rubber
Original Physical Properties:		
*Hardness ASTM Designation D-2240 (Durometer)	60 ± 5	55±5
Tensile Strength*, min psi ASTM Designation D-412	3500	2500
Elongation at Break, minimum point	550	425
Accelerated Tests To Determine Aging Characteristics**:		
**Either - after 7 days in air at 158°(±2°) F. (ASTM Designation D-573)		
Or - after 48 hours in oxygen (ASTM Designation D-572) at 158°(±2°) F. and 300 psi pressure Tensile Strength, % change max.		
	35	35
Elongation, % change, Maximum	35	--

8) Manufacturer's Certification - The manufacturer shall furnish certified test results indicating compliance with these specifications for each batch or lot of waterstop furnished under the contract. In case of doubt of the quality furnished, the burden of proof shall be on the manufacturer and the decision of the Engineer shall be final.

9) Manufacturing Requirements

a) Rubber Waterstops - Waterstops shall be manufactured with an integral cross section which shall be uniform within plus or minus one-eighth (1/8) inch in width, and the web thickness or bulb diameter within plus one-sixteenth (1/16) inch and minus one thirty-second (1/32) inch. No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured in a manner such that any cross sections shall be dense, homogeneous, and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanization period the joint shall be securely held by suitable clamps. Field splices shall be either vulcanized, mechanical, using stainless steel parts, or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a tensile strength of not less than fifty (50) percent of the unspliced material.

b) PVC Waterstops - Requirements shall be as in paragraph 3(a) above for rubber waterstops except that splicing of PVC shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not to char the plastic.

c) Elastomeric Pads - When so specified on the plans, rail posts, rail members, metal shoes, or minor structural members shall be insulated, leveled, shimmed, or otherwise protected by elastomeric pads, sheets, or washers. Such bearings may be any elastomeric material, plain, fibered, or laminated, having a hardness (durometer) between seventy (70) and one hundred (100) as certified by the manufacturer to the Engineer. Acceptance testing will not be required.

d) Other Elastomeric Products - Other elastomeric products shall be in accordance with the requirements on the plans.

943.03 - CONSTRUCTION METHODS

A) Elastomeric Bearings - Unless shown otherwise on the plans, concrete bearing seats shall be float finished to the required elevation. Variation from a level plane shall not exceed one-sixteenth (1/16) inch within the limits of the bearing. After erection of the steel superstructure the horizontal

distortion of the bearings shall be measured, corrected for temperature and adjusted if necessary, so that the horizontal displacement between top and bottom of bearing at seventy (70) degrees F does not exceed fifteen (15) percent of the elastomer thickness. Welding in the vicinity of the bearings shall be done with care to avoid injury to the elastomer.

B) Waterstops - Field splices shall be either vulcanized, mechanical, using stainless steel parts, or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a tensile strength of not less than fifty (50) percent of the unspliced material.

943.04 - METHOD OF MEASUREMENT

Unless specified otherwise on the plans elastomeric bearings used with prestressed concrete units, and other miscellaneous elastomeric materials will not be measured for payment but will be considered subsidiary to the various pertinent bid items in the contract.

Unless specified otherwise on the plans elastomeric bearings used in conjunction with steel superstructures will be measured by each elastomeric bearing of the type shown on the plans.

943.05 - BASIS OF PAYMENT

Payment for elastomeric bearings, measured as specified above will be at the unit price bid for each "Elastomeric Bearing" of the type specified.

ELASTOMERIC BEARING (TYPE) EA.

This price shall be full compensation for all materials, tools, equipment, labor, and for all incidentals, including anchor bolts and top plates, necessary to complete the work.

SECTION 944 - DRAINAGE CONDUITS

944.01 - DESCRIPTION

This section covers the conduit material to be used specifically for storm sewer and culvert construction. Conduits are considered to be either rigid or flexible and are categorized within the following subsections. This section supersedes any other material requirement within these specifications which conflicts with the intent of the material to be used specifically for drainage purposes.

944.02 - MATERIALS

A) Rigid Conduits - Materials covered in this Subsection: perforated pipe, reinforced concrete circular, elliptical, and arch pipe; precast reinforced concrete box sections, meeting the following requirements of the noted AASHTO Specification or the Equivalent ASTM Specification:

1) Concrete Culverts

   a) Reinforced Concrete Culvert, Pipe shall conform to AASHTO M 170 or M 170M (Metric).
   b) Reinforced Concrete Arch Culvert, shall conform to AASHTO M 206 or M 206M (Metric).
   c) Reinforced Concrete Elliptical Culvert, Pipe shall conform to AASHTO M 207 or M 207M (Metric).
   d) Reinforced Concrete D-Load Culvert, Pipe shall conform to AASHTO M 242 or M 242M (Metric).

2) Precast Box Sections for Culverts

   a) Precast Reinforced Concrete Box Sections for Culverts, shall conform to AASHTO M 259 or M 259M (Metric).
   b) Precast Reinforced Concrete Box Sections for Culverts, With Less Than 2 Feet of

Cover Subject to Highway Loadings shall conform to AASHTO M 259 or M 259M (Metric).

B) Flexible Conduits - Materials covered in this Subsection: steel conduits, coated and clad steel conduits, aluminum conduits, and clad aluminum conduits, meeting the following requirements of the noted AASHTO Specification or the Equivalent ASTM Specification:

1) Steel Conduits-Culverts

a) Metallic (Zinc or Aluminum) Coated, Corrugated Steel Culverts and Underdrains shall conform to AASHTO M 36.

b) 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.

c) Externally Coated or Clad Culverts

d) Precoated Galvanized Steel Culverts and Underdrains shall conform to AASHTO M 245 or M 245M (Metric) or steel sheet, metallic-coated and polymer precoated for corrugated steel pipe conforming to AASHTO M 246 or M 246M (Metric).

2) Aluminum Conduits-Culverts

a) Corrugated Aluminum Alloy Culverts and Underdrains shall conform to AASHTO M 196. If bituminous coating is specified it shall be type A coating unless type B or type C coating is specified, meeting the requirements of AASHTO M 190.

b) Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.

3) Steel Conduits-Underdrain

a) Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrain shall conform to AASHTO M 36.

b) Sheets for Underdrain shall conform to AASHTO M 36 (see Subsection (B) 1.1.1)

c) 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.

d) 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).

4) Aluminum Conduits-Underdrains

a) 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.

b) Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.

c) 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.

SECTION 945 - REINFORCED CONCRETE PIPE

945.01 - DESCRIPTION

This section covers specifications for reinforced concrete pipe.

945.01.01 - GENERAL

Concrete pipe is acceptable only in diameters of eighteen (18) inches and greater. All concrete pipe shall be reinforced concrete sewer or culvert pipe and shall be machine made pipe and shall be steam cured in accordance with ASTM Specifications. Concrete pipe forty-eight (48) inches and smaller shall be tested by the three (3) edge bearing method and conform to ASTM Designation C-76-82 and subsequent revisions thereto. Concrete pipe fifty-four (54) inches and larger shall be tested in accordance with ASTM Specifications C-42 or as directed by the Engineer. Pipe manufacturing equipment and pipe quality shall be approved by the Engineer, and meet these specifications.

Reinforced concrete standard-strength and extra-strength culvert pipe shall conform to ASTM Specifications Designation C-76-60 and any subsequent revisions thereof, together with requirements of the special provisions and these specifications and specific requirements and modifications thereof hereinafter designated.

945.01.02 - CLASS

Pipe manufactured according to these specifications shall be of two (2) classes known respectively as "Standard Strength Reinforced Concrete Culvert Pipe" and "Extra Strength Reinforced Concrete Culvert Pipe".

945.04 - JOINT REINFORCEMENT

Section 16, ASTM Designation C-76-82 Specifications shall be modified as follows: Joints shall conform to Section 3.3 of AWWA C-302-57

945.05 - COMPRESSION TEST CYLINDERS OF CONCRETE FOR CONCRETE PIPE

Section 26, ASTM C-75-55 Specifications shall be expanded as follows: When strength of concrete pipe is determined from six (6) inch by twelve (12) inch test cylinders in accordance with "Test for Compressive Strength of Molded Concrete Cylinders" (ASTM C-39-49), there shall be furnished by the Contractor not less than four (4) cylinders for testing for each fifty (50) joints of pipe.

