UNIFORM STANDARD SPECIFICATIONS for PUBLIC WORKS CONSTRUCTION

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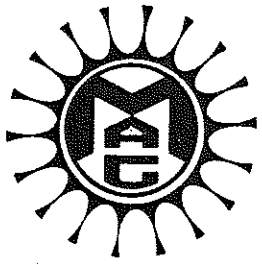

MARICOPA ASSOCIATION of GOVERNMENTS

1979
ARIZONA

FOREWORD

Publication of these Uniform Standard Specifications for Public Works Construction fulfills the goal of a group of agencies who joined forces in 1966 to produce such a set of documents. Subsequently, in the interest of promoting county-wide acceptance and use of these standards, the Maricopa Association of Governments accepted their sponsorship and the responsibility of keeping them current and viable.

These specifications, representing the best professional thinking of representatives of the several Public Works Departments, reviewed and refined by members of the construction industry, were written to fulfill the need for uniform rules governing public works construction performed for Maricopa County and the various cities and public agencies in the county. It further fulfills the need for adequate standards by the smaller communities and agencies who could not afford to promulgate such standards for themselves.

A uniform set of specifications, updated and embracing the most modern materials and construction techniques will redound to the benefit of the public and the private contracting industry. Uniform specifications will eliminate conflicts and confusion, lower construction costs, and encourage more competitive bidding by private contractors.

The Uniform Standard Specifications for Public Works Construction will be revised periodically and reprinted to reflect advanced thinking and the changing technology of the construction industry. To this end a Specifications Committee has been established as a permanent organization to continually study and recommend changes to the specifications. Interested parties may address suggested changes and questions to Standard Specifications Committee, c/o MAG, Phoenix, Arizona.

These suggestions will be reviewed by the committee and appropriate segments of the industry and a cumulative annual supplement will be published in May of each year. At approximately three-year intervals, the entire volume will be republished incorporating all current accepted revisions.

While in the interest of uniformity, it is hoped that all using agencies will adopt these standards with as few changes as possible, it is recognized that because of charter requirements and for other reasons some agencies will find it necessary to modify or supplement certain requirements. To accommodate such supplements a pocket has been provided inside the back cover.

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Project No. _____

BOND ISSUE OR BUDGET PROJECT

CITY OF _____, ARIZONA

ENGINEERING DEPARTMENT

PROPOSAL to the City Engineer of the City of _____.

In compliance with the Advertisement for Bids, by the City Engineer, the undersigned Bidder:

Having examined the contract documents, site of work, and being familiar with the conditions to be met, hereby submits the following Proposal for furnishing the material, equipment, labor and everything necessary for the completion of the work listed and agrees to execute the contract documents and furnish the required bonds and certificates of insurance for the completion of said work, at the locations and for the prices set forth on the inside pages of this form.

Understands that construction of this project shall be in accordance with all applicable Uniform Standard Specifications and Standard Details except as otherwise required by the Project Plans and Special Provisions.

Understands that his proposal shall be submitted with a proposal guarantee of cash, certified check, cashier's check or surety bond for an amount not less than 5 percent of the amount bid.

Agrees that upon receipts of Notice of Award, from the City of _____, he will execute the contract documents.

Work shall be completed within _____ calendar days, beginning with the day following the starting date specified in the Notice to Proceed. The time allowed for completion of the work includes lead time for obtaining the necessary material and/or equipment.

The Bidder hereby acknowledges receipt of and agrees his proposal is based on the following Addenda.

_____

_____

FOR PROJECT NO.		BID SCHEDULE				
PAY ITEM NO.	**UNIT AND APPROXIMATE QUANTITIES**	**DESCRIPTION** **UNIT BID PRICE IN WORDS**	**UNIT BID PRICE DOLLARS & CENTS**		**AMOUNT BID DOLLARS & CENTS**	
1.		For_____and /100 Dollars per_____				
2.		For_____and /100 Dollars per_____				
3.		For_____and /100 Dollars per_____				
4.		For_____and /100 Dollars per_____				
5.		For_____and /100 Dollars per_____				
6.		For_____and /100 Dollars per_____				
7.		For_____and /100 Dollars per_____				
8.		For_____and /100 Dollars per_____				
9.		For_____and /100 Dollars per_____				
TOTAL		For_____and /100 Dollars per_____				

THIS PROPOSAL IS SUBMITTED BY _____

_____, a corporation organized under the laws of the State of

_____, a partnership consisting of _____

_____

or individual trading as _____

of the City of _____ and is the holder of Arizona State

Contractor's License: _____

Classification _____ No. _____

Respectfully submitted,

FIRM _____

ADDRESS _____

BY _____
Officer and Title

Date _____

ATTEST:

_____
Officer and Title

_____

Witness: If Bidder is an
Individual

Project No. _____

IMPROVEMENT DISTRICT PROJECT

CITY OF _____, ARIZONA

ENGINEERING DEPARTMENT

PROPOSAL to the City Council of the City of _____.

In compliance with the advertisement for Bids, by the Superintendent of Streets, the undersigned Bidder:

Having examined the contract documents, site of work, and being familiar with the condition to be met, hereby submits the following Proposal for furnishing the materials, equipment, labor and everything necessary for the completion of the work listed and agrees to execute the contract documents and furnish the required bonds and certificates of insurance for the completion of said work, at the locations and for the prices set forth on the inside pages of this form.

Understands that construction of this project shall be in accordance with all applicable Uniform Standard Specifications and Standard Details except as otherwise required by the Project Plans and Special Provisions.

Understands improvement bonds, issued under the provisions of Sections 9-671 to 9-710, Arizona Revised Statutes, will be issued to represent the costs and expenses of the improvement. These bonds will bear interest at the rate of _____ percent per annum.

Submits herewith a surety bond, equal to 10 percent of the amount of the highest proposal submitted.

Agrees that upon publication of Notice of Award, in accordance with ARS Section 9-681, he will execute the contract documents.

Work shall be completed within _____ calendar days, beginning with the day following the date of execution of the contract. The time allowed for completion of the work includes lead time for obtaining the necessary materials and/or equipment.

THIS PROPOSAL IS SUBMITTED BY_____

_____, a corporation organized under the laws of the State of

_____, a partnership consisting of_____

_____

or individual trading as_____

of the City of_____and is the holder of Arizona State

Contractor's License: _____

Classification_____No. _____

Respectfully submitted,

FIRM_____

ADDRESS_____

BY_____
Officer and Title

Date_____

ATTEST:

_____
Officer and Title

_____
Witness: If Bidder is an
Individual

Project No. _____

SURETY BOND

KNOW ALL MEN BY THESE PRESENTS:

That we, _____

_____, as Principal, (hereinafter called the Principal), and the _____, a corporation duly organized under the laws of the State of _____, as Surety, (hereinafter called the Surety), are held and firmly bound unto the _____ of _____ as Obligee, in the sum of _____ percent (_____%) of the total amount of the bid of Principal, submitted by him to the _____ of _____ for the work described below, for the payment of which sum, well and truly to be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, and administrators, successors and assigns, jointly and severally, firmly by these presents, and in conformance with A.R.S.

WHEREAS, the said Principal is herewith submitting its proposal for _____

_____

_____

NOW, THEREFORE, if the _____ of _____ shall accept the proposal of the Principal and the Principal shall enter into a contract with the _____ of _____ in accordance with the terms of such proposal and give such Bonds and Certificates of Insurance as specified in the Standard Specifications with good and sufficient Surety for the faithful performance of such contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter into such contract and give such Bond and Certificates of Insurance, if the Principal shall pay to the _____ of _____ the sum of money set forth above as liquidated damages for failure of the Principal to enter into the contract, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and sealed this _____ day of _____, A.D., 19 _____

_____
Principal

_____
Title

Witness:

_____

_____
Surety

_____
Title

Witness:

_____

BOND ISSUE OR BUDGET PROJECT

CONTRACT

THIS AGREEMENT, made and entered into this _____ day of _____, 19_____, by and between _____ _____ of the City of _____, County of _____, and State of _____, party of the first part, hereinafter designated the CONTRACTOR, and the City of _____, a municipal corporation, organized and existing under and by virtue of the laws of the State of Arizona, party of the second part, hereinafter designated the OWNER.

WITNESSETH: That the said Contractor, for and in consideration of the sum to be paid him by the said Owner, in the manner and at the time hereinafter provided, and of the other covenants and agreements herein contained, and under the penalties expressed in the bonds provided, hereby agrees, for himself, his heirs, executors, administrators, successors, and assigns as follows:

ARTICLE I — SCOPE OF WORK: The Contractor shall furnish any and all labor, materials, equipment, transportation, utilities, services and facilities required to perform all work for the construction of Project No. _____ _____ and to completely and totally construct the same and install the material therein for the Owner, in a good and workmanlike and substantial manner and to the satisfaction of the Owner through its Engineers and under the direction and supervision of the Engineer, or his properly authorized agents and strictly pursuant to and in conformity with the Plans and Specification prepared by the Engineers for the Owner, and with such modifications of the same and other documents that may be made by the Owner through the Engineer or his properly authorized agents, as provided herein.

ARTICLE II — CONTRACT DOCUMENTS: The Call for Bids, Plans, Standard Specifications and Details, Special Provisions, Addenda, if any, and Proposal, as accepted by the Mayor and Council per Council Minutes of _____, 19_____, Performance Bond, Payment Bond, Certificates of Insurance, and Change Orders, if any, are by this reference made a part of this Contract to the same extent as if set forth herein in full.

ARTICLE III — TIME OF COMPLETION: The Contractor further covenants and agrees at his own proper cost and expense, to do all work as aforesaid for the construction of said improvements and to completely construct the same and install the material therein, as called for by this agreement free and clear of all claims, liens, and charges whatsoever, in the manner and under the conditions specified within the time, or times, stated in the proposal pamphlet.

ARTICLE IV — PAYMENTS: For and in consideration of the faithful performance of the work herein embraced as set forth in the Contract Documents, which are a part hereof and in accordance with the directions of the Owner, through its Engineer, and to his satisfaction, the Owner agrees to pay the said Contractor the amount earned, computed from actual quantities of work performed and accepted or materials

furnished at the unit bid price on the Proposal made a part hereof, and to make such payment within forty-five (45) days after final inspection and acceptance of the work.

The Contractor hereby agrees to indemnify and save harmless the City of _____, and any jurisdiction or agency issuing permits for any work included in the project, their officers, agents and representatives from all suits, actions, loss, damage, expense, cost, or claims of any character or any nature brought on account of any injuries or damage sustained by any person or property arising out of the work done in fulfillment of the construction of the improvement under the terms of this agreement, or on account of any act or omission by the Contractor or his agents, or from any claims or amounts arising or recovered under Workmen's Compensation laws or any other law, bylaw, ordinance, or order or decree.

IN WITNESS WHEREOF, six (6) identical counterparts of this contract each of which shall be for all purposes be deemed an original thereof, have been duly executed by the parties hereinabove named, on the date and year first above written.

The Contractor agrees that this Contract, as awarded, is for the stated work, and understands that payment for the total work will be made on the basis of the indicated amount(s), as bid in the Proposal.

ATTEST:

_____

_____

_____
(Contractor — Party of the First Part)

By _____
(Name and Title)

WITNESS: If Contractor is an Individual

(Corporate Seal)

ATTEST:

_____

_____
(Authorized Officer)

City Clerk
(Official Title)

Authority — City Council

_____

City of , a municipal corporation
(Owner — Party of the Second Part)

_____

By _____
(Official Title)

(Corporate Seal)
APPROVED AS TO FORM THIS

_____ day of _____, 19____.

_____
City Attorney

IMPROVEMENT DISTRICT PROJECT

CONTRACT

	INCIDENTALS	
Ordinance of Intention No._____	Engineering	$
Resolution Ordering Work No._____	Inspection	$
Date Contract Awarded_____	Clerical	$
Improvement District		
Contract No._____	Printing	$_____
Superintendent of Streets	Total	$

* * * * * *

THIS AGREEMENT, made and entered into this_____ day of_____, 19_____, by and between_____, party of the first part, and the City of_____, Arizona, County of Maricopa, State of Arizona, acting under the provision of Sections 9-671 to 9-710, both inclusive, Arizona Revised Statutes, and amendments thereto, party of the second part.

WITNESSETH:

THAT WHEREAS, the party of the first part, as will appear by reference to the minutes of the proceedings of the Council of the City_____, on the_____day of_____, 19_____, was duly awarded the contract for the work hereinafter mentioned; and

THEREFORE, the party of the first part, for the consideration hereinafter mentioned, promises and agrees to and with said party of the second part, that it will completely and totally do and perform, or cause to be so done and performed, in a good workmanlike manner, under the direction and to the satisfaction of the Superintendent of Streets, all the work described in an Ordinance in the records of the proceedings of the Council of the City of_____, a copy of said Ordinance being attached hereto and made a part hereof, for the purpose of providing a description of said work herein.

The party of the first part further agrees that it will completely and totally do or perform said work according to the Plans and Specifications, for said work referred to in said Ordinance, (a copy of which is attached hereto as aforesaid), which said Plans and Specifications are made a part of this contract, and that it will, at its own cost and expense, furnish all necessary labor and materials for said work and that the materials used therein shall comply with the said Specifications and be to the satisfaction of said Superintendent of Streets, and that it will within the time hereinafter fixed, turn the said work over to the Superintendent of Streets, complete and totally ready for use, free and discharged of all claims and demands whatsoever, for or on account of any and all labor and materials used or furnished to be used in said improvement.

And the party of the second part, hereby fixes the time for commencement of said work to be within ten (10) days from the date hereof, and for its completion to be within_____calendar days from the date hereof, and promises and agrees that upon the complete and total performance of the covenants

aforesaid by the said party of the first part, to make and issue an assessment and attach a warrant thereto as provided for in Sections 9-671 to 9-710, both inclusive, Arizona Revised Statutes, and amendments thereto, at the price specified in the Proposal of the party of the first part for said improvement as duly accepted by the Council of the City of_____, a copy of said Proposal being made a part hereof for the purpose of providing a statement of said prices.

In the event the Contractor completes the construction work within the time specified, this contract shall remain in full force and effect until the Bonds to be issued hereunder have been authorized by the Council of the City of_____.

AND IT IS EXPRESSLY UNDERSTOOD AND AGREED by the parties to this agreement that in no case (except where it is otherwise provided in Sections 9-671 to 9-710, both inclusive, Arizona Revised Statutes, and amendments thereto) will the City of_____ or any officer hereof, be liable for any portion of the expenses of the work, aforesaid, nor for any delinquency of persons or property assessed.

IN WITNESS WHEREOF, the parties hereto have caused these presents to be executed, the day and year first herein written.