Section 27, ASTM Designation C-76-82 Specifications shall be expanded as follows: Specifications under Section 304 with respect to number of cylinders to be tested, ordering of tests by the Engineer, manner of collecting test cylinders and requirements regarding seven (7) day and twenty-eight (28) day tests shall apply to this section.

The Engineer may order at any time additional test specimens be prepared and tested should there be a change in the concrete design mix, aggregates or from any cause which might affect the strength or absorptive qualities of the concrete pipe. Two (2) cylinders shall be tested for compressive strength at age of seven (7) days and two (2) cylinders at age of twenty-eight (280 days. One (1) of the cylinders in each age group shall be tested for absorption before being tested for compressive strength. Before being tested for compression the cylinder used for the absorption test shall be thoroughly dried.

Test cylinders shall be molded in a manner similar to that of placing the concrete in the pipe forms, insofar as possible, with particular reference to tamping, packing, and vibrating. For pipe manufactured by the field cast method test molds shall be welded or solidly attached to the pipe forms so that vibration of the specimen will be the same as that of the pipe form.

In the event the cylinders tested for compressive strength at the age of seven (7) days do not show strength of eight (80) percent of the required twenty-eight (28) day strength for pipe made using high early cement and seventy-five (75) percent of the required twenty-eight (28) day strength for pipe made using standard Portland Cement, the pipe represented by these tests will be held in storage until the results of the twenty-eight (28) day cylinder tests are known.

SECTION 946 - METAL PIPE

946.01 - GENERAL

Metal pipe meeting the requirements these specifications may be used as approved by the City Engineer.

946.02 - CORRUGATED STEEL PIPE

Corrugated steel pipe (CSP) manufactured in accordance with the latest AASHTO M-36 specification and designed according to AASHTO design requirements shall be an acceptable pipe material for culverts, storm drains, and sanitary sewers. The following types of CSP shall be acceptable based on appropriate hydraulic and durability considerations;

Culverts and Storm Drains

A) Galvanized per AASHTO M-218.
B) Bituminous coated per AASHTO M-190.
C) Aluminized per AASHTO M-274.
D) Polymeric coated per AASHTO M-245.

Pipe ends shall have a minimum of two reformed annular corrugations to accommodate connecting bands. Connecting bands shall be of the hugger type and shall be designed to accommodate "O" ring gaskets when required. Connecting bands shall meet the performance criteria set forth in Section 23 of AASHTO Standard Specifications for Highway Bridges. Dimpled bands will not be allowed except by special permission of the Engineer.

Flared metal end sections shall be considered as an acceptable method of end treatment.

946.03 - METAL END SECTIONS

This section covers the specifications for metal end sections to be attached to the inlet and outlet ends of pipe and Pipe-Arch culverts.

The materials used in the fabrication of end sections shall conform to the applicable requirements of AASHTO Specification M-36.

End sections shall be fabricated in accordance with the details and dimensions shown on the plans, except that minor variations may be accepted to permit the use of the manufacturer's standard methods of fabrication.

946.04 - SLOTTED DRAIN PIPE

Slotted drain shall be considered an acceptable material to collect surface drainage in such application as curb inlets, median or berm drains and pavement or parking lot drainage.

Slotted drain shall be of the diameter and gauge detailed on the plans and shall be made from pipe fabricated in accordance with the applicable provisions of Section 14, Welded Seams of AASHTO Designation M-36. Pipes shall be joined together by means of a Hugger-type coupling band that will provide soil tightness and when installed shall provide a maximum gap between ends of grating of not more than one (1") inch.

The grating shall have a one and three-fourths (1 3/4) inch wide opening and shall be comprised of two (2) vertically spaced bearing members, substantially normal to the axis of the pipe section. It shall extend longitudinally the length of the slot and shall be hot dip galvanized in accordance with ASTM A-123. The bearing members shall be joined by solid web spacers not more than six (6) inches center to center longitudinally. The spacers shall be substantially normal to the vertical bearing members and substantially at the neutral axis of the pipe section wall. They shall extend the full depth of the grating section except for a three-sixteenths (3/16) inch recess to accommodate an expanded wire mesh if called for in the plans. They shall be of sufficient thickness and shall be welded to the vertical bearing member in such a manner as to maintain structural continuity across the throat of the open slot.

SECTION 947 - CASTINGS FOR STORM SEWER MANHOLES AND INLETS

947.01 - GENERAL REQUIREMENTS

This section covers requirements for manhole frames and covers, sewer inlet frames and gratings for manholes and inlets if required. All castings shall conform strictly to the standard design or designs designated, or to special designs when required. Casting shall be of cast iron or cast steel as designated. Castings shall be free from pouring faults, sponginess, cracks, blow holes and other defects in locations affecting the strength and value of the casting for the service intended and shall be filleted at angles and the rises shall be sharp and true. All castings shall be free from warp and shall be true to the shape and dimension required. Surfaces shall be machined where indicated or where otherwise necessary to secure flat true surfaces. All covers, gratings, etc., fitting into frames shall fit properly and set uniformly and solidly.

Where weight is specified or shown on the plans castings shall conform to such requirements.

947.01 - QUALITY

A) Steel Castings - Steel castings shall conform to the requirements of the "Standard Specifications for Steel Castings" (Serial Designation A-27-55) of the ASTM and subsequent revisions thereof. Steel castings shall be Class "B", Grade U-60-60, unless otherwise specified.

B) Gray Iron Castings - Iron castings shall conform to the "Standard Specifications for Gray Iron Castings" (ASTM Designation A-48-48) and subsequent revisions thereof. Iron castings shall be equal to or better than Class No. 30.

947.03 - BOLTS, RIVETS, ETC.

Accessories such as bolts, rivets, spacers, small I-beams, channels, plates, etc., used for the assembling or supporting gratings in multiple grating sewer inlet installations shall be first quality standard commercial materials free of defects which affect their value for the service intended. Steel shapes, plates, and bars covered under this section shall comply with requirements of Tentative Specifications for Steel Bridges and Buildings, ASTM Designation A-36 or A-709.

Rivet steel shall conform to Tentative Specifications for Structural Rivet Steel, ASTM Designation A-502-76, grade 1.

Certified copies of mill tests of bolts, rivets, and metal used in structural shapes, herein specified, shall be furnished by the manufacturer if requested by the Engineer. Any defects appearing upon delivery or installation of material covered in this section in such degree as to affect the strength or quality of the work shall be cause for rejection and such material shall be replaced by the Contractor as ordered by the Engineer.

SECTION 948 – PAINT FOR STRUCTURAL STEEL

948.01 – GENERAL REQUIREMENTS.

This Section covers the various types of paint used to protect structural steel.

948.01.01 - CERTIFICATION

For each shipment of paint, furnish a Type C certification in accordance with Section 109, for each lot of each paint. For a paint system to be considered for inclusion on the list of approved products, the paint manufacturer shall submit a Type A certification showing satisfactory test results from an approved testing laboratory.

The certification shall include

A) The Manufacturer' S Name,
B) System Performance
C) Test Results And

D) Dates

The Certification will also show the following for each paint:

A) Test Results And Dates,
B) Brand Name,
C) Lot Number, And
D) Date Of Manufacture.

New certification shall be required if any of the following conditions occur:

A) the manufacturing process or paint formulation is changed,
B) testing indicates nonconformance to the Specifications, or
C) the certification is older than 5 years.

A 1-gallon (4 liter) sample of each component in a paint system may be required by the Engineer for testing purposes. In case of variance, the Department' s test results will govern. Failure to meet Specification requirements will be grounds for removal from the list of approved products. The Department reserves the right to suspend approval of products if paint system performance is unsatisfactory (i.e., the paint has poor durability or appearance).

948.01.02 – SYSTEM PERFORMANCE.

Paint shall be evaluated according to Performance Class. The performance of the coating system shall be measured using test panels. These test panels shall be coated with all required paint coats. Each coat shall be applied as specified.

A) ***Performance Class 1.*** Performance Class 1 coating systems shall be tested as follows: Three test panels shall be made for each of the specified tests; the test panels shall be prepared as described in AASHTO M300; and, where applicable, blistering shall be rated by ASTM D714.

1) ***Fresh Water Resistance.*** Fresh water resistance testing shall conform to the requirements of ASTM D870. Panels shall be scribed in accordance with AASHTO M300 for Salt Fog Resistance and then immersed in fresh tap water at 75±5°F (24 ± 3° C). After 30 days of immersion, the panels shall not show any rusting, nor shall the coating show any blistering, softening, or discoloration.

2) ***Salt Water Resistance.*** Salt water resistance testing shall conform to the requirements of ASTM D870. Panels shall be scribed in accordance with AASHTO M300 for Salt Fog Resistance and then immersed in a solution of water and 5% sodium chloride at 75±5°F (24 ± 3° C). After 30 days of immersion, the panels shall not show any rusting, nor shall the coating show any blistering, softening, or discoloration. Panels shall be rated at 7, 14, and 30 days. The saline solution shall be replaced with fresh saline solution after the 7 and 14 day examinations.

3) ***Salt Fog Resistance.*** Panels shall be tested as described in AASHTO M300 for Salt Fog Resistance except that the exposure will be 2,500 continuous hours.

4) ***Weathering Resistance and Specular Gloss.*** Weathering resistance testing shall conform to the requirements of ASTM D4587, Method D, utilizing UVA 340 bulbs. Testing of the panels shall start at the beginning of a wet cycle. After 3,000 hours continuous exposure, the coating shall not show any blistering or loss of adhesion, nor shall the panels show any rusting. The 60° specular gloss measurements shall be performed on the sprayed panels utilized for the weathering resistance test. The initial specular gloss measurements (one from each panel) shall be averaged together. The final specular gloss measurements shall also be averaged together.

5) ***Elcometer Adhesion Test.*** Elcometer adhesion testing shall conform to the requirements of ASTM D4541. The panels shall be tested using an adhesion tester 1000 psi (6.9 MPa) in accordance with the following: the coating surface and aluminum dolly shall be lightly sanded and a quick-set adhesive applied; the adhesive is cured overnight; the coating and

adhesive around the dolly is scribed before testing; and a minimum of three trials is made and reported. For a paint to be acceptable, each trial must have adhesion of 400 psi (2.76 MPa) or more and show no evidence of fracture at the primer-blast interface.

B) **Performance Class 2.** Performance Class 2 coating systems shall be tested as follows: Three test panels shall be made for each of the specified tests; the test panels shall be prepared as described in AASHTO M300. Where applicable, blistering shall be rated by ASTM D714 and rusting in accordance with ASTM D610.

1) ***Salt Fog Resistanc***e. Panels shall be tested as described in AASHTO M300 for Salt Fog Resistance except that the exposure will be 1,000 continuous hours.

2) ***Prohesion.*** Panels shall be tested for 2,000 hours in accordance with ASTM G 85, Appendix A5. The electrolyte solution for the cyclic fog/dry test shall consist of a Timmins solution: 0.40 wt% (NH 4) 2 SO 4 with 0.05 wt%NaCl. The temperature shall be maintained at 100°F (38°C) during the fog/dry cycles. Any test panels having rust spots, blisters, or undercutting at the scribe will be considered a failure.

3) ***Fluorescent UV.*** Test for 2,000 hours in accordance with ASTM G53 (8 hours UV at 160°F (71°C) followed by four hours condensation at 120°F(49°C)). Any test panels with rust spots, blisters, or undercutting at the scribe will be considered a failure. Additionally, the paint system shall have at least three years of satisfactory performance (less than 1% of the painted surface shows visible rust, rust breakthrough, paint blistering, peeling, or scaling) in a bridge environment. Case histories from at least five bridge projects shall be included in the Type A certification data.

C) **Containers and Labeling.** All paint furnished under these Specifications shall be supplied in strong, tight, approved containers. Each container shall be labeled with the manufacturer' s name, paint type, Volatile Organic Compounds (VOC) content, date of manufacture, lot number, mixing instructions, and equipment cleanup instructions. Labels shall be sufficiently weather resistant to withstand one year of outdoor storage exposure without deterioration or fading. If not affixed to the paint containers, Material Safety Data Sheets and Product Data Sheets shall be supplied with each paint shipment. Copies of both sheets shall be posted on the project site and submitted to the Resident Engineer prior to painting.

D) **Toxic Substance Restriction.** Lead paint, or similar coatings containing lead or lead compounds, in which the lead content (calculated as lead metal) is in excess of 0.19% by mass of the total nonvola-tile content of the paint or the mass of the dried paint film shall not be used on Department projects. Paints containing asbestos or containing leachable hazardous elements in the dry paint film exceeding the limits shown below when tested using the Toxicity Characteristic Leaching Procedure (TCLP), 40 CFR 261, "Identification and Listing of Hazardous Waste ," shall not be used on Department projects. The TCLP test shall be included in the Type A certification.

Arsenic, ppm	5.0
Barium, ppm	100.0
Cadmium, ppm	1.0
Chromium, ppm	5.0
Lead, ppm	5.0
Mercury, ppm	0.2
Selenium, ppm	1.0
Silver, ppm	5.0

A) **VOC Limitation.** The maximum permissible Volatile Organic Compound (VOC) level in any paint used for Department projects shall be 2.9 lb/gal (350 g/l) as thinned for application. VOC is defined as any organic compound which has a vapor pressure of .0019 psi (13 Pa) absolute or greater at standard condition. Lower VOC limits may be specified in the plans depending on project location. When shop painting is done, be aware that VOC regulations could be stricter than required by the Department. The Contractor shall comply with the most severe VOC regulations applicable.

B) **Color.** Unless otherwise specified on the plans, the color of the coatings shall be as follows: the topcoat shall be light gray, Federal Standard No. 595A-16440, except for weathering steel, in which case the topcoat shall be dark brown, Federal Standard No. 595A-10075. The primer and intermediate-ate coats shall be colored so that each layer is clearly distinguishable from the other.

948.02 – REQUIREMENTS FOR PAINT SYSTEMS.

Inorganic Zinc/Epoxy/Urethane (IZ-E-U) System. The IZ-E-U system shall comply with the system performance requirements for Performance Class 1. This system shall produce a tough, durable film of minimum 9 mils (230 µm) dry film thickness, each coat well bonded to the previous layer. Prepare each surface and apply paint in such a manner to assure bonding of each coat. Cure each coat according to the manufacturer' s recommendations prior to further coating. The dry film thickness of an individual coat shall be within -0.5/+2.0 mils (-15/+50 µm) of the specified coat thickness.

A) ***Inorganic Zinc-Rich (IZ) Primer.*** The first coat shall be an IZ primer conforming to the requirements of AASHTO M300, Type IA and the following: the primer shall have a Class B classification, with a minimum slip coefficient of 0.50, as tested by the "Test Method to Deter-mine the Slip Coefficient for Coatings Used in Bolted Joints" from the Research Council on Structural Connections. (See Appendix A of Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts, published by the Research Council on Structural Connections.) Immediately prior to the application of the IZ primer, prepare the steel surface by the Steel Structure Painting Council' s preparation specification SSPC-SP10, Near-White Blast Cleaning. For new steel, the surface profile shall be 1 to 3 mils (25 to 75 µm) as determined by ASTM D4417, Method A, B, or C. For new structural steel, the IZ primer shall be applied in the shop. The dry film thickness of the IZ primer shall be 3 mils (80 µm).