_____
(Contractor — Party of the First Part)

By_____
(Name and Title)

City of_____
(Party of the Second Part)

By_____
(Superintendent of Streets)

CONTRACT BOND

STATUTORY PERFORMANCE BOND PURSUANT TO TITLE 34, CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES

(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That, _____ (hereinafter called the Principal) as Principal, and _____ a corporation organized and existing under the law of the State of _____ with its principal office in the City of _____, (hereinafter called the Surety), as Surety are held and firmly bound unto the City of _____ and the County of Maricopa, State of Arizona in the amount of _____

_____

Dollars ($_____), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written contract with the City of _____, dated the _____ day of _____, 19_____, for _____

_____

which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extension thereof, with or without notice to the Surety, and during the life of any guaranty required under the contract, and shall also perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the Surety being hereby waived; then the above obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of said Title, Chapter and Article, to the extent as if it were copied at length herein.

The prevailing party in a suit on this bond shall be entitled to such reasonable attorney's fees as may be fixed by a judge of the Court.

Witness our hands this _____ day of _____ 19_____.

_____ PRINCIPAL SEAL

_____
AGENT OF RECORD

By _____

_____ SURETY SEAL

_____
AGENT ADDRESS

By _____

LABOR AND MATERIALS BOND

STATUTORY PAYMENT BOND PURSUANT TO TITLE 34, CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES

(Penalty of this bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That, _____ (hereinafter called the Principal), as Principal, and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of _____, State of Arizona (hereinafter called the Obligee), in the amount of _____

_____

Dollars ($ _____), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written contract with the Obligee dated the _____ day of _____, 19_____, for _____

_____

which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall promptly pay all moneys due to all persons supplying labor or materials to him or his subcontractors in the prosecution of the work provided for in said contract, then this obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of said Title, Chapter and Article, to the extent as if it were copied at length herein.

The prevailing party in a suit on this bond shall be entitled to such reasonable attorney's fees as may be fixed by a judge of the court.

Witness our hands this _____ day of _____, 19_____.

_____
PRINCIPAL SEAL

_____
AGENT OF RECORD By _____

_____
SURETY SEAL

_____
AGENT ADDRESS By _____

CITY OF_____, ARIZONA

ENGINEERING DEPARTMENT

CERTIFICATE OF INSURANCE

Project No._____

The _____

Certifies that the following insurance policies have been issued on behalf of

Name of Insured_____

Address of Insured_____

Type of Insurance	Policy No.	Eff. Date	Exp. Date	Limits of Liability
(1) Workmen's Compensation				Statutory
(2) Contractors Protective Bodily Injury		$500,000		Each Occurrence
(2) Contractor(s) Protective Property Damage		$100,000 $100,000		Each Accident Aggregate
(3) Contractual Bodily Injury		$500,000		Each Occurrence
(3) Contractual Property Damage		$100,000 $100,000		Each Accident Aggregate
(4) Automobile Bodily Injury & Property Damage		$500,000		Each Occurrence

When the project includes construction of a new, or modification of an existing building **(in addition to the above types)**:

(5) Fire and Extended Coverage plus Vandalism and Malicious Mischief For the Full Amount of the Contract, with the City of_____named as an additional insured.

	Policy No.	Exp. Date	Amount
(6) Umbrella Coverage			

Policy Includes Coverage For:

(1) a. Damage caused by blasting
b. Damage caused by collapse or structural injury
c. Damage to underground utilities

(2) Liability assumed in construction agreements and other types of contracts or agreements in effect in connection with insured operations.

(3) All owned, hired or non-owned automotive equipment used in connection with the insured operation.

It is agreed that none of these policies will be cancelled or changed so as to affect

this certificate until ten (10) days written notice of such cancellation or change has been delivered to City of_____.

It is further agreed that:

(1) These policies shall not expire until all work has been completed and the project has been accepted by the City of_____. **(If a policy does expire during the life of the Contract, a renewal Certificate of the required coverage must be sent to the City of_____ not less than five days prior to expiration date.)**

This certificate is not valid unless countersigned by an authorized representative of the Insurance Company.

Date_____ Countersigned by_____

_____
Signature

CITY OF_____ARIZONA
ENGINEERING DEPARTMENT

CONTRACTOR'S AFFIDAVIT REGARDING SETTLEMENT OF CLAIMS

Part 100, Section 109, General Conditions

_____, Arizona
Date_____

Project No. _____

To The City of_____, Arizona

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $_____, as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of _____ against any and all liens, claims of liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performance and materials furnished for the performance of said installations.

Signed and dated at _____, this _____ day of _____, 19____.

_____
Contractor

_____
By

STATE OF ARIZONA)
ss
COUNTY OF MARICOPA)

The foregoing instrument was subscribed and sworn to before me this day of_____, 19_____.

_____
Notary Public

My Commission Expires _____

CITY OF , ARIZONA

CHANGE ORDER REQUEST

Date: _____ Request: _____

Name of Project: _____

Project No: _____ Contractor: _____

Description of Proposed Change Order:

Reason for Change:

Estimated Cost: $ _____ Change in Contract Time: _____
(See Attached Sheet for Detailed Cost) (Calendar Days)

Submitted By: _____ Title: _____

Recommended By: _____ Title: _____

Approved By: _____ Title: _____

CITY OF _____, ARIZONA

AUTHORIZED SIGNATURE FORM

Project Name: _____

Project No: _____

Whereas, _____, an _____ Corporation, is
(Name of State)

required to execute certain documents which are necessary for the prompt and efficient execution of the corporate business;
NOW, THEREFORE, BE IT RESOLVED, by the Board of Directors of the _____ that (name of parties authorized) _____
(Corporate Name)

_____, _____ authorized to execute and sign on behalf of said corporate the following documents:

1. The Contract
2. The Bond
3. Payrolls
4. Claims
5. Change Orders
6. All other papers necessary for the conduct of the corporation's affairs and the execution of the Contract.

The powers and duties herein granted shall be and is hereby granted for the duration of the contract for this project or until express notice of revocation has been duly given in writing, whichever is the lesser period.
Dated and passed by the Board of Directors this _____ day of _____, 19____

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
(Signature of Persons Authorized to Sign)	(Title)	(Document No.)

CERTIFICATE

STATE OF)
) ss
COUNTY OF)

I, _____ of the _____, a corporation do hereby certify that the above is a true and correct copy of a resolution adopted by the Board of Directors of said corporation, at a meeting of said board held on _____, 19____, and that the same is in full force and effect at this time.

Dated _____, 19____

_____
(Officer of Corporation)

(Seal of Corporation)
STATE OF ARIZONA) ss.
COUNTY OF_____)

This instrument was acknowledged before me _____ day of _____ 19____

by _____
appearing before the undersigned Notary Public, and stated that he executed such instrument on behalf of said corporation for the purpose and consideration therein expressed.

My commission Expires: _____
(Notary Public)

_____

PART 100

GENERAL CONDITIONS

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SECTION 101
ABBREVIATIONS AND DEFINITIONS

101.1 ABBREVIATIONS:

Wherever the following abbreviations are used in these specifications, standard details or on the plans, they are to be construed the same as the respective expressions represented.

AASHTO	American Association of State Highway and Transportation Officials
AAN	American Association of Nurserymen
AB	Aggregate base
Aban	Abandon
ABC	Aggregate base course
AC	Asphalt cement or concrete
ACB	Asphalt concrete base
ACI	American Concrete Institute
ACP	Asbestos cement pipe
ACPA	American Concrete Pipe Association
ACWS	Asphalt concrete wearing surface
AFRB	Arizona Fire Rating Bureau
AGC	Associated General Contractors of America, Inc.
Agg	Aggregate
ADOT	Arizona Department of Transportation
Ahd	Ahead
AIA	American Institute of Architects
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
APA	American Plywood Association
Approx	Approximate
APWA	American Public Works Association
AR	Aged residue
ARS	Arizona Revised Statutes
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
Asph	Asphalt
ASTM	American Society for Testing Materials
Ave	Avenue
AWPA	American Wood Preservers Association
AWSC	American Welding Society Code
AWWA	American Water Works Association

Bbl	Barrel
BC	Beginning of curve
BCR	Beginning of curb return
Beg	Beginning
Bk	Book or Back
Blvd	Boulevard
BM	Bench Mark or Board Measure
Brg	Bearing
BST	Bituminous Surface Treatment
BTB	Bituminous Treated Base
BTU	British Thermal Units
BVC	Beginning of vertical curve

C	Centigrade or Curb
CB	Catch Basin
CBF&C	Catch basin frame & cover
CC or C/C	Center to Center
CE	City or County Engineer
Cem	Cement
CF	Curb face
cfs	Cubic Feet per second
CIP	Cast Iron pipe
CIPP	Cast-in-place concrete pipe
CL or C	Centerline
Cm	Centimeter
CMP	Corrugated metal pipe
CO	Clean out
Col	Column
Conc	Concrete
Const	Construct
CP	Concrete pipe (non-reinforced)
CTB	Cement Treated Base
Cu	Cubic
Deg	Degree
DF	Douglas Fir
DG	Decomposed granite
Dia	Diameter
Dim	Dimension
DIP	Ductile Iron Pipe
Div	Division
Dr	Drive
Drwg	Drawing
Dwy	Driveway
Ea	Each
Ease	Easement
E	East
EC	End of curve
ECR	End of curb return
El or Elv	Elevation
Equa or Eq	Equation
EVC	End of vertical curve
Ex or Exist	Existing
F	Fahrenheit
FB	Field book
F & C	Frame & cover
FH	Fire hydrant
FL or F	Floor line or flow line
Fl El	Floor Elevation
Fnd	Found
fps	Feet per second
FS	Finished surface
FSS	Federal Specifications and Standards
Ft	Foot or feet

G	Gutter
Ga	Gage
Galv	Galvanized
GL	Ground line
gpm	Gallons per minute
Gr	Grade
H	High or height
HC	House connection
Hdwl	Headwall
Horiz	Horizontal
Hwy	Highway
ICA	Industrial Commission of Arizona
ID	Improvement District or inside diameter
IE	Invert Elevation
IEEE	Institute of Electrical and Electronic Engineers
In	Inch
Inv	Invert
IP	Iron Pipe
IPS	Iron Pipe Size
Irrig	Irrigation
Jt	Joint
JC	Junction Chamber
Jct	Junction
JS	Junction Structure
L	Length
Lb	Pound
L&T	Lead and tack
LD	Local depression
LF	Linear Feet
LH	Lamp hole
Lin	Linear
Long	Longitudinal
Lt	Left
M	Map or maps
MAG	Maricopa Association of Governments
Max	Maximum
MCR	Maricopa County Records
Meas	Measured
MH	Manhole
MHF&C	Manhole frame and cover
Min	Minutes or minimum
Misc	Miscellaneous
ML or M	Monument line
Mm	Millimeter
Mon	Monolithic or monument
MTD	Multiple tile duct
N	North
NBS	National Bureau of Standards

NCPI	National Clay Pipe Institute
NE	Northeast
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NP	Non-plastic
NPI	Non pay item
NSC	National Safety Council
NSF	National Sanitation Foundation
NW	Northwest
No	Number
OC	On center
OD	Outside diameter
Oz	Ounces
PC	Point of curvature
PCC	Point of compound curve or Portland Cement Concrete
PI	Point of intersection or plastic index
PL	Property line
POC	Point of Curve
POS	Point of Spiral
PP	Power pole
ppm	Parts per million
PRC	Point of reverse curve
Prod	Produced
Prop	Proposed or property
psi	Pounds per square inch
psf	Pounds per square foot
PT or POT	Point of Tangent
P&TP	Power and telephone pole
Pvmt	Pavement
Q	Rate of flow
R	Radius
RC	Reinforced concrete
RCP	Reinforced concrete pipe
Rd	Road
Rdwy	Roadway
Reinf	Reinforced, Reinforcing
Ret Wall	Retaining Wall
RGRCP	Rubber Gasket Reinforced Concrete Pipe
rpm	Revolutions Per Minute
Rt	Right
R/W	Right-of-way
S	South or slope
SAE	Society of Automotive Engineers
San	Sanitary
SC	Spiral to Curve
SCCP	Steel cylinder concrete pipe
SD	Storm drain or Sewer District
Sdl	Saddle

Sec	Seconds
Sect	Section
SE	Southeast
Sht	Sheet
Spec	Specifications
SPR	Simplified Practice Recommendation
Sp MH	Special manhole
Sq Ft Yd	Square Foot, Yard
SS	Sanitary sewer
St	Street
Sta	Station
Std	Standard
Str gr	Structural grade
Struct	Structure or structural
SW	Southwest
T	Tangent Distance
Tel	Telephone
Temp	Temporary
TH	Test hole
TP	Telephone pole
Tr	Tract
Trans	Transition
TS	Traffic signal or Tangent to spiral
TSC	Traffic signal conduit
Typ	Typical
UL	Underwriters' Laboratories Inc.
USC & GS	United States Coast and Geodetic Survey
USGS	United States Geological Survey
V	Velocity of flow
VC	Vertical curve
VCP	Vitrified clay pipe
Vert	Vertical
W	West or width
WI	Wrought iron
WS	Wearing surface
Wt	Weight
Yd	Yard
'	feet or minutes
"	inches or seconds
°	degrees
%	percent
#	number or pound
@	at
/	per
=	equals

101.2 DEFINITIONS AND TERMS:

Whenever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

Addendum: A supplement to any of the Contract Documents issued, in writing, after advertisement of but prior to the opening of bids for a contract.

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

Agency: The governmental agency for which the construction is being done, either by permit or contract.

Architect: The individual or firm who has accomplished the architectural services for the project, including his representatives.

Award: The formal action of the governing body is accepting a proposal.

Backfill: Material placed in an excavated space to fill such space. For trenches, this space will be the area from 1 foot above the top of the pipe or conduit to the existing or proposed finished grade of pavement.

Base Course: The upper course of the granular base of a pavement or the lower course of an asphalt concrete pavement structure.

Bedding: Is the material placed in the area from the bottom of the trench to 1 foot above the top of the pipe or conduit.

Bidder: Any qualified individual, firm, partnership, corporation or combination thereof, acting directly or through a duly authorized representative who legally submits a proposal for the advertised work.

Board of Supervisors: The Maricopa County Board of Supervisors acting under the authority of the laws of the State of Arizona.

Bond Issue Project: A project financed from bonds issued by the City or County pledging credit or a revenue resource.

Bridge: A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of more than 20 feet between undercopings of abutments or extreme ends of openings for multiple boxes.

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

(Roadway Width) The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom or curbs or guard timbers or in the case of multiple height of curbs, between the bottom of the lower risers.

Budget Project: A project financed by funds from General Tax levies and shared revenue funds set aside in the annual budget adopted by the Council or Board of Supervisors.

Building: Any structure built for the support, shelter, or enclosure of persons, animals, chattel or movable property.

Building Code: A regulation adopted by the governing body establishing minimum standards of construction for the protection of the public health, safety, and welfare in terms of measured performance rather than in terms of rigid specification of materials and methods.

Calendar Day: Everyday shown on the calendar.

Call for Bids: The standard forms inviting proposals or bids.