B) ***Epoxy (E) Intermediate Coat.*** The epoxy-polyamide paint intermediate coat shall be applied over IZ primer-coated steel in plan position on the project and shall conform to the following requirements:

Epoxy (E) Intermediate Coat

Pot Life 4 hours, minimum SSPC Paint 22, Para. 5.5
Dry Through Time, 75°F (24°C), 45%R.H. 24 hours, maximum ASTM D 1640
Fineness of Grind, Hegman Units 3.0, minimum ASTM D 1210
Solvent Resistence (see test method) SSPC Paint 22, Para. 5.6
Test Panels (see test method) SSPC Paint 22, Para. 5.7
Elcometer Adhesion Test (see test method) SSPC Paint 22, Para. 5.8
Salt Spray Resistance (see test method) SSPC Paint 22, Para. 5.9
Dry Film Thickness 4 mils(100µm)

C) ***Urethane (U) Topcoat.*** The two-package, aliphatic urethane paint top coat shall conform to the requirements of the most recent edition of the Steel Structures Painting Council SSPC-PS Guide No. 17.00. The paint shall have a minimum 2-hour usable pot life at 77°F (2? ?C), and a maximum 4-hour dry-to-touch time at 77°F (2? ?C). The U topcoat shall be applied over E intermediate coat. The urethane topcoat also shall conform to the following requirements:.

Urethane (U) Topcoat

Characteristic	Value	Test Method
Solids by weight	67%, minimum	ASTM D 1644
Solids by volume	54%, minimum	ASTM D 1644
Specular Gloss,		ASTM D 4587, Method D
60° 85% minimum after drying, 70% minimum after 3,000 hours of weathering resistance testing		
Dry Film Thickness	2 mils(50 µm)	See ODOT Subsection 512.04(b)4

Single-Component Moisture-Cured Urethane (SC-MC-U) System. The SC-MC-U system shall

comply with the system performance requirements for Performance Class I. This system shall pro-duce a tough, durable film of minimum 10 mils (0.25 mm) film thickness, each coat well bonded to the previous layer. Prepare each surface and apply paint in such a manner to assure bonding of each coat. Cure each coat according to the manufacturer' s recommendations prior to further coating. The dry film thickness of each coat shall be within -0.5/+2.0 mils (-15/+50 µm) of the specified coat thickness. The first coat shall be either a zinc-rich or zinc/MIO primer. The primer shall be formulated with other synthetic or natural MIO. If approved, the primer may be two component. The intermediate coat and topcoat shall be formulated with natural micaceous iron oxide (MIO). The MIO intermediate coat shall be a SC-MC-U paint. The topcoat shall be a MIO-based SC-MC-Aliphatic-U paint. The SC-MC-U paint coats shall be formulated as follows:

	Zinc-Rich Primer	**Zinc/MIO Primer**	**MIO Intermediate Coat**	**MIO Topcoat**
Minimum Zinc Powder (mixed paint)	78% by weight	--	--	--
Minimum MIO Content	--	--	4lb/gal	--
Minimum Solids (mixed paint)	60% by volume	60% by volume	60% by volume	53% by volume
Pigment Type	zinc dust	zinc dust & MIO	--	--
Minimum Weight/Volume (mixed paint)	23 lb/gal	19 lb/gal	12 lb/gal	11 lb/gal
Minimum Zinc Content (dry film)	86% by weight	--	--	--
Dry Film Thickness	3.5 mils	3.5 mils	3.5 mils	3 mils

(c) **Repair Paint Systems.** The coating system for Category R applications as defined in Section 408.04.13 shall comply with Performance Class 2 requirements. The system may be comprised of one to three coats, but one coat systems may only be used when permitted in the plans.

SECTION 950 - MISCELLANEOUS WATER LINE MATERIALS

950.01 - BOLTS AND NUTS

All bolts used in underground fittings, flanges, hydrant risers, tapping sleeves and other underground locations shall be sherardized iron machine bolts or an equal quality, with hexagon nuts. Bolts for mechanical joints shall be high tensile strength cast iron, ACIPCO Ni-Resist, stainless steel, silicon bronze, or Corten steel, or an approved equal. Bolts and nuts installed for underground service shall have one of the following protective coatings in accordance with the manufacturer's instructions:

A) Texaco Rust Proof Compound "L"

B) NO-OX-ID "A"

C) Biturine #7105, Solution No. 5

D) Inertol 49

E) Hot Coal Tar Enamel, in accordance with AWWA Standard C-203-66

SECTION 960 - SEWER JOINT MATERIALS

960.01 - VITRIFIED CLAY OR CONCRETE PIPE JOINT MATERIALS

A) General - Jointing materials for vitrified clay or concrete pipe may consist of the materials hereinafter described. The type of materials to be used for each class of work to be in conformance

with these specifications. All bituminous joint materials shall adhere thoroughly to cold, vitrified clay or concrete pipe, be dense and resistant to root penetration, be chemically inactive to acids, alkalis and solvents found in sewage and sufficiently elastic and cohesive so that a slight movement of the pipe will not cause joint defects. The material shall set quickly so that backfilling may be completed promptly and, except in the case of plastic material, shall be strong enough to permit making joints outside the trench and to resist not less than fifteen (15) pounds hydrostatic pressure. Materials shall contain no filler which might settle out. All bituminous materials for joints shall be used as recommended by the manufacturer except as otherwise directed by the Engineer.

B) Compression Joints - shall comply with the requirements of ASTM C-425-77 or the latest revisions thereof.

960.02 - CAST IRON PIPE JOINT MATERIAL

A) Jute - Joint packing shall be of the best quality long fiber, clean, dry jute, either square braided or hard twisted, or an approved substitute acceptable to the Engineer. Unless otherwise permitted by the Engineer, all braided or hard twisted joint packing shall be not less than one-half (1/2) inch in size.

B) Lead - Lead used for filling bell and spigot joints shall be of the best quality soft pig lead, suitable for caulking and securing tight permanent joints and shall conform to the requirements of Federal Specification QQ-L-156, "Lead; Caulking".

C) Sulphur Jointing Compound - Sulphur compound for use in filling bell and spigot joints shall be of an approved make, brand and quality of established reputation such as "Leadite" or its equal. The compound shall be composed principally of an intimate mixture of sulphur, silica and lampblack. The silica may be either in silica sand or in ground crystalline silica form. Any other ingredients incorporated in the compound shall be of such nature that when exposed to the action of water, air or earth, they will have no deleterious physical or chemical effect on the joint compound or the pipe in which the compound is used. All joint compound shall be of a make, type and composition which has been in successful use in service similar to that which will be encountered in this work.

D) The manufacturer's recommendations for melting, manipulating and completing the joint with the sulphur compound, will be strictly followed.

960.03 - REINFORCED CONCRETE CULVERT PIPE JOINTS

Section 16, ASTM Designation C-76-60 Specifications shall be modified as follows: Joints shall conform to Section 3.3 of AWWA C-302-57

960.04 - JOINTS ON OTHER PIPE MATERIALS

Joints on other pipe materials conforming to appropriate ASTM Specifications and approved by the Engineer may be used.

SECTION 961 - POLYVINYL CHLORIDE SEWER PIPE

961.01 - DESCRIPTION

This section covers PVC Plastic Sewer Pipe intended to be used for the conveyance of sewage and industrial wastes.

961.02 - GENERAL

Polyvinyl Chloride sewer pipe, referred to hereinafter as PVC Plastic, shall conform to the requirements of ASTM Standard D-3034-73a and any subsequent revisions thereof together with requirements of special provisions and revisions contained in these specifications.

961.03 - MINIMUM BEDDING REQUIREMENTS

PVC plastic sewer pipe shall be embedded in accordance with the provisions of the "Standard

Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe".

To assure compliance, all PVC plastic pipe shall be inspected for deflection by pulling a sphere, cylinder, or other acceptable measuring device through the pipe. The maximum allowable pipe deflection for completely backfilled non-rigid sewer pipe shall not exceed five (5) percent of the nominal internal diameter.

961.04 - TYPE DESIGNATION

Unless specifically authorized by the Engineer, only Type PSM-35 PVC sewer pipe shall be considered as meeting the requirements of these specifications.

SECTION 962 - DUCTILE IRON PIPE

962.01 - DESCRIPTION

This section covers Ductile Iron Pipe intended to be used for the conveyance of sewage and industrial waste.

962.02 - GENERAL

Ductile Iron Pipe shall conform to the requirements of USASI A21.51 together with requirements of these specifications.

962.03 - MINIMUM BEDDING REQUIREMENTS

Class C bedding as outlined in Chapter 9, "Structural Requirements", Section D, pages 211 and 212, WPCF Manual of Practice No. 9, 1970, shall be used unless otherwise noted on construction plans.

962.04 - PROTECTIVE COATING - INTERIOR AND EXTERIOR

Ductile Iron Pipe shall be coated inside and out with standard coal tar pitch varnish for water service and conform to Federal Specification, WW-p-421a Pipe, "Water, Cast Iron (Bell and Spigot)".

SECTION 970 - TRAFFIC MATERIALS

Refer to Section 700 for specific specifications on items. All specifications shall apply to all projects with Section 700 items.

SECTION 971 - ADA COMPLIANT TACTILE WARNING

971.01 - DESCRIPTION

This section covers specifications for ADA compliant tactile warning surfaces

971.02.01 - ADA COMPLIANT TACTILE WARNINGS – PRE-FORMED MODULAR CONCRETE

A. Compressive Strength when tested by ASTM-D 695-91 shall be 10,000 PSI minimum.
B. Slip Resistance when tested by ASTM-C 1028 combined wet / dry friction coefficient shall be 0.70 on top of domes and remaining areas.
C. Color of cured material shall provide a minimum of 70% contrast with surrounding surfaces (light on dark or dark on light) as determined by:

$$\text{Contrast} = \frac{B_1 - B_2}{B_1} \times 100$$

where:

B1 – light reflectance value (LRV) of the lighter area

B2 – light reflectance value (LRV) of the darker area.

971.02.02 ADA COMPLIANT TACTILE WARNINGS – SURFACE APPLIED MATS

A. Tensile Strength of Matt when tested by ASTM-D412 shall be 1,100 PSI minimum.
B. Slip Resistance of Matt when tested by ASTM-C1028 combined wet / dry friction coefficient shall be 0.70 on top of domes and remaining areas.
D. Color of cured material shall provide a minimum of 70% contrast with surrounding surfaces (light on dark or dark on light) as determined by:

$$\text{Contrast} = \frac{B_1 - B_2}{B_1} \times 100$$

where:

B1 – light reflectance value (LRV) of the lighter area

B2 – light reflectance value (LRV) of the darker area.

Tactile warning surfaces that are stamped into the sidewalk or ramp surface, when wet, are not allowed.

SECTION 981 - STONE FOR MASONRY AND RIPRAP

981.01 - MATERIALS COVERED

This section covers stone for Ashlar Masonry, Mortar Rubble Masonry, Dry Rubble Masonry, Plain Riprap, Laid Up Riprap or Grouted Riprap, precast concrete blocks for Laid Up Riprap or Grouted Riprap, stone for Special Plain Riprap and material for Filter Blanket.

981.02 - ASHLAR STONE

The stone shall be tough, dense, sound, and durable, resistant to weathering action and shall be free from seams, cracks, or other structural defects. Preferably, stone shall be from a quarry the product of which is known to be of satisfactory quality. Stone shall be of such character that it can be wrought to such lines and surface, whether curved or plain, as may be required. Any stone having defects which have been repaired with cement or other material shall be rejected.

The individual stones shall be large and well proportioned. They shall not be less than twelve (12) inches or more than thirty (30) inches in thickness.

981.03 - RUBBLE STONE

Stone for mortar rubble or dry rubble masonry shall be of approved quality, sound and durable, free from segregations, seams, cracks, and other structural defects or imperfections tending to destroy its resistance to the weather. Stone for mortar rubble shall be reasonably free from rounded, worn or weathered surfaces and weathered stone shall be rejected. Selected stones with flat faces as nearly parallel as practicable shall be used.

Individual stones shall have a thickness of not less than four (4) inches and a width of not less than one and one-half (1 1/2) times the thickness. No stones, except headers, shall have a length less than one and one-half (1 1/2) times their width.

981.04 - RIPRAP STONE

Stone for riprap shall be hard, sound and durable and shall be approved by the Engineer prior to use. Samples of the stone to be used shall be submitted to and approved by the Engineer before any stone is used.

Tests for weight and absorption will be determined in accordance with ASTM C-97. The minimum weight shall be one hundred-forty (140) pounds per cubic foot and the maximum absorption shall be six

(6) percent.

The size of stone for the various kinds of riprap shall be as follows:

TABLE 981.04.01 Stone for Plain Riprap			
Riprap Thickness	**Maximum**	**Average Size**	**20 Percent Shall Weigh Less Than**
Inches	Pounds	Pounds	Pounds
12	150	30-50	20
18	350	70-125	30
24	1000	225-400	40
30	1000	225-400	40

When placed on the embankment the smaller stones shall be well distributed throughout the mass. Neither the breadth nor the thickness of any piece of riprap shall be less than one-third (1/3) of its length.

TABLE 981.04.02 Stone for Laid Up or Grouted Riprap		
12 Inch Thick:	Size of Stone 50 to 250 lbs.	with at least 60% weighing 100 lbs. or more
18 Inch Thick:	Size of stone 50 to 500 lbs.	with at least 60% weighing 150 lbs. or more

Slabs or sliver will be rejected. Spalls shall be well graded, of a suitable size for the work.

TABLE 981.04.03 Stone for Special Plain Riprap	
40 to 60 Percent	– 5 cf to 12 cf volume
5 to 15 Percent	– may be less than 0.25 cf in volume

981.05 - PRECAST CONCRETE BLOCKS

Precast concrete blocks for laid up riprap or grouted riprap shall have a vertical dimension of six (6) to eight (8) inches, a horizontal dimension of from eight (8) to sixteen (16) inches, and a dimension perpendicular to the slope of the wall of nine (9) inches.

Cement sand blocks will be permitted when composed of one (1) part cement to three (3) parts approved clean sand by volume.

981.06 - 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 be reasonably free from flat and/or elongated particles in an amount exceeding twenty (20) percent. A flat or elongated piece is one where the length is greater than five (5) times the average thickness. The backing material in place shall be reasonably well graded within the following limits:

TABLE 981.06.01 Filter Blanket Material

Single Course Backing (Filter Blanket)		
Sieve Designation, U.S. Standard	Percent by Weight	
Square Mesh (Inch)	Passing	
4	100	
2	60-90	
1	40-70	
08-Mar	15-40	
No. 4	0-15	
Two Course Backing (Filter Blanket)		
Sieve Designation, U.S. Standard	Lower Course of 2 Layers	Upper Course of 2 Layers
Square Mesh (Inch)	Percent by Weight Passing	
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	-

SECTION 982 - METALS FOR GUARD RAIL AND FENCE

982.01 - DESCRIPTION

This section covers the requirements for metals for guard rail, bridge rail and fence.

982.02 - METAL BEAM RAIL STEEL

A) Beams - Corrugated steel beams shall conform to the requirements of AASHTO M180 for the gauge specified and modified to include sheet made with a basic oxygen furnace.

B) Posts - Steel posts and base plates shall be of the section and length as specified or as shown on the plans. Steel shall conform to the requirements of AASHTO M-183. Galvanizing shall conform to the requirements of AASHTO M-111.

C) Guard Rail Hardware - Offset brackets of the resilient and non-resilient types shall be of the type specified or as shown on the plans and shall meet the strength requirements specified.

Splices and end connections shall be of the type and design specified or shown on the plans and shall be of such strength as to develop the full design strength of the rail elements.

End spring assemblies, when specified, shall be positive and of a type and design coinciding with the intent, design and strength of the railing structure and shall be as specified or as shown on the plans.