Change Order: A written order issued by the Engineer to the Contractor to make changes in the work or to perform extra work, and setting forth conditions for payment and/or adjustment in time of completion.

City: A municipal corporation, organized and existing under and by virtue of the laws of the State of Arizona.

City/County Clerk: The duly authorized person who performs the duties of clerk for the Contracting Agency.

Completion Time: The number of calendar days for completion of an act, including authorized time extensions. In case a calendar date of completion is shown in the proposal in lieu of the number of calendar days, the contract shall be completed by that date. The time within which an act is to be done shall be computed by excluding the first and including the last day; and if the last day be Sunday or a legal holiday, that shall be excluded.

Conflicting Utility Line: An existing utility line, shown or not shown on the plans, is conflicting line when any part falls within the trench pay widths as listed in Section 336 or within the dimensions, as shown on the plans, for appurtenant structures.

Construction Project: The erection, installation, remodeling, alteration, of durable facilities upon, under, or over the ground. This shall include, but is not limited to buildings, roadways and utility pipes, lines, poles or other structures.

Contingent Bid Item: This is a minor bid item which is likely, but not certain, to occur during the course of work. If the engineer determines that this work is required, the contractor will accomplish the work and payment will be made based on the contingent unit bid price included in the proposal. Since the quantity listed in the proposal is primarily for bid comparison, the amount of work required by the engineer may vary materially from this.

Contract: The written instrument executed by the Contractor and the Contracting Agency by which the Contractor is bound to furnish all labor, equipment, and materials and to perform the work specified, and by which the Contracting Agency is obligated to compensate the Contractor therefor at the prices set forth therein. The Contract Documents are herewith by reference made a part of the contract as if fully set forth therein.

Contract Documents: All the integral documents of the contract, including but not limited to, Call for Bids, Plans, Standard Specifications and Details, Special Provisions, Proposal, Addenda, Performance Bond, Payment Bond, Certificates of Insurance, Ordinance, Contract, and Change Orders.

Contracting Agency: The legal entity that has contracted for the performance of the work or for whom the work is being performed.

Contractor: The individual, firm, partnership, corporation or combination thereof entering into a contract with the Contracting Agency to perform the advertised work.

Council: The City Council which by law constitutes the Legislative Department of the City.

County: Maricopa County, organized and existing under and by virtue of the laws of the State of Arizona.

Culvert: Any structure not classified as a bridge, which provides an opening under or adjacent to the roadway.

Days: Unless otherwise designated, days will be understood to mean calendar days.

Emergency: Unforeseen occurrences and combinations of circumstances involving the public welfare or the protection of work already done under the Contract Documents, or which endanger life or property and call for immediate action or remedy.

Engineer: The person, appointed as City or County Engineer by the Council or the Board of Supervisors, acting directly or through his duly authorized representative.

Equipment: (Construction) – All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of work. (Installed)–All material or articles used in equipping a facility as furnishings or apparatus to fulfill a functional design.

Extra Work: An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

Flooding: Flooding will consist of the inundation of the entire lift with water, puddled with poles or bars to insure saturation of the entire lift.

Force Account Work: Work done by personnel of the Contracting Agency as in house work.

Foundation: For buildings or structures, this will be the substructure. For pipe this will be the native material or prepared material on which the pipe rests; normally, this is the bottom grade line of the trench.

Full Depth Pavement: An asphalt concrete pavement structure in which the granular base and subbase are replaced by proportionate thickness of asphalt concrete.

Improvement District Project: A project financed by assessments against the property included in a special assessment district authorized under, or implemented by an act of the legislature of the State and/or a procedural ordinance of the City or County.

Inspector: The Engineer's authorized representative assigned to make detailed inspections of contract performance.

Jetting: Jetting is the densification of material, using a continuous supply of

water, under pressure, transmitted to the material through a rigid pipe of sufficient length to reach the bottom of the lift being densified. In all cases, the entire lift will be completely saturated working from the top to the bottom.

Laboratory: The established materials testing laboratory of the Contracting Agency's, Engineering Department, or other laboratories acceptable to and/or authorized by the Engineer to test materials and work involved in the Contract.

Major Item: Any item of work and/or materials having an original contract value which exceeds ten percent of the amount of the original contract.

Materials: Any substance specified in the project, equipment and other material used or consumed in the performance of the work.

Median: The portion of a divided highway separating the roadways used by traffic going in opposite directions.

Non Pay Item: An item of work for which no separate payment will be made under the proposal, but which must be included as an incidental cost for payment on an associated item included in the proposal.

Notice of Award: A letter from the City or County Clerk advising the Contractor that he is the successful bidder and the Council or Board of Supervisors has accepted his proposal.

Notice to Proceed: A directive issued by the Engineer, authorizing the Contractor to start the work or improvements required in the Contract.

Obligee: One to whom another is obligated.

Open Trench: The excavated area shall be considered as open trench until all the aggregate base course for pavement replacement has been placed and compacted or, if outside of a pavement area, until the excavated area is brought to finish grade or natural grade.

Owner: The City or County, acting through its legally constituted officials, officers or employees.

Pavement: Any surfacing of streets, alleys, sidewalks, courts, driveways, etc., consisting of mineral aggregate bound into a rigid or semi-rigid mass by a suitable binder such as, but not limited to, portland cement or asphalt cement.

Pavement Structure: The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

Pay Item: A detail of work for which separate payments are to be made under the Contract, as specified in the proposal.

Payment Bond: The security provided by the Contractor solely for the protection of claimants, supplying labor and materials to the Contractor or his Subcontractors.

Performance Bond: The security provided by the Contractor solely for the protection of the Contracting Agency and conditioned upon the faithful performance of the contract in accordance with the plans, specifications and conditions thereof.

Permit: The license to do construction in public rights-of-way and/or easements; issued by an Agency to a Contractor working for another party.

Plans: All approved drawings or reproductions thereof pertaining to the work and details therefor, which are made a part of the Contract Documents.

Plant: The Contractors and/or subcontractors facilities, including but not limited to small tools and mobile equipment, located on and/or offsite, necessary for preparation of materials and prosecution of work for the project.

Principal: The individual, firm or corporation primarily liable on an obligation, as distinguished from a surety.

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

Project: A specific coordinated construction or similar undertaking identified by a single project number and bid and awarded as one contract. On occasion two or more projects may be bid and awarded as a single contract.

Proposal: The offer of a bidder on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

Proposal Form: The approved form on which the Contracting Agency requires bids to be prepared and submitted for the work.

Proposal Guarantee: The security furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

Proposal Pamphlet: The book or pamphlet pertaining to a specific project, containing proposal forms, special provisions and other information necessary for and pertinent to the preparation of the proposal or bid.

Referred Documents: On all work authorized by the Contracting Agency, any referenced documents in the specification, i.e.: Bulletins, Standards, Rules, Methods of Analysis or test. Codes and Specifications of other Agencies, Engineering Societies or Industrial Associations, refer to the Latest Edition thereof,

including Amendments, which are in effect and published at the time of Advertising for Bids or the issuing of a permit for the work, unless otherwise stated.

Right-of-way: A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a street, highway, or other public improvement.

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

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

Roadside Development: Those items necessary to the complete roadway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the roadway.

Roadway: The portion of the right-of-way intended primarily for vehicular traffic, and including all appertenant structures and other features necessary for proper drainage and protection. Where curbs exist, it is that portion of roadway between the faces of the curbs.

Sewers: Conduits and related appurtenances employed to collect and carry off water and waste matter to a suitable point of final discharge.

Shop Drawings: Drawings or reproduction of drawings, detailing; fabrication and erection of structural elements, falsework and forming for structures, fabrication of reinforcing steel, installed equipment and installation of systems, or any other supplementary plans or similar data, which the Contractor is required to submit for approval.

Shoulder: The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Sidewalk: That portion of the roadway primarily constructed for the use of pedestrians.

Special Provisions: The special conditions, requirements, additions, and/or revisions to the Standard Specifications, applicable to the work, to cover conditions or requirements peculiar to the project under consideration.

Specifications: The descriptions, directions, provisions, and requirement for performing the work as contained in the Contract Documents.

Standard Details: Uniform detail drawings of structures or devices adopted as Standard Details by the Engineer.

Standard Specifications: Uniform general specifications adopted as Standard Specifications by the Engineer.

Storm Drain: Any conduit and appurtenance intended for the reception and transfer of storm water.

Street: Streets, avenues, alleys, highways, crossings, lanes, intersections, courts, places, and grounds now open or dedicated or hereafter opened or dedicated to public use and public ways.

Structures: Bridges culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, sewers, service pipes underdrains foundation drains, fences, swimming pools, and other features which may be encountered in the work and not otherwise classed herein.

Subbase: The lower course of the base of a roadway, immediately above the subgrade.

Subcontractors: Those having direct contracts with the Contractor and those who furnish material worked into a special design according to the Plans and Specifications for the work, but not those who merely furnish material not so worked.

Subgrade: The supporting structures on which the pavement and its special undercourses rest.

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

Superintendent: The Contractor's authorized representative in responsible charge of the work.

Superintendent of Streets: The person duly appointed by the Council of the Contracting Agency, as provided by Sections 9-601 and 11-701 of the Arizona Revised Statutes.

Superstructure: The entire structure or building except the substructure.

Supplemental Specifications: Additions and revisions to the Standard Specifications that are adopted subsequent to issuance of the printed book.

Supplementary General Conditions: Requirements, or revisions, to the Standard General Conditions, applicable to the work, and to cover conditions or requirements peculiar to the project under consideration.

Surety: The individual, firm or corporation, bound with and for the Contractor for the acceptable performance, execution, and completion of the work, and for the satisfaction of all obligations incurred.

Surface Course: The finish or wearing course of an asphalt concrete pavement structure.

Title or Headings: The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

Township, City, Town or District: A subdivision of the County used to designate or identify the location of the proposed work.

Traveled Way: The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Utility: Pipe lines, conduits, ducts, transmission lines, overhead or underground wires, railroads, storm drains, sanitary sewers, irrigation facilities, street lighting, traffic signals, and fire alarm systems, and appurtenances of public utilities and those of private industry, businesses or individuals solely for their own use or use of their customers which are operated or maintained in, on, under, over or across public right-of-way or public or private easement.

Waterworks (Water Supply System): The reservoirs, pipe lines, wells, pumping equipment, purification works, mains, service pipes, and all related appliances and appurtenances utilized in the procurement, transportation and delivery of an adequate, safe, and palatable water supply for the Contracting Agency.

Work: Any or all of the improvements mentioned and authorized to be made, and the construction, demolition, reconstruction, and repair of all or any portion of such improvements, and all labor, services, incidental expenses, and material necessary or incidental thereto.

Working Day: A calendar day, exclusive of Saturdays, Sundays, and Contracting Agency recognized legal holidays, on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time.

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

SECTION 102

BIDDING REQUIREMENTS AND CONDITIONS

102.1 ELIGIBILITY AND PREFERENCE:

The employment of Contractors and Subcontractors on Public Works shall be governed by the provisions of Section 34-241 of the Arizona Revised Statutes.

102.2 CONTENTS OF PROPOSAL PAMPHLET:

The prospective bidder may examine and/or purchase plans, special provisions and proposal pamphlets at the Engineering Office of the Contracting Agency advertising for bids.

The proposal pamphlet will state the location of the contemplated construction: give the description of the various quantities of work to be performed or materials to be furnished, and have a bid schedule of pay items for which unit bid prices are invited. In addition, it will state the form and amount of the proposal guarantee, the time in which the work shall be completed and include additional instructions not included in these specifications.

The plans, the standard specifications, the standard details, the special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy or conflict, plans will govern over both standard specifications and standard details: special provisions will govern over standard specifications, standard details and plans.

Each and every provision of law and clause required by law to be inserted in the contract shall be deemed to be inserted herein, and the contract shall be read and enforced as though it were included herein.

102.3 INTERPRETATION OF QUANTITIES IN PROPOSAL:

The quantities appearing in the proposal are approximate only and are to be used for the comparison of bids. Payment to the Contractor will be made only for the actual quantities of work performed and accepted or materials furnished in accordance with the contract at the unit bid price in the proposal.

After the contract is awarded the quantities of work listed by any pay item, or all pay items, may be increased or decreased a reasonable amount at the discretion of the Contracting Agency, without in any way invalidating the unit bid price.

102.4 EXAMINATION OF PLANS, SPECIAL PROVISIONS AND SITE OF WORK:

The Contracting Agency will prepare plans and special provisions in accordance with acceptable engineering standards, giving such direction as will enable any competent Contractor to carry them out.

The bidder shall examine the site of the proposed work and all documents pertaining to the work. It is mutually agreed that the submission of a proposal shall be considered prima facie evidence that the bidder has made such examination and is familiar with the character, quality and quantity of the work to be performed and material to be furnished.

Logs of test holes, ground water levels, and any accompanying soil reports as furnished by the Contracting Agency are furnished for general information only. The field condition so set forth shall not constitute a representation or warranty, expressed or implied, that such conditions are actually existent. Bidders shall make their own investigations and form their own estimates of the site conditions.

After the submission of the proposal, no complaint or claim that there was any misunderstanding as to the quantities, conditions or nature of the work will be entertained.

102.5 PREPARATION OF PROPOSAL:

The bidder shall submit his proposal on the forms obtained from the Contracting Agency. The bidder shall specify a unit bid price and extension in words, figures or both, whichever is required, for each pay item where units and approximate quantities are given.

The proposal total will be obtained by adding the extension amount or lump sum indicated for the individual pay items. If there is a conflict between words and figures, the words shall apply. If there is a conflict between the unit bid price and the extension for a particular pay item, the unit bid price shall govern. In either case, the Contracting Agency shall correct the discrepancy in accordance with the above procedure and the corrected proposal total will apply.

In addition, the following shall be completed by the bidder on the proposal:

(A) Acknowledge receipt of and agree that the proposal is based on the listed Addenda received with and/or after receipt of the proposal pamphlet.

(B) Note the bidders Arizona State Contractor's License number and classification.

(C) Signatures in ink and attested or witnessed as applicable.

102.6 SUBCONTRACTORS' LIST:

When required, the List of Subcontractors' form will be attached to the proposal pamphlet. The bidder shall submit this form with his proposal, in a separate sealed envelope, listing the firm name and business address of each specialty subcontractor to whom he proposes to subcontract any portion of the work. Only one name shall be listed for each category.

The bidder may list himself to perform one or more of the listed categories of work for which he has any requisite State licenses when required.

102.7 IRREGULAR PROPOSALS:

Proposals will be considered irregular and may be rejected for the following reasons:

(A) If the proposal is on a form other than that furnished by the Contracting Agency; or if the form is altered or any part thereof is detached.

(B) If there are unauthorized additions, statements, conditional or alternate bids, or irregularities of any kind.

(C) If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

(D) If the proposal does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.

(E) If, when required, the bidder fails to accomplish and submit the List of Subcontractors' form.