End anchor rods and accessories shall be as specified or as shown on the plans and shall be of such size and strength as to develop the full design strength of the rail elements.

Unless specified otherwise 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. All galvanizing shall be done after fabrication.

982.03 - METAL BEAM RAIL - ALUMINUM

A) Aluminum Beam Guard Railing and Fittings - The rail element shall be aluminum alloy 2024 T3 Sheet, ASTM B-209. The thickness of aluminum shall be as shown on the plans. All bolts shall be aluminum alloy 2024 T4, ASTM B-211. Bolt head and thread dimensions shall conform to the standard drawings. All nuts shall be aluminum alloy, 6262 T9 and shall be made from rod conforming to ASTM B-211. Nut and thread dimensions shall conform to the standard drawing.

B) Aluminum Alloy Guard Rail Post - Aluminum alloy posts for double faced aluminum beam guard rail shall be aluminum alloy 6061 T6, ASTM B-308. When set on concrete median strip the post shall be secured to the concrete median as shown on the plans. Structural shapes for fastening the post to the concrete median shall be alloy 6061 T6 or 2024 T4, ASTM B-211.

982.04 - METAL BRIDGE RAILING

A) Materials

1) Structural steel shapes for posts and rail shall meet the requirements of Section 946.

2) Metal beam shall meet the requirements of Subsection 982.02 for steel or 982.03 for aluminum alloy.

3) Aluminum alloy tubes for bridge railing shall meet ASTM B-221, alloy 6063 T6 or 6061 T6. Welding when shown on the plans or permitted shall be in accordance with Subsection 946.04.

4) A certificate of analysis executed by the producer shall be furnished the City, setting forth the chemical analysis and test results for tubes.

5) Cast aluminum alloy bridge railing posts shall meet the requirements of (Alloy A 344 T4) AASHTO M-913. Welding when shown on the plans or permitted shall be in accordance with Subsection 946.04.

982.05 - PIPE RAILING

A) Galvanized Steel Pipe and Fittings shall meet requirements of ASTM A-120, Standard Weight Pipe.

B) Black Steel Pipe and Fittings shall comply with the requirements of ASTM A-120, Standard Weight Pipe.

982.06 - WIRE CABLE AND FITTINGS

Materials shall meet the requirements of AASHTO M-30.

982.07 – FENCE MATERIALS

A) The woven wire shall be design number 832-6-12 1/2, Class 1 coating conforming to ASTM A-116 or ASTM A-584.

B) Barbed wire shall consist of two (2) strands of No. 12 1/2 gauge wire twisted with four (4) point barbs and Class 1 coating conforming to ASTM A-121, or ASTM A-585.

C) Steel tension wire shall be No. nine (9) gauge and develop an ultimate tensile strength of not less than sixty thousand (60,000) psi. Coating shall match the material and weight of coating of the woven wire fabric furnished.

D) Line posts shall be either steel or treated wood. The same kind of material shall be used throughout any one project.

Unless specified otherwise steel posts shall be seven and one-half (7 1/2) feet long studded "T"

weighing not less than 1.33 " 0.05 pounds per foot in the black, painted with a shop coat of red lead and a finish coat of aluminum weather resistant paint or galvanized by the hot-dip process at the rate of not less than two (2) ounces of zinc per square foot.

A primer coat of Federal Specifications TTP 636 which contains the proper amounts of zinc oxide and zinc chromate to give it rust inhibiting characteristics and a finish coat of orange red fence post baking enamel will also be acceptable. The primer and finish coats shall be applied by a modern flow coat system. After each application the post shall pass through a sufficient drip-off two hundred seventy-five (275) degrees F baking, and cooling zone appropriately designed to give suitable paint applications.

Unless specified otherwise wood posts shall be seven (7) feet long with a minimum diameter of three and one-half (3 1/2) inches. They shall be sound and reasonably straight commercial grade posts and shall be treated in accordance with Section 982.

E) Post tie wire of not less than eleven (11) gauge to tie the wire fabric to steel posts shall be commercial fasteners of galvanized wire approved by the Engineer.

F) The pipe for the gate frame shall be as specified in Section 982.

G) The frame shall be covered and braced as indicated on the plans. Fittings, latches and hinges shall be of a type approved by the Engineer before installation.

H) Staples used for fastening wire to wood posts shall be made of No. nine (9) gauge galvanized wire. They shall be one and one-half (1 1/2) inches long.

I) Nails shall be round or oval steel wire of the size shown on the plans unless otherwise directed by the Engineer.

982.08 - STANDARD CHAIN LINK FENCE, TYPE II

A) Description - This section covers the requirements for chain link fence fabric, line posts, terminal posts, post ties, tension wire, and gates for the construction of chain link type fence. The height of fence fabric required and the length and cross section of line and terminal posts shall be as shown on the plans or in the proposal.

B) Materials

1) Chain link fabric and accessories shall conform to the requirements of AASHTO M-181 for the kind of coating, sizes of wire and mesh specified. Unless otherwise provided the fabric shall be two (2) inch mesh Type I or Type II, nine (9) gauge minimum wire with aluminum or Class A zinc coating.

2) Pipe posts shall be galvanized and of the length required with a nominal inside diameter of one and one-half (1 1/2) inches and shall conform to the requirements of ASTM A-120. Posts shall be furnished with an approved type ornamental top of malleable cast steel or iron galvanized as required by the plans.

3) "H" column post shall be hot dipped galvanized to meet the requirements of AASHTO M-181 of the length shown on the plans. The minimum weight per linear foot of post shall be 3.26 pounds.

4) Roll formed line posts shall be hot dipped galvanized to meet the requirements of AASHTO M-181 of the length shown on the plans. The dimensions of the roll formed post shall be 1.625 x 1.875 inches and weigh more than two and one-fourth (2.25) pounds per linear foot.

5) Terminal posts shall be galvanized and shall be the length required with a nominal inside diameter of two (2) inches and shall conform to the requirements of ASTM A-120. Ornamental tops shall be of the same type and quality as tops for line posts.

6) All rails, posts, braces and gate frames shall conform to ASTM A-120 or ASTM A-501 with a nominal OD of 1.66 inches and a minimum weight of 1.81 pounds per linear foot.

7) Post ties shall be minimum nine (9) gauge aluminum, aluminum coated or galvanized steel wire for tubular and roll form line posts and minimum six (6) gauge galvanized steel clips for "H" column line posts. Connections to terminal posts shall be by stretcher bar and tension bands, all galvanized. Bands shall be twelve (12) gauge x one (1) inch wide and fabricated for minimum three-eighths (3/8) inch carriage bolts. The stretcher bar shall be not less than one-fourth (1/4) x three-fourths (3/4) inches flat. The ties and bands shall be spaced at fifteen (15) inch maximum.

8) The tension wire for chain link fence shall be either galvanized steel wire or aluminum coated steel wire of the same type coating as the fence fabric. Galvanized tension wire shall be 0.177 inch carbon steel wire conforming to the requirements of ASTM A-641, hard grade - eighty thousand (80,000) psi minimum tensile strength with Class 3 zinc coating. Aluminum coated tension wire shall be 0.177 inch carbon steel wire meeting the requirements of ASTM A-641, hard grade for tensile strength and shall have a minimum .40 ounce per square foot of surface area aluminum coating. Ties to top of fence fabric shall be with eleven (11) gauge galvanized hog rings on twelve (12) inch centers. Post ties shall be as specified for chain link fabric and shall be tied to the post separate from the fabric.

9) The pipe for the gate frame shall conform to ASTM A-120 or ASTM A-501 with a nominal OD of 1.66 inches and a minimum weight of 1.81 pounds per linear foot. The frame shall be covered with the above fence fabric connected by bar, tension bands and ties. The frame shall be braced with two (2) minimum three-eighths (3/8) inch diameter, diagonal galvanized steel rod braces. Fittings shall be of an approved type with galvanized steel hinges, catch stops and center rests.

982.09 - GLARE DEFLECTOR FENCE, TYPE IV

Unless otherwise provided all materials, except size of mesh, shall conform to the requirements of AASHTO M-181.