102.8 PROPOSAL GUARANTEE:

No proposal will be read unless accompanied by a proposal guarantee in the form and amount stated in the proposal pamphlet. The guarantee shall be made payable and acceptable to the Contracting Agency as a guarantee that the bidder, if awarded the contract, will execute the contract documents and furnish the required bonds and certificates of insurance, to be forfeited if the Contractor fails or refuses to enter into a contract as required by the bid documents.

102.9 SUBMISSION OF PROPOSAL:

The proposal and proposal guarantee shall be submitted in a sealed envelope. The outside, lower righthand corner of which shall be marked as follows:

Bid of_____, Contractor

For _____

_____ Project No. _____

Contracting Agency

Envelopes shall be mailed or delivered to the office of the Contracting Agency, and must be received before the time and date specified in the Call for Bids or any Addenda.

Proposals received after the time and date specified will be returned, unopened, to the bidder.

102.10 WITHDRAWAL OR REVISION OF PROPOSAL:

Any bidder may withdraw or revise a proposal after it has been deposited with the Contracting Agency, provided his request is received by the Contracting Agency, in writing or by telegram, before the time specified for opening proposals or as stipulated herein.

SECTION 102

102.11 PUBLIC OPENING OF PROPOSALS:

Proposals will be opened and read publicly at the time and place specified in the Call for Bids or any Addenda. Bidders, their authorized agents and other interested parties are invited to be present.

When proposals for more than one project are to be opened at the same time, any bidder may, after the time set for opening proposals, request to withdraw his second or succeeding proposal prior to the opening of proposals for that project. Should this occur, there will be a brief delay in the opening of proposals to permit the bidder to submit his request. Upon receipt of the bidder's written request, by the Contracting Agency, his proposal will be returned unopened.

102.12 DISQUALIFICATION OF BIDDERS:

Either of the following reasons may be considered as being sufficient for the disqualification of a bidder and the rejection of his proposal:

(A) Receipt of more than one proposal for the same work from an individual, partnership or coroporation under the same or different names.

(B) Evidence of collusion among bidders or assistance from any officer of the Contracting Agency, or of any Department thereof.

102.13 SUCCESSFUL BIDDERS:

Unless otherwise specified in the proposal pamphlet, the successful bidder may obtain 7 sets of plans and special provisions, for the project from the Contracting Agency, at no cost.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103.1 CONSIDERATION OF PROPOSALS:

After the proposals, for the contemplated work, have been opened and read as provided in these specifications, the respective totals will be checked and compared by the Contracting Agency. The basis of comparison will be to verify the accuracy of the total proposal by checking the extensions and additions. In the event of a discrepancy, in the amount bid for a pay item, the unit bid price will govern unless obviously in error. The results of such comparison will be considered public information.

The right is reserved to award the contract to the lowest and/or best responsible bidder, or to reject all proposals and to readvertise for any reason the Contracting Agency determines.

In case all proposals are rejected, any subsequent changes, additions, addenda, or new sets of plans and special provisions will be provided to all purchasers of the first issue of the plans and special provisions at no additional charge, except that out-of-town bidders will pay shipping charges.

103.2 RETURN OF PROPOSAL GUARANTEE:

All proposal guarantees, except those of: the two lowest responsible bidders on Bond Issue and Budget Projects; the lowest responsible bidder or the lowest responsible

bidders of alternative plans and specifications on Improvement District Projects, will be returned immediately following the opening and checking of proposals. The retained proposal guarantee or guarantees will be returned immediately after the contract documents have been executed by all parties.

103.3 AWARD OF CONTRACT:

The Contracting Agency, through its duly authorized body or agent will award the contract to the lowest and/or best responsible bidder, or all proposals will be rejected, as soon as practicable after the date of opening proposals.

No proposal shall be withdrawn for a period of 30 days after opening without consent of the Contracting Agency through the body or agent duly authorized to accept or reject the proposal except that in the case of Federally-assisted projects, or other projects award of which is conditioned on the approval of an agency not under the control of the Contracting Agency, withdrawal shall not be made within a period of 50 days after opening without such consent.

If written notice of the acceptance of a proposal is delivered to the successful bidder within the times noted above, or at any time thereafter before such proposal has been withdrawn, the bidder shall execute and deliver a contract in the prescribed form, and shall furnish the required bonds, within 10 days after receipt of such notice or his proposal guarantee shall be forfeited as provided elsewhere herein.

The successful bidder will be furnished a Notice of Award on:

(A) Bond Issue or Budget Projects by letter, to the address shown on the proposal.

(B) Improvement District Projects by publication in accordance with the requirements of ARS, Section 9-681.

103.4 CANCELLATION OF AWARD:

The Contracting Agency reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties, without any liability against the Contracting Agency.

103.5 REQUIREMENT OF CONTRACT BONDS:

Concurrently with the execution of the contract, the Contractor shall furnish the Contracting Agency the following bonds, which shall become binding upon the award of the contract to the Contractor:

(A) A Performance Bond in an amount equal to the full contract amount conditioned upon the faithful performance of the contract in accordance with plans, specifications and conditions thereof. Such bond shall be solely for the protection of the Contracting Agency awarding the contract.

(B) A Payment Bond in an amount equal to the full contract amount solely for the protection of claimants supplying labor or materials to the Contractor or his Subcontractors in the prosecution of the work provided for in such contract.

Each such bond shall include a provision allowing the prevailing party in a suit on such bond to recover as a part of his judgement such reasonable attorney's fees as may be fixed by a judge of the court.

Each such bond shall be executed by a surety company or companies duly authorized to do business in the State of Arizona. The bonds shall be made payable and

acceptable to the Contracting Agency. The bonds shall be written or countersigned by an authorized representative of the surety who is either a resident of the State of Arizona or whose principal office is maintained in this State, as by law required, and the bonds shall have attached thereto a certified copy of Power of Attorney of the signing official.

103.6 CONTRACTOR'S INSURANCE:

103.6.1 General: The Contractor shall agree to carry all insurance which may be required by Federal and State laws, County and City ordinances, regulations and codes.

Concurrently with the execution of the contract the Contractor shall furnish the Contracting Agency the following:

(A) Public Liability and Property Damage Insurance: The Contractor shall maintain during the life of the contract such public liability and property damage insurance, both general and automobile liability, as shall protect him and any subcontractor performing work under the contract from all claims for bodily injury, including accidental death, as well as for property damage arising from operations under the contract — whether such operations be by himself or by any subcontractor or by anyone directly or indirectly employed by either of them. Concurrently, with the execution of the contract, the Contractor shall furnish the Contracting Agency the certificate of insurance form provided by this Agency that will give no less than the minimum limits of liability insurance required. The certificate shall be issued by an insurance company authorized by the Insurance Department of Arizona to transact business in the state of Arizona. These policies shall not expire until all the work has been completed and the project has been accepted by the Contracting Agency. If a policy does expire during the life of the contract, the Contractor shall provide a renewal certificate of the required insurance coverage to the Contracting Agency not less than five (5) days prior to the expiration date.

(B) Workmen's and Occupation Disease Compensation: A letter of certification, from the Industrial Commission of Arizona, that the Contractor is insured by the State Compensation Fund or is an authorized self-insurer or a certificate of insurance issued by an insurance company authorized by the Insurance Department of Arizona to write workmen's compensation and occupational disease insurance in the State of Arizona.

(C) Builder's Risk/Course of Construction Insurance: When the project includes construction of a new or modification of an existing building, the Contractor shall obtain fire and extended coverage plus vandalism and malicious mischief for the full amount of the contract in addition to coverage (A) and (B), with the Contracting Agency named as an additional insured.

Neither the Contractor nor any Subcontractor shall commence work under a contract until the Contracting Agency has approved all insurance.

103.6.2 Indemnification of the Contracting Agency Against Liability: The Contractor agrees to indemnify and save harmless the Contracting Agency, and any jurisdiction or agency issuing permits for any work included in the project, their officers, agents and representatives from all suits, including attorney's fees and costs of litigation, actions, loss, damage, expense, cost or claims, of any character or any nature arising out of the work done in fulfillment of the construction of the improvement under the terms of this contract or on account of any act, claim or amount arising or recovered under the Workmen's Compensation Law, or arising out

of the failure of the Contractor or those acting under Contractor to conform to any statutes, ordinance, regulation, law or court decree. It is the intent of the parties to this contract that the Contracting Agency shall, in all instances, be indemnified against all liability, losses and damages of any nature whatever for or on account of any injuries to or death of persons or damages to or destruction of property belonging to any person arising out of or in any way connected with the performance of this contract.

103.7 EXECUTION AND APPROVAL OF CONTRACT:

The Contractor shall execute the contract with the Contracting Agency as follows:

(A) Bond Issue or Budget Projects within 10 calendar days after the date of Notice of Award of contract from the Contracting Agency.

(B) Improvement District Projects, not less than 15 or more than 20 calendar days after the date of the first publication of Notice of Award, if no objections have been filed.

The Contracting Agency will approve and execute the contract within 10 calendar days following receipt of signed contract and acceptable bonds and certificates of insurance.

No contract shall be considered in effect until it has been fully executed by all parties concerned.

Information relative to the execution of contract documents may be obtained from the Engineering Office of the Contracting Agency advertising for bids.

103.8 FORFEITURE OF PROPOSAL GUARANTEES:

If the Contractor fails or refuses to enter into the contract, within the time stated, then the Contracting Agency may declare a forfeiture of his proposal guarantee as liquidated damages for failure to enter into the contract.

SECTION 104

SCOPE OF WORK

104.1 WORK TO BE DONE:

104.1.1 General: The Contractor shall perform all work as may be necessary to complete the contract in a satisfactory and acceptable manner in full compliance with the plans, specifications and terms of the contract.

Unless otherwise specified in the special provisions, he shall furnish all labor, materials, equipment, transportation, utilities, services and facilities required to perform all work for the construction of the project within the time specified.

104.1.2 Maintenance of Traffic: The Contractor's operations shall be in accordance with the traffic manual and/or policies of the appropriate public agency having jurisdiction over the project and Section 401. These operations shall cause no unnecessary inconvenience to the public and public access rights shall be considered at all times. Unless otherwise authorized in the specifications or on a temporary basis by the Engineer, traffic shall be permitted to pass through the work area. The Contractor shall coordinate with the various agencies both commercial and public, involved in the collection and removal of trash and garbage, so that adequate services are maintained.

Safe and adequate pedestrian and vehicular access shall be provided and maintained to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, motels, hospitals, fire stations, police stations, and establishments of a similar nature. Access to residential properties shall be in accordance with Section 107.

Grading operations, roadway excavation and fill construction shall be conducted and maintained in such a manner as to povide a reasonably satisfactory and safe surface for vehicular and pedestrian traffic. When rough grading is completed, the roadbed shall be brought to and maintained in a reasonably smooth condition, satisfactory and safe for vehicular traffic at the posted speed limit. Pedestrian walkways shall be provided and maintained in a like manner. The Contractor shall accomplish any additional grading operations and/or repairs, including barricade replacement or repairs during working and nonworking periods which, in the opinion of the Engineer, are required.

In the event of abnormal weather conditions, such as windstorms, rainstorms, etc., the Contractor shall immediately inspect his work area and take all necessary actions to insure that public access and safety are maintained.

The Contractor shall provide the Engineer with the emergency address of his representatives as required by Section 105.

104.1.3 Cleanup and Dust Control: Throughout all phases of construction, including suspension of work, and until final acceptance of the project, the Contractor shall keep the work area clean and free from rubbish, excess materials and debris generated by Construction Activities.

The Contractor shall take whatever steps, procedures or means required to prevent any dust nuisance due to his construction operations. The dust control measures shall be maintained at all times to the satisfaction of the Engineer and in accordance with the requirements of the Maricopa County Bureau of Air Pollution Control Rules and Regulations.

Failure of the Contractor to comply with the Engineer's cleanup orders may result in an order to suspend work until the condition is corrected. No additional compensation or time will be allowed as a result of such suspension and the Engineer has the authority to take such other measures as may be necessary to remedy the situation. Subsection 104.2.5 applies.

104.1.4 Final Cleaning Up: Before final acceptance, all private or public property and grounds occupied by the Contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures and equipment, and all parts of the work area shall be left in an acceptable condition.

104.2 ALTERATION OF WORK:

***104.2.1 By the Contracting Agency:** The Contracting Agency reserves the right to make, at anytime during the progress of the work, such alterations in the details of construction and such increases or decreases in quantities as may be found necessary or desirable. Such alterations and changes shall not invalidate the contract nor release the surety and the Contractor agrees to peform the work as altered, the same as if it had been a part of the original contract. The Engineer will issue Change Orders to cover unforeseen circumstances which make it impossible to carry out the work in accordance with the original contract plans and specifications.

If the alterations or changes made by the Contracting Agency increases or decreases the total cost of the contract or the total cost of any major item by more than 20 percent, either party may request an adjustment in payment in accordance with Section 109.

104.2.2 Due to Physical Conditions:

*A) Should the Contractor encounter or discover during the process of the work, subsurface or latent physical conditions at the site differing materially from those indicated in the contract, or unknown physical conditions at the site of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract, the Engineer shall be promptly notified in writing of such conditions before they are disturbed. The Engineer will thereupon promptly investigate the conditions and, if he finds they do so materially differ and cause an increase or decrease in the cost of or the time required for performance of the contract, an equitable adjustment will be made and the contract modified in writing accordingly.

*B) If at the time of opening up any portion of the work, material from which the subgrade, backfill or bedding is to be constructed contains an excess of moisture so that the required compaction cannot be obtained without additional manipulation, the Engineer will determine the cause of such condition. If the cause of such condition is determined to have been unforeseeable and beyond the control of and without fault or negligence of the Contractor, the Engineer will determine whether the material shall be aerated or removed and replaced. Such work shall be done as directed and will be paid for as provided in Section 109.

*C) Failure to notify the Engineer of the conditions described in A and B above prior to doing any work may be just cause to reject any claims for additional monies and/or time.

D) Material in ditches and ditch banks that contains moisture in an amount considered excessive by the Engineer shall be removed and shall be aerated to the extent required by the Engineer before compaction is effected. No measurement or direct payment for the removal and aeration of such material will be made.

E) After any portion of the work has been opened up, saturation of material caused by irrigation water, storm drainage, weather or such similar causes will be considered as within the responsibility of the Contractor.

***104.2.3 Due to Extra Work:** The Contractor shall perform unforeseen work, for which there is no unit bid price in the proposal, whenever it is deemed necessary or desirable by the Engineer in order to fully complete the work as contemplated. Such work shall be governed by all applicable provisions of the contract documents and payment will be made in accordance with the provisions set forth in Section 109.

Should the Contractor claim that any instuctions received involve extra work under the contract, he shall give the Engineer written notice thereof within 48 hours after receipt of such instructions, and in any event before proceeding to execute the work, except in emergencies endangering life or property. No claim shall be valid unless written notice is given.

If this extra work is performed by others, the Contractor agrees to cooperate fully with the other source accomplishing this work and agrees that this action shall not invalidate the Contract or release the surety.

104.2.4 At the Contractor's Request: Changes in the plans or specifications, which do not materially affect and are not detrimental to the work or to the interests of the Contracting Agency, may be granted to facilitate the work. Requests shall be in writing and submitted to the Engineer for approval. These changes, if approved and when resulting in a saving to the Contractor, will be made at an equitable reduction in cost or in no case at any additional cost to the Contracting Agency.

104.2.5 Due to the Failure of the Contractor to Properly Maintain the Project:

A) If the Contractor fails to provide adequate Maintenance of Traffic or Cleanup and Dust Control or to correct deficiencies resulting from abnormal weather conditions, the Engineer has the authority to suspend the work wholly or in part until this condition has been corrected.

B) If the Contractor fails to comply with the Engineer's written order to provide adequate maintenance of traffic, cleanup, dust control, or to correct deficiencies resulting from abnormal weather conditions, the Engineer has the authority to have this work accomplished by other sources.

C) The Contractor agrees to cooperate fully with the other source accomplishing this work and agrees that this action shall not invalidate the Contract or release the surety.

*Not applicable in improvement district projects.

SECTION 105

CONTROL OF WORK

105.1 AUTHORITY OF THE ENGINEER:

The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor. The Engineer's estimates and decisions shall be final and conclusive. In case any question should arise, relative to the Contract Documents, the determination or decision of the Engineer shall be a condition precedent to the right of the Contractor to receive final approval of the work being questioned under the contract.

In giving instructions, the Engineer may make minor changes in the work, not involving extra work and not inconsistent with the purpose of the work, except in emergencies endangering life or property.

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

105.2 PLANS AND SHOP DRAWINGS:

Plans will show details of all structures, utilities, lines, elevations, grades, typical cross sections of the roadway, and location and design of all work.

The plans will be supplemented by such shop drawings as are necessary to adequately control the work. Shop drawings for structures and utilities shall be furnished by the Contractor and shall consist of such detailed plans as may be required to adequately control the work and are not included in the plans furnished by the Contracting Agency. All shop drawings must be approved by the Engineer but such approval shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the work.

The number of copies required by the Contracting Agency will be specified in the special provisions. The cost of furnishing all shop drawings shall be considered as included in the amount bid for one or more of the pay items.

105.3 CONFORMITY WITH PLANS AND SPECIFICATIONS:

All work performed and all materials furnished shall be in conformity with the lines, elevations, grades, cross sections, dimensions and material requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not in conformity with the plans and specifications; but that reasonably acceptable work has been produced, he shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgement.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by the Contractor at no additional cost to the Contracting Agency.

In all instances wherein the items and/or specifications require installation or construction in accordance with either manufacturers' or suppliers' recommendations and/or instructions, said recommendations and/or instructions shall be submitted with the applicable portion clearly marked for approval prior to the commencement of work on that item or portions of the contract.

105.4 COORDINATION OF PLANS AND SPECIFICATIONS:

The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

105.5 COOPERATION OF CONTRACTOR:

The Contractor will be supplied with a minimum of seven sets of approved plans and special provisions, one set of which the Contractor shall keep available on the work at all times.

The Contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other contractors in every way possible.

The Contractor shall at all times be present at the work in person or represented by a competent superintendent authorized to receive and fulfill instructions from the Engineer and who shall supervise and direct the work. Instructions and information given by the Engineer to the Contractor's superintendent shall be considered as having been given to the Contractor.

(A) All phases of the project such as concrete work, pipe work, etc., shall be under the direct supervision of a foreman or his designated representative on the site who shall have authority to accept instructions, with respect to that particular phase of the project, and take action required to properly carry out the work.

(B) In the event of noncompliance with the above, the Engineer may require the contractor to stop work on that part of the project until the required supervision is present.

The Contractor shall file with the Engineer, the names, addresses, and telephone numbers of representatives who can be contacted, at any time, in case of emergency. These representatives must be fully authorized and equipped to correct unsafe or excessively inconvenient conditions on short notice.

Emergencies may arise during the progress of the work which may require special effort or require extra shifts of men to continue the work beyond normal working hours. The Contractor shall be prepared in case of such emergencies from whatever cause, to do all necessary work promptly.

105.6 COOPERATION WITH UTILITIES:

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

The Contractor shall give all utility companies, all pipe line owners or other parties affected the maximum notice possible when their underground or overhead services interfere with his work. The Contractor shall resolve all problems with the utility owners concerned.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense except as otherwise provided for in the special provisions or as noted on the plans. In the event an existing service is found to be in a materially different location than shown on the plans and requires additional or more costly work on the part of the Contractor, the procedures in Section 104, will apply.

It is understood and agreed that the Contractor has considered in his proposal all of the permanent and temporary utility appurtenances in their present or relocated positions

as shown on the plans and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenance or the operation of moving them. If delays are encountered because utility owners have not relocated or adjusted their facilities, the contract time will be adjusted in accordance with Section 108.

It shall be the responsibility of the Contractor to ascertain the need for bracing or shoring of utility poles during the construction of the project and no additional compensation will be allowed for such bracing or shoring.

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

105.7 COOPERATION BETWEEN CONTRACTORS:

The Contracting Agency reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the Contracting Agency from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operations of other contractors working within the limits of the same project.

The Contractor shall arrange his work and shall place and dispose of the materials being used so as not to interefere with the operations of the other contractors within the limits of the same project. He shall join his work with that of others in an acceptable manner and shall perform it in proper sequence to that of the others.

The Contracting Agency will not honor any claim for extra compensation due to delays, extra work, or extension of time caused by any other contractors working within the limits of the same project.

105.8 CONSTRUCTION STAKES, LINES AND GRADES:

The Engineer will set construction stakes establishing lines and grades for road work, curbs, gutters, sidewalks, structures and centerlines for utilities and necessary appurtenances as he may deem necessary. he will furnish the Contractor with all necessary information relating to the lines and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall establish other necessary controls and perform the work.

The Contractor shall perform the work in accordance with the Engineer's stakes and marks, and shall be charged with full responsibility for conformity and agreement of the work with such stakes and marks.

The Contractor shall be held responsible for the preservation of all stakes and marks, and if the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost for replacing them will be charged against him and will be deducted from the payment for the work.

The Contractor shall give notice to the Engineer not less than 2 working days in

advance of when he will require survey services in connection with any portion of the work.

The Contractor shall set the construction stakes for buildings establishing lines, grades, and elevations to include necessary utilities and appurtenances and shall be responsible for their conformance with plans and specifications. The Engineer will establish or designate a control line or bench mark of known location and elevation for use as a reference.

105.9 DUTIES OF INSPECTOR:

Inspectors employed by the Contracting Agency will be authorized to inspect all work done and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector will not be authorized to alter or waive the provisions of the contract. The inspector will not be authorized to issue instructions contrary to the plans and specifications or to act as foreman for the Contractor.

The inspector will, however, have the authority to reject work or materials until any questions at issue can be referred to and decided by the Engineer.

105.10 INSPECTION OF WORK:

Inspection of the work by the Engineer or his authorized representative shall not be considered as direct control of the individual workman and his work. The direct control shall be solely the responsibility of the Contractor's foreman and superintendent.

The Engineer shall be permitted to inspect all materials, and each part or detail of the work at any time for the purpose of expediting and facilitating the progress of the work. He shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

Any work done or materials used without supervision and inspection by an authorized Contracting Agency representative may be ordered removed and replaced at no additional cost to the Contracting Agency. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered nor obligate the Engineer to final acceptance.

When any unit of government or political subdivision is to pay a portion of the cost of the work covered by the contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision a party to the contract, and shall in no way interfere with the rights of either party to the contract.

105.11 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK:

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

No work shall be done without lines and grades having been given by the Engineer. Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, or as given, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the

contract. Work so done may be ordered removed or replaced at no additional cost to the Contracting Agency.

105.12 MAINTENANCE DURING CONSTRUCTION:

The Contractor shall maintain the work during construction and until the project is accepted. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end so that the roadway or structures are kept in satisfactory conditions at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations. All cost of maintenance work during construction and before the project is accepted shall be included in the unit bid price on the various pay items.

105.13 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE:

If the Contractor, at any time, fails to perform maintenance during construction, the Engineer will immediately notify the Contractor of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the project. The entire cost of this maintenance will be deducted from monies due or to become due the Contractor on his contract.

105.14 PARTIAL USE OR OCCUPANCY:

Should an urgent or unforeseen need occur, the Contractor agrees to let the Contracting Agency use or occupy a unit or portion of the project, such as a structure, utility service, or a section of road or pavement, prior to final acceptance.

Prior to such use or occupancy the Contracting Agency will prepare a written agreement with the Contractor and accomplish a partial acceptance inspection. The written agreement will include a revised construction schedule, responsibilities for maintenance of the partial acceptance and continued construction of the original project to final acceptance, payments, insurance and bond requirements.

105.15 ACCEPTANCE:

(A) PARTIAL ACCEPTANCE: If at any time during the prosecution of the project the Contractor substantially completes a unit or portion of the project, such as a structure, utility service, or a section of road or pavement, he may request the Engineer to make final inspection of that work. If the Engineer finds, upon inspection, that the work has been satisfactorily completed in compliance with the contract he may accept the work as being completed and the Contractor may be relieved of further responsibility for that work. Such partial acceptance shall in no way void or alter any terms of the contract.

(B) FINAL ACCEPTANCE: Upon due notice from the Contractor of presumptive completion of the entire project, the Engineer will make an inspection. If all construction provided for and contemplated by the contract is found completed to his satisfaction, that inspection shall constitute the final inspection and the Engineer will make the final acceptance. The Contractor will be notified in writing of this acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction of same, and the Contractor shall immediately comply with and execute such instructions. Upon correction of the work, another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of the final inspection.

SECTION 106

CONTROL OF MATERIALS

106.1 SOURCE OF MATERIALS AND QUALITY:

All construction materials to be used on the work or incorporated into the work, equipment, plant, tools, appliances or methods to be used on the work shall be subject to the inspection and approval or rejection of the Engineer.

The materials used on the work shall meet all quality requirements of the contract. In order to expedite the inspection and testing of materials, the Contractor shall notify the Engineer of his proposed source of materials prior to delivery. At the option of the Engineer, materials may be approved at the source of supply before delivery is started. If it is found after trial that sources of supply for previously approved materials do not produce specified products the Contractor shall furnish materials from other sources.

106.2 SAMPLES AND TESTS OF MATERIALS:

All materials to be incorporated in the work may be subject to sampling, testing and approval, and samples furnished shall be representative of the materials to be used. The Engineer may select samples, or may require that samples be delivered by the Contractor to a laboratory designated by the Engineer.

The Contracting Agency will pay for the initial or normal test required by the Engineer to guard against unsuitable materials or defective workmanship. Additional tests, required due to failure of the initial or normal test(s), shall be paid for by the Contractor. The Engineer will designate the laboratory which will accomplish the additional test(s).

The procedures and methods used to sample and test materials will be determined by the Engineer. Unless otherwise specified, samples and tests will be made in accordance with either: the Materials Testing Manual of the Contracting Agency; the standard methods of AASHTO or ASTM, which were in effect and published at the time of advertising for bids.

The laboratory responsible for the test shall furnish at least one copy of the test results to the Contracting Agency or his designated representative, to the Contractor, and to the appropriate material supplier.

With respect to certain manufactured materials, the Engineer may permit the use of some materials prior to sampling and testing provided they are delivered with either a certificate of compliance or analysis or both, stating that the materials comply in all respects with the requirements of the specifications. These certificates shall be furnished in triplicate and clearly identify each delivery of materials to the work area. The certificates shall be signed by a person having legal authority to bind the supplier or manufacturer.

106.3 PLANT INSPECTION:

The Engineer may undertake the inspection of materials at the source. In this event, the following conditions shall be met:

(A) The Engineer shall have the cooperation and assistance of the Contractor and the producer with whom he has contracted for materials.

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

It is understood that the Contracting Agency reserves the right to retest all materials, prior to their use in the work, upon delivery.

106.4 TRADE NAMES AND SUBSTITUTIONS:

Plans and specifications may contain references to equipment, materials or patented processes by manufacturer, trade name, make or catalog number. Such references shall be regarded as establishing a standard of quality, finish, appearance, performance or as indicating a selection based upon compatibility with existing equipment or materials. It shall not be construed as limiting the selection to a specified item or source.

The use of an alternate or substitute, item or source will be permitted, subject to the following:

(A) No consideration will be given a request for substitution prior to award of the contract.

(B) After the award and to permit consideration and approval without delaying the work, the Contractor shall submit a written request for substitution. The request shall include all information necessary for proof of equality and suitability for substitution. The Contractor shall submit samples when required.

(C) The Engineer will evaluate the information submitted, perform tests when necessary and make comparisons. The Engineer will then make the final decision as to the acceptability of the proposed substitution.

106.5 STORAGE OF MATERIALS:

The Contractor shall provide storage facilities and exercise such measures as will insure the preservation of the quality and fitness of all materials and/or equipment to be used in the work. Stored materials and/or equipment, even though approved before storage, may again be inspected prior to their use in the work. Stored items shall be located so as to facilitate their prompt inspection. That portion of the right-of-way and easements not required for public travel may be used for storage purposes, when approved by the Engineer. Any additional storage area required must be provided by the Contractor. Private property shall not be used for storage purposes without written permission of the owner or lessee. If requested, by the Engineer, copies of such written permission shall be made available.

106.6 HANDLING MATERIALS:

All materials and/or equipment shall be handled in such a manner as to preserve their quality and fitness for the work.

SECTION 106

106.7 UNACCEPTABLE MATERIALS:

All materials and/or equipment not conforming to the requirements of the specifications, whether in place or not, may be rejected. Rejected materials and/or equipment shall be removed immediately from the site of work unless otherwise permitted by the Engineer. No rejected material and/or equipment, the defects of which have been subsequently corrected, shall be used until approved in writing by the Engineer.

106.8 FURNISHED MATERIALS:

Materials and/or equipment, furnished by the Contracting Agency, will be delivered or made available to the Contractor as indicated in the special provisions. The cost of handling and placing shall be considered as included in the contract price for the pay item with which they are used.

The Contractor will be held responsible for all materials and/or equipment accepted by him and will make good any shortages, deficiencies and damages which may occur after such acceptance.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.1 LAWS TO BE OBSERVED:

The Contractor shall keep fully informed of all Federal and State laws, County and City ordinances, regulations, codes and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, codes, orders and decrees; and shall protect and indemnify the Contracting Agency and its representatives against any claim or liability arising from or based on the violation of such, whether by himself or his employees.

The attention of the Contractors is directed to the provisions of the following sections, Arizona Revised Statutes.

(A) 23-373. Contracts negotiated between public contractors and public employers shall contain the following contractural provisions:

In connection with the performance of work under this contract, the Contractor agrees not to discriminate against any employee or applicant for employment because of race, religion, color or national origin. The aforesaid provision shall include, but not be limited to, the following: Employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. The Contractor agrees to post hereafter in conspicuous places, available for employees and applicants for employment, notices to be provided by the contracting officer setting forth the provision of the nondiscrimination clause.