The chain link fence fabric shall have nine (9) gauge wire and one (1) inch mesh. If AASHTO M-181 Type I fence is used, the fabric shall have a Class A coating.

Line posts, terminal posts, rails, and braces shall be as specified in Subsection 982.08.

Tension wires, tie wires and hog rings shall be as specified in Subsection 982.08.

SECTION 983- GUARD RAIL POSTS AND GUIDE POSTS

983.01 - DESCRIPTION

This section covers the requirements for wood, concrete and steel posts used for guard rails and wood posts for guide posts.

983.02 - WOOD POSTS

Wood posts shall be of the length and size specified on the plans and shall be cut from live trees and shall be close grained. Posts shall contain only sound wood.

Both the outer and inner bark shall be completely removed from all round posts and all knots trimmed flush with the face. Defects of any kind which give any post an unsightly appearance will be sufficient ground for rejection.

The size of the post shall be determined at the treating plant immediately prior to treatment. The diameter of round posts shall be determined by means of a circumference diameter tape. Minimum diameter at the tip as measured with a circumference diameter tape shall not be less than the nominal diameter by more than one (1) inch and no actual diameter shall vary from the diameter as determined with the circumference diameter tape by more than one-half (1/2) inch over or under.

Sawed posts shall be of the dimensions and grade shown on the plans. They shall meet the

requirements of Section 983.

Wood posts shall be treated in accordance with Section 983. Sawing, chamfering, boring or cutting as shown on the plans shall be performed prior to treatment.

Spacer blocks shall be as shown on the plans and treated in accordance with Section 983.

983.03 - STEEL POSTS

Steel posts shall be of the length and size shown on the plans. Unless specified otherwise they shall be galvanized and meet the requirements of AASHTO M-111. Steel bases shall be as shown on the plans and galvanized in accordance with AASHTO M-111.

983.04 - CONCRETE POSTS AND SPACER BLOCKS

983.04.01 – MATERIALS

Materials shall meet the following requirements:

Concrete	935
Wire Stirrups	AASHTO M-32
Reinforcing Steel	940

983.04.02 – METHODOLOGY

Curing - Concrete posts and blocks will be cured in a manner that will produce thirty-five hundred (3500) psi minimum compressive strength at twenty-eight (28) days.

Tolerances - Dimensional tolerances not shown or implied on the plans are intended to be those consistent with the proper functioning of the posts and blocks, including appearance and accepted manufacturing practices.

983.04.03 – TESTING

Testing and Acceptance - One (1) set of cylinders will be cast and tested for each one thousand (1000) posts and blocks. Cylinders will be at seventy (70) degrees F, and one hundred (100) percent humidity or by immersion in water for twenty-seven (27) days. The basis of acceptance will be compliance with these specifications as evidenced by test reports and certifications where applicable. Posts that are honeycombed or have been broken or cracked will not be accepted.

SECTION - 984 – PAINT

984.01 – WOOD SURFACES

These formulas are intended for new wood structures or handrails. When white paint is specified it shall be ready mixed paint conforming to Federal Specification TTP 101-2. When a colored finish is specified the prime coat shall be as specified above. The finish coat shall conform to Federal Specification TTP 105-A with the necessary tint added.

984.02 – ZINC DUST, ZINC OXIDE PRIMER FOR GALVANIZED SURFACES

The material shall be a ready mixed paint conforming to Federal Specifications TTP 641, Class B, Type I.

SECTION 985 - SODDING, SPRIGGING, SEEDING AND FERTILIZER

985.01 - SODDING AND SPRIGGING MATERIALS

A) 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 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 three (3) inches in height shall be mowed and the residue removed prior to harvesting the sod or sprigs.

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. 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. The slab must have a dense vegetative growth and be capable of being transported in a condition closely resembling its original state.

C) Sprigging - This material shall consist of vegetative parts (Rhizomes, Stolons and Roots) of 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 then 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 forty-eight (48) hours after removal from the soil.

985.02 - SEEDING MAT ERIALS

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 the Table 985.02.01 “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 two (2) copies of the invoices for the seed. The invoice shall describe each specie 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 two (2) copies of the report shall be supplied to the Engineer by the Contractor. Each seed test shall have been completed not more than nine (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 985.02.01 Seed Specifications		
Kind of Seed Common and Botanical Name	**P.L.S. Index**	**Weed Seeds**

	Min. Permitted [1]	Purity Min (%)	Germination Min. (%)	Max Permitted (%)
Bermuda Grass, Common (Cynodon dactylon) unhulled	80			0.2
Bermuda Grass, Common (Cynodon dactylon) hulled	82			0.2
Bluestem, big(Andropogon gerardi)[2]	20			
Bluestem,Caucasian(Andropogon caucasicus)	15			
Bluestem, Little(Andropogon scoparious)[2]	15			
Bluestem, Sand(Andropogon halli)[3]	20			
Bluestem, Yellow(Andropogon ischaemum)	18			
Brome, Smooth (Bromus inermis)	70			
Buffalograss (Buchloe dactyloides) [2 3]	55			
Burclover (Medicago hispida, arabica or rigidula)		98	85	1.0
Clover, Large Hop(Trifolium procumbens)[5]		95	85	0.5
Clover, Small Hop(Trifolium dubium)[5]		95	85	0.5
Dropseed, Sand(Sporobolus cryptandrus)	70			2.0
Fescue, Tall (Festuca arundinacea)	80			0.5
Grama, Blue(Boutelous gracilis)[2]	25			
Grama, Side-Oats (Boutelous curtipendula)[2]	30			
Indiangrass (Sorghastrum nutans) [2]	35			2.0
Lespedeza, Striata (Lespedeza straita)		97	90	0.5
Lespedeza, Korean (Lespedeza stripulacea)[5]		97	90	0.5
Lespedeza, sericea (Lespedeza cuneata)[5]		98	90	0.5
Lovegrass, Sand (Eragrostis trichodes)[2]	65			0.5
Lovegrass, Weeping (Eragrostis curvula)	80			0.3
Millet, German Foxtail (Setaria italica)		98	80	0.5
Native Grasses (Predominately little blue stem)[2]	15			
Oats (Avena sativa)		95	80	0.5
Rye (Secale cereale)		90	70	0.3
Ryegrass, Annual (Lolium multiflorum)	85			0.2
Ryegrass, Perennial (Lolium perenne)	85			0.2
Sudangrass (vulgare sudanense)		98	80	0.5
Switchgrass (Panicum virgatum)	60			2.0
Wheat (Triticum aestivum)		96	80	0.1
Wheatgrass, Western (Agropyron smithii)[2]	56			1.0

[1] The P.L.S. Index (Pure Live Seed Index) shall be calculated from information given on the seed tag, as follows:

$$\frac{\text{Percent Purity} \times (\text{Percent Germination} + \text{Percent Firm Seed})}{100} = \text{P.L.S. Index}$$

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 twenty-five (25%) percent or more, the pounds of bulk seed to be planted will be adjusted by using the following formula:

$$(S \times C) / F = P$$

Where:

S= P.L.S. index specified,

C = pounds of bulk seed called for,
F = P.L.S. index furnished, and
P = pounds of bulk seed to be planted.

[2]The seed source shall be Oklahoma, Texas or New Mexico.
[3] The seed shall have been prechilled and treated with potassium nitrate in accordance with the Hays Treatment Technique.
[4] The seed shall contain no Johnson grass seed. (This note applied to all seed).
[5] The seed shall be treated with an approved nitrogen fixing inoculant, such as manufactured by commercial laboratories suitable for the particular legume. The inoculant shall be stored and handled in accordance with the manufacturer's direction.

985.03 - 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", respective, in accordance with the requirements of Oklahoma Department of Agriculture.

Fertilizer furnished in standard, factory-sealed containers shall have all labeling required by the Oklahoma Department of Agriculture, intact and legible until the contents are used.

Each vehicle load of fertilizer furnished in bulk form shall be accompanied by two (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 granular 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:

Grade of Specified Fertilizer x Specified Rate = Pounds of Actual Plant Food
(Converted from Percent to Decimal) (N, P2O5, K20)
Pounds of Actual Plant Food (N, P205, K20) = New Application Rate
New Grade (Converted from Percent to Decimal)

B) Agricultural Liming Material - This material shall consist of either "agriculture limestone" or "hydrated lime" or shall meet the requirements of Section 985.03. When agriculture limestone is called for, seventy (70) pounds of hydrated lime may be substituted for one hundred (100) pounds of agriculture limestone. Agriculture limestone shall not be substituted for hydrated lime.

1) 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.

2) Each vehicle load of liming material furnished in bulk form shall be accompanied by two (2) 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.

SECTION 986 - MASONRY BRICK

986.01 - 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.

986.02 - MASONRY BRICK MADE FROM CLAY OR SHALE

Masonry brick of this type shall comply with the requirements of AASHTO M-114 for building brick. Unless shown otherwise on the plans, grade "MW" brick shall be used.

986.03 - CONCRETE BUILDING BRICK

Concrete building brick shall conform to the requirements of ASTM C-55. Unless shown otherwise on the plans, Type I, Grade S-1 shall be used.

Concrete brick shall not be used in the construction or reconstruction of sanitary sewer manholes.

SECTION 988 – GEOTEXTILES AND FILTER FABRIC

988.01 – 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. In addition, use AASHTO M288 Subsurface Drainage, Table 2 with 15% to 50% of in situ soil passing the No. 200 sieve.

B) Acceptance. Furnish a type D material certification for the fabric in accordance with Section 109.17. Also, furnish a 3 square yard sample of the fabric for testing to the Materials Specialist from each lot or shipment by the Engineer.

C) The geotextile shall be of nonwoven needlepunched construction and consist of long chain polymeric fibers composed of polypropylene, polyethylene, or polyamide. The fibers shall be oriented into a multi-directional stable network whereby they retain their positions relative with each other and allow the passage of water as specified. The fabric shall be free of any chemical treatment or coating which reduces permeability and shall be inert to chemicals commonly found in soil. The geotextile shall conform to the physical property requirements listed in Table 988.01.01.

Table 988.01.01 Geotextile For Subsurface Drainage

Acceptable Typical Physical Property	Test Method	Test Results
Tensile Strength, wet, lbs.	ASTM D-1682	90 (*minimum)
Elongation, wet, %	ASTM D-1682	40 (*minimum)
Coefficient of Water Permeability, cm/sec		0.1
Constant Head	ASTM D-7511	40 (minimum)
Puncture Strength, lbs.		40 (maximum)
Pore Size-EOS, US Standard Sieve	Corps of Engineers CW-00215	

*Minimum is the minimum value in any principal direction for the typical fabric weight.1Tension testing machine with ring clamp; steel ball replaced with a five-sixteenth (5/16") inch diameter solid steel cylinder with hemispherical tip centered within the ring clamp.

The geotextile shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling.

The drainage fabric shall be placed in the manner and at the locations shown on the project plans. The surface to receive the fabric and/or the trench into which the fabric is to be placed shall be prepared to a smooth condition free of obstructions and debris.

The drainage fabric shall be covered with a permeable material within two (2) weeks of its placement. Should the fabric be damaged during construction, the torn or punctured section shall be repaired by placing a piece of fabric that is large enough to cover the damaged area and to meet the overlap requirement. Adjacent borders of the geotextile shall be overlapped a minimum of twelve (12) inches or sewn. The preceding roll shall overlap the following roll in the direction the material is being placed.

The quantity of drainage geotextile to be paid for will be measured by the square yard of area covered, not including additional fabric for overlap. The contract price paid per square yard for drainage geotextile shall include full compensation for furnishing all the work involved in placing the drainage geotextile, complete in place, as shown on the plans and as directed by the Engineer.

988.02 - GEOTEXTILE FOR EMBANKMENT/RIPRAP STABILIZATION

The geotextile shall be of monofilament woven or needlepunched nonwoven construction and consist of long-chain polymeric filaments or fibers composed of polypropylene, polyethylene or polyamide. The filaments and fibers shall be orientated whereby they retain their relative positions with each other and allow the passage of water as specified.

The fabric shall be mildew, insect, and rodent resistant and shall be inert to chemicals commonly found in soil. The geotextile shall conform to the physical property requirements listed in Table 988.02.01.

Table 988.02.01 Geotextile For Embankment/Riprap Stabilization

Acceptable Typical Physical Property	Test Method	Test Results
Tensile Strength, wet, lbs.	ASTM D-1682	200 (*minimum)
Elongation, wet, %	ASTM D-1682	15-90
Puncture Strength, lbs.	ASTM D-7511	100
Mullen Burst Strength, psi	ASTM D-3786	350
Coefficient of Water Permeability, cm/sec	Constant Head	0.03 (minimum)
Abrasion Resistance, lbs.	ASTM D-1175	55 (*minimum)
Taber Test	1000 revolutions	1 kg load/wheel
Pore Size-EOS, US Standard Sieve	Corps of Engineers CW-00215	40 (maximum)

*Minimum is the minimum value in any principal direction for the typical fabric weight.

[1]Tension testing machine with ring clamp; steel ball replaced with a five-sixteenth (5/16") inch diameter solid steel cylinder with hemispherical tip centered within the ring clamp.

The geotextile shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling. If the geotextile is to be exposed directly to sunlight in excess of two (2) weeks, the fabric shall be ultraviolet stabilized.

The embankment/riprap stabilization fabric shall be placed in the manner and at the locations shown on the project plans. The surface to receive the geotextile shall be prepared to a smooth condition free of obstructions, depressions and debris. The fabric shall be placed loosely, not in a stretched condition. The riprap shall be placed so that the geotextile is not punctured. The riprap shall complete cover the fabric.

The fabric shall be placed on the slopes so as to provide a minimum overlap of eighteen (18) inches. The geotextile shall be placed parallel to the direction of the flow and the upstream or higher panel shall overlap the downstream or lower panel. At the top of the embankment the fabric shall be keyed into the ground a minimum of eighteen (18) inches. If a cushion layer is placed, the bottom toe shall be finished by lapping the fabric back onto the cushion layer and securing with riprap.

Quantities of the geotextile placed as shown on the plans or as directed by the Engineer, will be determined from measurements taken of the area covered by the fabric, with no allowance for laps or toe-in anchorage.

The contract price paid per square yard for embankment/riprap stabilization geotextile shall include full

compensation for furnishing all labor, materials, tools, equipment and incidentals. The price per square yard also includes doing all the work involved in installing the geotextile, complete in place, as shown on the plans and as directed by the Engineer.

988.03 - PAVEMENT REINFORCING FABRIC

Description. This Section covers fabrics to be used for reinforcement of asphalt pavements.

A) General. The fabric shall meet the requirements for paving in AASHTO M 288.

1) 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. The rolls that are supplied shall provide full coverage of the pavement with a minimal number of joint splices. Wrap the rolls of fabric for protection against sunlight and moisture. When stored outdoors, elevate the rolls and cover them with a tarpaulin.

2) Sampling and Testing. Furnish a type A materials certification for the reinforcement fabric in accordance with Section 109.17.

B) SEPARATOR FABRIC FOR BASES.

1) General. This Subsection describes a pervious fabric to be used under base courses for separation. The fabric shall meet the requirements for separation in AASHTO M 288. A non-woven fabric is required.

2) Acceptance. Furnish a type A certification for the fabric in accordance with Section 109.17.

988.04 – FILTER FABRIC FOR SILT FENCE

A) General. This Subsection describes fabric to be used for the removal of soil particles from water flowing through the fence. The fabric shall meet the requirements for temporary silt fence in AASHTO M 288. In addition, use AASHTO M288, Table 6, Unsupported Silt Fence with an elongation less than 50%.

B) Acceptance. Furnish a type D material certification for the fabric in accordance with Section 109.17.