The Contractor further agrees to insert the foregoing provision in all subcontracts, except subcontracts for standard commercial supplies or raw materials.

(B) When Federal-aid funds are used on a project, the prevailing basic hourly wage rates and fringe benefit payments, as determined by the Secretary of Labor pursuant

to the provisions of the Davis-Bacon Act, shall be the minimum wages paid to the described classes of laborers and mechanics employed to perform the contract.

107.2 PERMITS:

Permits, bonding and insurance requirements shall be as required by the Contracting Agency's statutes, codes, ordinances or regulations.

The Public Agency, when acting as the Contracting Agency, will attempt to obtain the required permits, but it is the duty of the Contractor to determine that all necessary permits have been obtained. The Contractor shall, at his own expense, obtain all the required permits which have not been furnished.

In all cases, the Contractor or the person supervising the authorized work shall notify the appropriate permit agency so as to insure proper inspection by the agency concerned.

107.3 PATENTED DEVICES, MATERIALS AND PROCESSES:

If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the Contracting Agency, any affected third party or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Contracting Agency for any costs, expenses, and damages which it may be obligated to pay by reason of any infringement, at any time during the prosecution or after the completion of the work.

107.4 ARCHAEOLOGICAL REPORTS:

Attention is directed to Sections 41-844 and 41-846 Arizona Revised Statutes. In view of the above, it shall be a provision of every contract that when archaeological features are encountered or unearthed in the excavation of material pits or of the roadway prism, or other excavation, the Contractor shall report promptly to the Director of the Arizona State Museum and the Contracting Agency. The Contractor will be allowed extra time as appropriate in accordance with the provisions of Section 108.

107.5 SAFETY, HEALTH AND SANITATION PROVISIONS:

The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the Arizona State Department of Health or as specified by the Maricopa County Health Department, Sanitary Code.

The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions, on his own responsibility or as the Engineer may determine, reasonably necessary to protect the life and health of employees on the job, the safety of the public and to protect property in connection with the performance of the work covered by the contract.

Precaution shall be exercised by the Contractor at all times for the protection of persons (including employees) and property. The Contractor shall comply with the provisions of all applicable laws, pertaining to such protection including all Federal and State occupational safety and health acts, and standards and regulations promulgated thereunder.

107.6 PUBLIC CONVENIENCE AND SAFETY:

The contractor shall at all times so conduct his work as to assure the least possible obstruction to traffic and adjacent residents. The safety, convenience, and the protection of persons and property, of the general public and residents along the street, highway, and areas adjacent to the work area shall be provided for by the Contractor.

107.7 BARRICADES AND WARNING SIGNS:

The Contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs and other traffic control devices, and shall take all necessary precautions for the protection of the work and safety of the public. Roads, partially or fully closed to traffic, shall be protected by effective barricades, and obstructions shall be illuminated during hours of darkness. Suitable warning signs shall be provided to properly control and direct traffic.

The Contractor shall erect warning signs in advance of any place on the project where operations may interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road. Such warning signs shall be constructed and erected in accordance with the Traffic Barricade Manual prepared or adopted by the Contracting Agency's Traffic Engineering Department which is hereby made a part of these specifications.

107.8 USE OF EXPLOSIVES:

The use of explosives or blasting agents is controlled by the Uniform Fire Code, which is generally administered by the Fire Department of the Agency. The Contractor shall obtain a special permit from the Agency's Fire Department for the use of explosives. A copy of this permit shall be delivered to the engineer prior to the use of explosives. If the Agency does not use the Uniform Fire Code or have a department for enforcement of this Code, the Contractor shall use explosives only when authorized in writing by the Engineer.

Explosives shall be transported, stored, handled and used in accordance with the provisions and requirements of all applicable laws, ordinances and regulations. Work shall be done in accordance with recommendations of the AGC Manual of Accident Prevention in Construction and the Institute of Makers of Explosives.

The approval by the Engineer for the use of explosives shall not relieve the Contractor from his responsibilities. When explosives are used the Contractor shall:

(A) Exercise the utmost care not to endanger life or damage property.

(B) Be responsible for any and all damages resulting from their use.

(C) Furnish and erect special signs to warn the public of his blasting operations. They shall be located and maintained so as to be clearly evident to the public during all critical periods of blasting operations.

(D) Notify each public utility company, having structures adjacent to the work, of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to advise the Contractor of any precautions that should be taken to protect their structures from damage.

(E) Make a survey of adjacent properties, before commencing blasting operations, locating on drawings and by photographs all existing cracks and damages to structures. A copy shall be filed with the Engineer, including a report of any property owners who refused to cooperate and permit entry and inspection.

(F) Blasting mats shall be used at all times and shall be in good repair. Steel mats shall not be allowed within 2,000 feet of powerlines.

(G) Blasting shall be accomplished in such a manner that nearby houses and buildings will be safe from rocks and other projectiles and the Contractor shall be held responsible for any damage to life and property. The Contractor at the time of firing shall station men along the road at a sufficient distance from the blasting operations to flag down vehicles.

The Contracting Agency reserves the right to order the discontinuance of blasting operations at any time.

107.9 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE:

The Contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall be responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in his manner or method of executing the work, or at any time due to defective work or materials, and said responsibility will not be released until the project shall have been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the nonexecution thereof by the Contractor, he shall restore, at no cost to the Contracting Agency, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner.

The Contractor shall not dump spoil or waste material on private property without first obtaining from the owner written permission for such dumping. All such dumping shall be in strict conformance with the Grading and Drainage Ordinance of the Contracting Agency.

Access to private property shall be maintained to keep inconvenience to the property owner to a minimum. Prior to any construction in front of driveways the Contractor shall notify the property owner 24 hours in advance. Inconvenience caused by construction across driveways and sidewalks shall be kept to a minimum by restoring the serviceability as soon as possible. If it is necessary to leave open excavation for a long period of time the Contractor shall provide structurally adequate steel plates to bridge the excavation.

107.10 CONTRACTOR'S RESPONSIBILITY FOR WORK:

The Contractor shall properly guard, protect, and take every precaution necessary against injury or damage to all finished or partially finished work, by the action of the elements or from any other cause until the entire project is completed and accepted by

the Engineer. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work before final acceptance at no cost to the Contracting Agency. Partial payment for completed portions of the work shall not release the Contractor from such responsibility.

In case of suspension of the work for any cause whatever, the Contractor shall be responsible for the project and shall take such precautions as may be necessary to prevent damage to the project and shall erect any necessary temporary structures, signs, or other facilities at no cost to the Contracting Agency.

107.11 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES:

At points where the Contractor's operations are adjacent to properties of utility firms or other property, damage to which might result in considerable expense, loss, or inconvenience, work shall not commence until all arrangements necessary for the protection thereof have been made.

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

If any utility service is interrupted as a result of accidental breakage, the Contractor shall promptly notify the proper authority and shall cooperate with the said authority in the restoration of service. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

The Contractor shall expose all underground utilities and structures which might interfere with the construction of the project, in order to permit survey location prior to construction.

107.12 FURNISHING RIGHT-OF-WAY:

The Contracting Agency will provide right-of-way and easements for all work in advance of construction. Any exceptions will be indicated in the special provisions.

107.13 PERSONAL LIABILITY OF PUBLIC OFFICIALS:

In carrying out any provisions of these specifications, or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Contracting Agency, Engineer, or their authorized representatives, either personally or as officials of the Contracting Agency, it being understood that in all such matters they act solely as agents and representatives of the Contracting Agency.

107.14 NO WAIVER OF LEGAL RIGHTS:

Upon completion of the work, the Contracting Agency will expeditiously make final inspection and notify the Contractor of acceptance. Such final acceptance, however, shall not preclude or estop the Contracting Agency from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Contracting Agency be precluded or estopped from recovering from the Contractor or his surety, or both, such overpayment as it may sustain, or by failure on the part of the Contractor to fulfill his obligations under the contract. A waiver on the part of the

Contracting Agency of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract and in addition to any specific remedy provided the Contracting Agency in the contract documents, shall be liable to the Contracting Agency for latent defects, fraud or such gross mistakes as may amount to fraud, or as regards the Contracting Agency's rights under any warranty or guaranty or remedy required by law.

SECTION 108

COMMENCEMENT, PROSECUTION AND PROGRESS

108.1 NOTICE TO PROCEED:

(A) On Bond Issue and Budget Projcts, neither the Contractor nor any Subcontractor shall commence work on a project prior to receipt of the written Notice to Proceed from the Contracting Agency. The Contractor shall commence work as soon as practicable after the starting date specified in the Notice to Proceed. All work under the contract shall be completed within the number of calendar days stated in the proposal, plus extensions, beginning with the day following the starting date specified in the Notice to Proceed.

(B) On Improvement District Projects, the Contractor shall commence work within 10 days from the date of execution of the contract with the Contracting Agency. All work under the contract shall be completed within the number of calendar days stated in the proposal, plus any days extended on the contract, beginning with the day following the date of execution of the contract. The time set for completion of the project will be established by the Contracting Agency, in accordance with ARS Section 9-683.

The Contractor shall notify the Field Engineering Inspection Section 24 hours in advance of the time and place where work will begin and the Survey Section 2 working days in advance for staking.

108.2 SUBLETTING OF CONTRACT:

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts, or of his right, title, or interest therein, without written consent of the Contracting Agency.

Subcontracts shall be in accordance with and the Contractor shall be bound by the following provisions:

(A) All subcontracts shall be subject to the approval of the Engineer.

(B) All subcontracts shall be in writing and shall provide that all work to be performed thereunder shall be performed in accordance with the terms of the contract.

(C) Subcontractors shall conform to the regulations governing employment of labor.

(D) The subcontracting of any portion of the work will in no way release the Contractor of his liability under the contract and bonds.

108.3 CORRESPONDENCE TO THE CONTRACTOR:

A written notice, to the Contractor from the Contracting Agency, shall be considered delivered and the service thereof completed, when said notice is posted, by certified

mail, to the said Contractor at his last given address, or delivered in person to the Contractor or his authorized representative on the work.

108.4 CONTRACTOR'S CONSTRUCTION SCHEDULE:

The Contractor, when required, shall furnish the Engineer a construction schedule for his approval. In the event the schedule does not meet the necessary program schedule, as determined by the Contracting Agency, he may be required to resubmit a schedule that shall conform to an approved program of construction operation. The right to direct the sequence of the work is a function vested solely in the Engineer and the construction schedule, when approved, shall not be changed, without the written consent of the Engineer. The orderly procedure of all work to be performed shall be the full responsibility of the Contractor.

108.5 LIMITATION OF OPERATIONS:

The Contractor shall conduct the work at all times in such a manner and sequence that will assure the least interference with traffic and inconvenience to the public. The Enginer may require the Contractor to finish a section on which work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

All traffic affected by the construction will be regulated in accordance with the current Traffic Barricade Manual prepared or adopted by the Contracting Agency's Traffic Engineering Department.

Except in emergencies endangering life or property, written permission shall be obtained from the Engineer to perform any work after regular working hours, on weekends, or legal holidays. Prior to the start of such work, the Contractor shall arrange with the Engineer for the continuous or periodical inspection of the work, surveys and tests of materials, when necessary.

If, in the opinion of the Engineer, the Contractor has fallen behind the approved progress schedule, the Contractor shall take such steps as may be required by the Engineer, including but not limited to, increasing the number of personnel, shifts, and/or overtime operations, days of work, and/or amount of construction equipment until such time as the work is back on schedule. He shall also submit for approval no later than the time of submittal of the next request for partial payment, such supplementary schedule or schedules as may be deemed necessary to demonstrate the manner in which the approved rate of progress will be regained, all at no additional cost to the Contracting Agency.

108.6 CHARACTER OF WORKMEN; METHODS AND EQUIPMENT:

The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by the specifications.

All workmen shall be competent and have sufficient skill, knowledge and experience in their class of work and in the operation of equipment required to perform all work properly and satisfactorily.

Any person employed by the Contractor or any Subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Enginer, be removed

from the work by the Contractor or Subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer. The Contractor or Subcontractor shall keep the Contracting Agency harmless from damages or claims for compensation that may occur in the enforcement of this section.

Should the Contractor or Subcontractor fail to remove such person as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until such orders are complied with.

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that it will not damage property adjacent to the work area.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed, the Contractor is free to use any methods or equipment that he demonstrates to the satisfaction of the Engineer will accomplish the work in conformity with the requirements of the specifications.

When the specifications state the construction shall be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing construction work in conformity with the specifications. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet the specifications, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor in contract time as result of authorizing a change in methods or equipment under these provisions.

108.7 DETERMINATION AND EXTENSION OF CONTRACT TIME:

The number of calendar days allowed for the completion of the work included in the contract will be as stated in the proposal and will be known as the contract time.

When the contract time is on a calendar day basis it shall consist of the number of calendar days specified, including all weekends and legal holidays. All calendar days elapsing between the effective dates of any written notice from the Engineer to suspend work and to resume work following suspensions, not the fault of the Contractor, shall be excluded.

When the contract completion time is a fixed calendar date it shall be the date on which all work on the project shall be completed and meet final inspection.

If the Contractor finds it impossible for reasons beyond his control to complete the work within contract time as specified or as extended, he shall immediately submit a written request to the Engineer for an extension of time setting forth therein the

reasons which he believes will justify the granting of his request. The Contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the Engineer finds that the work was delayed because of conditions beyond the control and through no fault of the Contractor, he may extend the time for completion in such amount as the conditions justify. The extended time for completion shall then be in full force and effect the same as though it were the original time for completion.

*For Improvement District Project: The words ''Suprintendent of Streets'' will be substituted for the word ''Engineer.'' Any extension of contract time will be determined by the Superintendent of Streets with the consent of the governing body.

108.8 GUARANTEE AND WARRANTEE PROVISIONS

The Contractor shall guarantee the work against defective workmansip or materials for a period of 1 year from the date of its final acceptance under the contract, ordinary wear and tear and unusual abuse or neglect excepted.

Any omission on the part of the Engineer to condemn defective work or materials at the time of construction shall not be deemed an acceptance, and the Contractor will be required to correct defective work or materials at any time before final acceptance and within 1 year thereafter.

Should any defects develop within 1 year from the date of final acceptance due to faults in workmanship or materials the Contractor shall, within 14 calendar days of receipt of written notice from the Contracting Agency, begin making the necessary repairs to the satisfaction of the Engineer. Such work shall include the repair or replacement of other work or materials damaged or affected by making the above repairs or corrective work, all at no additional cost to the Contracting Agency.

In case of work, materials, or equipment for which written warranties are required by the special provision the Contractor shall provide or secure from the appropriate Subcontractor or supplier such warranties addressed to and in favor of the Contracting Agency and deliver same to the Engineer prior to final acceptance of the work. Delivery of such warranties shall not relieve the Contractor from any obligation assumed under any other provisions of the contract.

The warrantees and guarantees provided in this subsection of the contract documents shall be in addition to and not in limitation of any other warrantees, guarantees or remedies required by law.

108.9 FAILURE TO COMPLETE ON TIME:*

For each and every calendar day that work shall remain incompleted after the time specified for the completion of the work in the proposal, or as adjusted by the Engineer, the sum per calendar day shown in the following table, unless otherwise specified in the proposal form, may be deducted from monies due to or to become due to the Contractor, not as a forfeit or penalty but as liquidated damages. This sum is fixed and agreed upon between the parties because the actual loss to the Contracting Agency and to the public caused by delay in completion will be impractical and extremely difficult to ascertain and determine.

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time fixed for its completion may have been extended, will in no way operate as a waiver on the part of the Contracting Agency of any of its rights under the contract.

TABLE 108 LIQUIDATED DAMAGES		
Original Contract Amount		**Daily Charges**
From More Than	To and Including	Calendar Day or Fixed Date
$ 0	$ 25,000	$ 30.00
25,000	50,000	50.00
50,000	100,000	75.00
100,000	500,000	100.00
500,000	1,000,000	150.00
1,000,000	2,000,000	200.00
2,000,000	—	300.00

108.10 FORFEITURE AND DEFAULT OF CONTRACT:

It is further agreed to by the Contractor that if he:

(A) Fails to begin the work under the contract within a reasonable time, or

(B) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work, or

(C) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or

(D) Discontinues the prosecution of the work, or

(E) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

(F) At any time colluded with any party or parties, or

(G) Allows any final judgment to stand against him unsatisfied for a period of 14 calendar days, or

(H) For any cause whatsoever, fails to carry on the work in an acceptable manner, the Engineer will give notice in writing to the Contractor and his surety of such delay, neglect, or default, and advise them that the work must be resumed immediately.

If the Contractor or surety, within a period of 14 calendar days after such notice, has not proceeded in accordance therewith, then the Contracting Agency will, upon written notification from the Engineer of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Contracting Agency may appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the Engineer will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Contracting Agency, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due said Contractor. If such expense exceeds the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the Contracting Agency the amount of such excess.

*108.11 TERMINATION OF CONTRACT

The Contracting Agency may terminate the contract or a portion thereof if conditions encountered during the progress of the work make it impossible or impracticable to proceed with the work or a local or national emergency exists.

When contracts, or any portion thereof, are terminated before completion of all work in the contract, adjustments in the amount bid for the pay items will be made on the actual quantity of work performed and accepted, or as mutually agreed for pay items of work partially completed or not started. No claim for loss of anticipated profits will be considered.

Termination of the contract or any portion thereof shall not relieve the Contractor of his responsibilities for the completed work nor the surety of its obligation for and concerning any just claims arising out of the work performed.

*Not applicable to Improvement Districts Projects.

SECTION 109

MEASUREMENTS AND PAYMENTS

109.1 MEASUREMENT OF QUANTITIES:

All work completed under the contract will be measured by the Engineer according to United States standard measures. The methods of measurement and computation to be used in determination of quantities of materials furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

A station, when used as a definition or term of measurement, will be 100 linear feet.

Unless otherwise specified, longitudinal measurements will be made along the grade line.

Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the Engineer.

The term ton will mean the short ton consisting of 2,000 pounds avoirdupois.

Unless otherwise specified, structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

In computing volumes of excavations or fill, the average end area method or other acceptable methods as determined by the Engineer will be used.

Volumes will be computed at 60°F. using ASTM D-1250 for Asphalt or ASTM D-633 for Tars.

Lumber will be measured by the thousand board foot measure actually used in the work. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

The term lump sum, when used as a pay item, will mean complete payment for the work described.

Sundry items which have a basis for measurement and payment herein and which are incidental to or required in the construction of the work but are not included as items in the bid schedule shall be considered an integral part of the contract, and all labor, materials, etc. required for such items shall be furnished by the Contractor and the cost of same included in the unit price bid.

109.2 SCOPE OF PAYMENT:

Measurement and payment for pay items in the proposal will be as indicated in the applicable standard specification or in the special provisions.

When payment is specified to be made on the basis of weight, the weighing shall be done on certified platform scales sealed by the State Inspector or the City Sealer of Weights and Measures as defined by ARS Sections 44-2112 and 44-2116. The Contractor shall furnish the Engineer with duplicate Weighmaster's Certificates showing the actual net weights together with the information required by ARS Section 44-2142. The Contracting Agency will accept the certificates as evidence of the weight delivered.

Payment for the various items in the proposal will be made at the unit price bid in the proposal, and shall be compensation in full for furnishing all labor, materials, equipment and appurtenances necessary to complete the work in a satisfactory manner as shown on the plans and as required in the specifications, with all connections, testing, and related work completed. Each item, fixture, piece of equipment, etc., shall be complete with all necessary connections and appurtenances, for the satisfactory use and operation of said item. No additional payment will be made for work related to any item unless specifically called for in the proposal. This compensation shall also cover all risk, loss, damage or expense of whatever character arising out of the nature of the work or the prosecution thereof, subject to the provisions of Section 107.

109.3 ASSIGNMENT OF PAYMENTS:

The Contractor shall not assign payments of a contract or any portion thereof without approval of surety and written consent of the Contracting Agency.

Claims for monies due or to become due the Contractor may be assigned to a bank, trust company, or other financing institution, and may thereafter be further assigned and reassigned to any such institution. Any such assignment or reassignment may be made to one party as agent or trustee for two or more parties participating in such financing. Any assignment of money shall be subject to all proper setoffs and withholdings in favor of the Contracting Agency and to all deductions provided for in these specifications.

109.4 COMPENSATION FOR ALTERATION OF WORK:

*109.4.1 By The Contracting Agency:

(A) For a decrease greater than 20 percent in either the total cost of the contract or the total cost of a major item and when a reasonable cost analysis supports an increase in the pro rata share of fixed cost chargeable to this item in total, an increase adjustment in the monies due the Contractor may be made. This adjusted compensation will not exceed 80 percent of the original lump sum contract amount or, if for a unit price item, the adjustment will not exceed 80 percent of the original extended unit bid price. This does not apply to items labeled as contingent bid item in the bid proposal.

(B) For an increase greater than 20 percent, any adjustment made will only apply to that cost in excess of 120 percent of the original bidding schedule. If either party presents a reasonable cost analysis that shows a change in the pro rata share of fixed costs chargeable to this item in total, an increase or decrease adjustment will be made. This increase or decrease adjustment will be made on such basis as is necessary to cover a reasonable estimate of cost, plus an allowance, not to exceed 15 percent, for overhead and profit. If the parties are unable to reach an agreement, the Engineer has the authority to order the excess work done on an actual cost basis as specified in Subsection 109.5.

(C) For either an increase or decrease in cost, no claim shall be made by the contractor for any loss of anticipated profits.

***109.4.2 Due to Physical Conditions:**

(A) If the Engineer, after his investigation of the site conditions, agrees that they materially differ from those indicated in the contract and would cause an increase in the Contractor's bid cost of accomplishing the work, new unit bid prices or a lump sum cost (for the additional work only) may be negotiated. If the parties are unable to reach an agreement on price, the Engineer has the authority to order this additional work accomplished on an actual cost basis as specified in Subsection 109.5.

(B) If the Engineer, after his investigation of the site conditions, finds that these conditions do not materially differ from those indicated in the contract, he has the authority to order the work to be accomplished at the original bid price(s).

***109.4.3 Due to Extra Work:** If the contractor can present valid, factual evidence, satisfactory to the Engineer, that the work in question is an item not provided for in the contract as awarded then a unit bid price or lump sum cost, for this item only, may be negotiated. If the parties are unable to reach an agreement on price or cost, the Engineer has the authority to order the extra work accomplished on an actual cost basis as specified in 109.5.

109.4.4 Made at the Contractor's Request: Any alterations, if approved, will be a reduction in cost or at no additional cost to the Contracting Agency.

109.4.5 Due to Failure of Contractor to Properly Maintain the Project.

(A) For any suspension of work during normal working hours due to failure of the Contractor to properly maintain the project, there will be no additional compensation or time allowed.

(B) If the Contractor fails to comply with the Engineer's written order within a reasonable time to provide adequate maintenance of traffic, adequate cleanup and dust control or to correct deficiencies resulting from abnormal weather conditions and the Engineer has the work done by other sources, the cost of accomplishing this work plus the Contracting Agency's administrative cost of controlling the work will be deducted from monies due or which shall become due to the Contractor.

***109.5 ACTUAL COST WORK:**

The compensation for actual cost work performed by the Contractor (Subcontractor) shall be determined by the Engineer in the following manner.

109.5.1 Equipment: For all equipment, the use of which has been authorized by the Engineer, except for small tools and manual equipment, the Contractor will be paid in accordance with the latest Schedule of Equipment Rates published by the Arizona Department of Transportation.

109.5.2 Material: For all material, accepted by the Engineer and used in the work, the Contractor will be paid the actual cost of such material including transportation cost, to which total cost will be added a sum equal to 15 percent thereof.

109.5.3 Labor: For all labor and for the foreman, when he is in direct charge of the operation, the Contractor will be paid:

(A) The actual wages paid plus the current percentage thereof as determined by the Arizona Department of Transportation which is deemed to cover the Contractor's cost incurred as a result of payment imposed by State or Federal Law and payments that are made to, or on behalf of, the workman other than the actual wage. Actual wage is defined as the required current hourly rate paid to the labor classification concerned and does not include any fringe benefits or dislocation allowances. If the Contractor is not required to pay fringe benefits equivalent to the Current rates published in the Federal Register, an equitable deduction will be made from the Current percentage established by the Arizona Department of Transportation.

(B) For the first $50,000 of labor cost computed under paragraph (A) above, the Contractor will be paid an amount equal to (15) fifteen percent for overhead and profit.

(C) For all labor cost computed under paragraph (A) above, in excess of $50,000 but not exceeding $100,000, the Contractor will be paid an amount equal to (12) twelve percent for overhead and pofit.

(D) For any labor cost computed under paragraph (A) above in excess of $100,000, the Contractor will be paid an amount equal to (10) ten percent for overhead and profit.

109.5.4 Work Performed by Subcontractors: If it is determined by the Engineer that portions of the Actual Cost Work to be performed requires specialized labor or equipment not normally used by the Contractor and such work is then authorized to be performed by a subcontractor(s), the subcontractor(s) will be paid by the Contractor in accordance with the actual cost work procedures outlined herein. The Contractor will be paid by the Contracting Agency the full amount of the subcontract(s) plus the following percentages for administration and supervision.

(A) For the first $10,000.00 accumulated total of work performed by subcontractors (less mark-up for overhead and profit), the Contractor will be paid an amount equal to 10 percent of the accumulated total for administration and supervision. If the accumulated total is $3,000 or less, the Contractor will be paid $300 for administration and supervision.

(B) For all work in excess of $10,000.00 accumulated total performed by subcontractors (less mark-up for overhead and profit), the Contractor will be paid an amount equal to 5 percent of the accumulated total for administration and supervision.

109.5.5 Documentation:

(A) Except in emergency situations, the Contracting Agency will not be liable for any Actual Cost Work performed by the Contractor prior to written authorization by the Engineer or prior to full execution of a written agreement by all parties concerned.

(B) Payment for work performed on an actual cost basis will not be made until the Contractor has furnished the Engineer, on forms agreed to by the Contracting Agency, duplicate itemized statements of such work, including subcontractor(s) costs, detailed as follows:

1. Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.

2. Designation, dates, daily hours, total hours, rental rates and extension for each unit of equipment, and machinery.

3. Quantities of material, prices, extension and transportation cost on a daily basis. These charges shall be substantiated by vendor invoices.

(C) The Engineer will compare his records with the statement furnished by the Contractor, resolving any differences and making the required adjustments. This statement when agreed upon and signed by both parties, shall be the basis of payment for the work performed.

109.5.6 Bonds and Insurance: The Contractor shall be paid for the actual cost plus (10%) ten percent for Administrative cost when the Contractor can provide evidence of payment for premiums on required payment and performance bonds, premiums on railroad and/or airport extended liability insurance, and premiums for property damage and/or publc liability insurance. No duplicaton of payment for contractors costs included under paragraph 109.5.3(A) will be allowed.

109.5.7 Authority of Engineer: The Engineer is in charge of Actual Cost Work and has the authority to direct which labor and equiment will be used, to suspend operations, and to refuse to pay for any labor or equipment which he feels is not doing productive work.

109.6 PAYMENT FOR IMPROVEMENT DISTRICT PROJECTS:

Payment to the Contractor shall be made in accordance with ARS Sections 9-621 to 9-710, both inclusive.

As soon as the Contractor has fulfilled his contract, the Superintendent of Streets shall estimate the benefits arising from the work and make assessments to cover the work performed and specified in the contract, including incidental expenses in accordance with ARS Section 9-686.

The Contractor agrees to accept payment in the form of Assessments with attached Warrants and/or Improvement Bonds at the rate of interest declared in the resolution of intention prepared by the Contracting Agency.

109.7 PAYMENT FOR BOND ISSUE AND BUDGET PROJECTS:

(A) Partial Payments: No later than the 15th day of each calendar month the Contracting Agency will make a partial payment to the Contractor on the basis of an estimate prepared by the Engineer for work completed and accepted through the last day of the preceding calendar month.

The Contracting Agency will retain 10 percent of all estimates as a guarantee for complete performance of the contract in accordance with ARS Section 34-221, unless the Contractor elects to deposit securities in accordance with ARS Section 34-221, Paragraph 3.

Payment for materials on hand may be made when a paid invoice is presented the Engineer for inclusion with his estimate provided the materials meet the requirements of the plans and specifications and are stored under acceptable storage conditions. The Contractor will be held responsible for all materials until final acceptance of the work.

(B) Final Payment: When the project has been accepted as provided in Section 105, and within 30 calendar days after final inspection of the work completed under the contract, the Engineer will render to the Contracting Agency and the Contractor, a final estimate which will show the amount of work performed and accepted under the contract. All prior estimates and partial payments will be subject to correction in the final estimate for payment.

Within forty-five (45) calendar days after final acceptance, the Contracting Agency will pay the Contractor all amounts due him under the contract, except that before final payment will be made, the Contractor shall satisfy the Contracting Agency by affidavit that all bills for labor and materials incorporated in the work have been paid. The Contractor's Affidavit may be obtained from the Engineering Office of the Contracting Agency.

The acceptance of the project and the making of the final payment shall not constitute a waiver by the Contracting Agency/Owner of any claims arising from faulty or defective work appearing after the completion or from failure of the Contractor to comply with the requirements of the contract documents.

*Not applicable to Improvement District Projects.

PART 200

EARTHWORK

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EARTHWORK

SECTION 201

CLEARING AND GRUBBING

201.1 DESCRIPTION:

This work shall consist of removing objectionable material from the right-of-way, easements and such other areas as may be specified in the special provisions. Clearing and grubbing shall be performed in advance of grading operations.

201.2 PRESERVATION OF PROPERTY:

Existing improvements, adjacent property, utilities and other facilities, and trees and plants not to be removed, shall be protected from injury or damage resulting from the Contractor's operations, see Section 107.

201.3 CONSTRUCTION METHODS:

The construction site and areas on each side of the roadway from centerline to the toe of an embankment, the top of a cut slope, the slope rounding limit or to a line 10 feet outside the edge of the surfaced area, whichever is greater, but not beyond the limits of the right-of-way, shall be cleared of all trees, stumps, brush, roots, rubbish, debris and other objectionable matter, except as follows.

All trees and shrubs found suitable for improvement and beautification, which will not interfere with excavation or embankment or cause disintegration of the improvements shall not be disturbed. In any event, the contractor shall avoid, as far as practicable, injury to shrubbery, vines, plants, grasses and other vegetation growing outside of the clearing limits. The dragging and the piling of materials of various kinds and the performing of other work which may be injurious to vegetation shall, insofar as practicable, be confined to areas which have no vegetation or which will be covered by embankment or disturbed by excavation during grading operations.

For the full width of all water courses within the right-of-way lines, no stump, root or other obstruction shall be left higher than the natural stream bed.

From excavated areas, all stumps, roots and other obstructions 3 inches or over in diameter shall be grubbed to a depth of not less than 18 inches below finish grade.

In embankment areas or other areas to be cleared outside the road prism slope lines, all stumps, roots and other obstructions shall not be left higher than specified in the following table:

TABLE 201

Height of Embankment Over Stump	Height of Clearing and Grubbing
0 Feet to 2 Feet	All stumps or roots 6 inches or over in diameter shall be grubbed to 18 inches below original grade. All others shall be cut flush with the ground.
2 Feet to 3 Feet	All stumps 1 foot and over in diameter shall be grubbed to 18 inches below original grade. All others shall be cut flush with the ground.
Over 3 Feet	No stumps shall be left higher than the stump top diameter, and in no case more than 18 inches.

Cavities left below subgrade elevation by removal of stumps or roots shall be carefully backfilled and compacted.

Tree branches extending over the roadway, which hang within 12 feet of the profile grade or that restrict sight distance shall be cut off close to the trunk or stem of the tree in a neat and workmanlike manner. The Contractor shall remove additional tree branches under the direction of the Engineer, in such a manner that the tree will present a balanced appearance. Scars resulting from the removal of branches shall be treated with a heavy coat of an approved tree sealant.

All tree trunks, stumps, brush, limbs, roots, vegetation and other debris removed in clearing and grubbing shall be removed to locations outside of and out of sight of the right-of-way, or otherwise disposed of so as to leave the construction site and adjacent areas in a neat and finished condition, free from unsightly debris.

201.4 REMOVAL AND DISPOSAL OF SALVAGEABLE ITEMS:

Items and materials of salvage value as determined by the Engineer, unless incorporated in the new work, shall remain the property of the Contracting Agency and shall be storaged in adjacent areas as directed by the Engineer. Such items and materials shall be carefully removed and in such a manner as to permit reuse.

201.5 PAYMENT, CLEARING AND GRUBBING:

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

201.6 MEASUREMENT, REMOVAL AND DISPOSAL OF TREES:

If the proposal includes separate estimates of quantities for the removal of trees, the tree will be classified by size as follows:

(A) Trees 12 inches or less in diameter at 1-foot above the original ground surface will be included in the bid price for clearing and grubbing or excavation and no additional compensation will be allowed therefore.

(B) Trees more than 12 inches in diameter at 1-foot above the original ground will be included as separate bid item and payment will be made at the unit bid price quoted in the proposal.

201.7 PAYMENT, REMOVAL AND DISPOSAL OF TREES:

Payment for removal of trees will be on a unit price for each tree measured and removed, in accordance with the above classifications, at the unit price stipulated in the proposal.

SECTION 205

ROADWAY EXCAVATION

205.1 DESCRIPTION:

Roadway excavation shall consist of excavation involved in the grading and construction of roadways, except structure excavation, trench excavation and any other excavation separately designated.

205.2 UNSUITABLE MATERIAL:

Material shall be considered unsuitable for fill, subgrade, shoulders and other uses if it contains organic matter, soft spongy earth, or other matter of such nature that compaction to the specified density is unobtainable.

Material that is unsuitable for the intended use, shall be excavated and removed from the site or otherwise disposed of as directed by the Engineer.

The removal and disposal of such unsuitable material will be paid for as roadway excavation.

205.3 OVERSHOOTING:

Material outside the authorized cross section which may be shattered or loosened because of blasting shall be removed by the Contractor at no additional cost to the Contracting Agency. The Contractor shall discontinue any method of blasting which in the opinion of the Engineer leads to excessive overshooting or is dangerous to the public or destructive to property or to natural features.

205.4 SLIDES AND SLIPOUTS:

Material outside the planned roadway or ditch slopes which in the opinion of the Engineer is unstable and constitutes potential slides, material which has come into the roadway or ditch, and material which has slipped out of new or old embankments shall be excavated to designated lines or slopes either by benching or in such manner as directed by the Engineer. Such material shall be used in the construction of the embankments or disposed of as directed by the Engineer.

The removal and disposal of slide and slipout material as specified above, not resulting from overshooting as specified above, will be paid for at the contract prices for roadway excavation; however, if due to the character of the work, the removal and disposal of such material is not properly compensable at the contract prices for roadway excavation, the work may be paid for as extra work provided the Contractor requests in writing such payment prior to performing any such work.

Only those quantities of slide or slipout material which are actually removed as ordered by the Enginer will be paid for.

205.5 SLOPES:

Excavation slopes shall be finished in conformance with the lines and grades shown on the plans. Debris and loose material shall be removed. When completed, the average plane of the slopes shall conform to the slopes indicated on the plans and no point on the completed slopes shall vary from the designated plane by more than 6 inches measured at right angles to the slope, except where excavation is in rock no point shall vary more than 2 feet from the designated plane of the slope. In no case shall any portion of the slope encroach on the roadbed.

Tops of excavation slopes and ends of excavations shall be rounded as shown on the plans and these quantities will not be included in the quantities of excavation to be paid for. This work will be considered as a part of finishing slopes and no additional compensation will be allowed therefore.

Embankment slopes shall be finished in conformance with lines and grades shown on the plans. When completed the average plane of slopes shall conform to slopes indicated on the plans and no point on the completed slopes shall vary from the designated plane by more than 6 inches measured at right angles to the slope.

205.6 SURPLUS MATERIAL:

Unless otherwise shown on the plans, specified in the special provisions, or approved by the Engineer, no surplus excavated material shall be disposed of within the right-of-way. The Contractor shall make all arrangements for disposal of the material at off-site locations as may be approved by the Engineer, and shall upon request file with the Engineer the written consent of the owner of the property upon which he intends to dispose of such material.

If the quantity of surplus material is shown on the plans or specified in the special provisions, the quantity shown or specified is approximate only. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments before disposing of any indicated surplus material inside or outside the right-of-way. Any shortage of material caused by premature disposal of surplus material by the Contractor, shall be replaced by him and no compensation will be allowed the Contractor for such replacement.

205.7 MEASUREMENT:

The following earthwork operations will be measured as roadway excavation for the quantities of material involved.

Excavating the roadway prism including public and private road approaches, connections and driveways; excavating unsuitable material when shown on the plans or specified in the special provisions; excavating slides and slipouts not resulting from overshooting; excavating surplus material; excavating selected material and topsoil from within the limits of project and removing such materials from stockpiles when stockpiling is ordered; excavating ditches and excavating borrow.

The Engineer will compute the quantities of material excavated by a method which in his opinion is best suited to obtain an accurate determination.

Excavation in excess of the planned or authorized cross section will not be paid for, except as provided above. The Contractor shall backfill and compact unauthorized excavated areas to the original ground elevation of authorized section at no additional cost to the Contracting Agency.

Material resulting from excavating ditches or channels may be used to construct roadway embankments, dikes, or for other purposes, or disposed of, as directed by the Engineer.

Care shall be exercised to prevent excavating below the grade for the bottom of the ditch and areas excavated below grade shall be filled with suitable material and compacted by the Contractor at no additional cost to the Contracting Agency.

205.8 PAYMENT:

Quantities of roadway excavation will be paid for at the contract unit price per cubic yard. Such price shall include excavating, sloping, rounding tops and ends of excavations, loading, depositing, conditioning, spreading, and compacting the material complete in place and disposal of surplus material.

When the proposal does not include a pay item for roadway excavation the cost thereof shall be considered as being included in the price bid for the construction or installation of the items to which such roadway excavation is incidental or appurtenant.

SECTION 206

STRUCTURE EXCAVATION AND BACKFILL

206.1 DESCRIPTION:

Structure excavation shall consist of the removal of material for the construction of foundations for bridges, manholes, retaining walls, box culverts, head walls for culverts, and other structures, and other excavation designated on the plans or in these specifications or in the special provisions as structure excavation.

Structure backfill shall consist of furnishing material, if necessary, and placing and compacting backfill material around structures to the lines designated on the plans or specified or directed by the Engineer.

Structure excavation and structure backfill shall include the furnishing of all materials and equipment and the providing of other facilities which may be necessary to perform the excavations and place and compact the backfill, and the subsequent removal of these facilities, except where they are required or permitted by the plans, special provisions or Engineer to remain in place.

206.2 FOUNDATION MATERIAL TREATMENT:

When footing concrete or masonry is to rest upon rock, the rock shall be fully uncovered and the surface thereof 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 Engineer may direct and the cost thereof will be paid for as extra work.

When no piles are used and 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 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.

The excavation for structures shall be completed to the bottom of the footings before any piles are driven therein, and excess material remaining in the excavation after pile driving shall be removed to the elevation of the bottom of the footings.

When piles are used and ground displacement results from pile driving operations, the Contractor shall at his expense excavate or backfill the footing area to the grade of the bottom of the footing as shown on the plans with structure backfill material.

206.3 INSPECTION:

When any structure excavation is completed, the Contractor shall notify the Engineer who will make an inspection of the excavation. No concrete or masonry shall be placed until the excavation has been approved by the Engineer.

206.4 STRUCTURE BACKFILL:

Backfilling operations shall conform to the following requirements: Structure backfill shall not be placed until the structure footings or other portions of the structure or facility have been inspected by the Engineer and approved for backfilling. No backfill material shall be deposited against the back of concrete abutments, concrete retaining

walls, or the outside walls of cast-in-place concrete box culverts until the concrete has developed a strength of not less than 2500 psi in compression as specified in Section 725.

All structural backfill in any existing or proposed street or where any portion of the backfill is within 2 feet of the above shall be compacted to the minimum density specified in Table 601-2, for Type I.

All other structural backfill shall be compacted to the minimum density specified in Table 601-2, for Type II.

206.5 PAYMENT:

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

SECTION 210

BORROW EXCAVATION

210.1 LOCAL BORROW

Local borrow shall consist of material excavated and used in the construction of fills or for use as selected material or for other construction purposes. Local borrow shall be obtained by widening cuts or by excavating from other sources outside the planned or authorized cross section within the right-of-way and within the limits of the project. Local borrow shall be excavated to the lines and grades established by the Engineer.

210.2 IMPORTED BORROW:

Imported borrow shall consist of material required for construction and unless otherwise designated in the special provisions, the Contractor shall make his own arrangements for obtaining imported borrow and he shall pay all costs involved. Imported borrow shall be obtained from sources indicated on the plans, designated in the special provisions, or approved by the Engineer.

The material shall be free from wood, vegetation, or other deleterious matter. The maximum size of this material shall not be greater than ⅔ the compacted thickness of the course placed in the subgrade.

The Contractor shall notify the Engineer sufficiently in advance of opening any material sites so that cross section elevations and measurements of the ground surface after stripping may be taken and sufficient time for testing the material will be allowed.

Borrow pits shall be excavated to regular lines to permit accurate measurement; depth of excavation throughout the areas of borrow pits shall be as uniform as practicable and the side slope shall be dressed to such slope as may be directed, leaving the borrow pit area in a clean and safe condition.

210.3 PLACING AND COMPACTING:

Local borrow and imported borrow shall be placed and compacted as specified in Section 211.

The Contractor shall satisfy himself that there is sufficient space available in fill locations for placing any excavated material, before placing borrow. Any excess excavation which develops as a result of placing borrow in advance of completing excavations shall be disposed of by the Contractor at no additional cost to the Contracting Agency in accordance with the provisions in Section 205 and a corresponding reduction in the quantity of borrow to be paid for will be made, for which the Contractor will have no claim for compensation.

210.4 MEASUREMENT:

Quantities of borrow will be measured as specified for roadway excavation in Section 205.

Material excavated at the borrow site and not used on the work will be deducted from the computed quantities and will not be paid for.

210.5 PAYMENT:

Quantities of borrow excavation will be paid for at the contract unit price per cubic yard. Such price shall include excavating, sloping and cleaning of borrow area, hauling, depositing, spreading and compacting the material complete in place, and disposal of surplus material, unless an alternate basis of payment is stipulated in the proposal.

SECTION 211

FILL CONSTRUCTION

211.1 DESCRIPTION:

Fill construction shall consist of constructing embankments except as may otherwise be specified, including the preparation of the areas upon which they are to be placed; the construction of dikes; the placing and compacting of approved material within areas where unsuitable material has been removed; and the placing and compacting of material in holes, pits, and other depressions.

211.2 PLACING:

Rocks, broken concrete, or other solid materials, which are larger than 4 inches in greatest dimension shall not be placed in fill areas where piles are to be placed or driven.

When fill is to be made and compacted on hillsides or where new fill is to be compacted against existing fill or where embankment is built ½ width at a time, the slopes of original hillsides and old or new fills shall be benched a minimum of 4 feet horizontally as the fill is placed. A new bench shall be started where ever the vertical cut of the next lower bench intersects the existing ground. Material thus cut out shall be recompacted along with the new embankment material by the Contractor at no additional cost to the Contracting Agency, unless the width of the bench required exceeds 4 feet, in which case the excavated material in excess of 4 feet will be measured and paid for as excavation.

Clods or hard lumps of earth of 6 inches in greatest dimension shall be broken up before compacting the material in embankment, except as provided in the following paragraph:

When the fill material includes large rocky material, or hard lumps, such as hardpan or cemented gravel which cannot be broken readily, such material shall be well distributed throughout the fill. Sufficient earth or other fine material shall be placed around the larger material as it is deposited so as to fill the interstices and produce a dense, compact fill. However, such material shall not be placed within 2 feet of the finished grade of the fill.

211.3 COMPACTING:

Fill shall be constructed in compacted layers of uniform thickness and each layer shall be compacted in accordance with the requirements herein specified with the following exception.

Where fills are to be constructed across low, swampy ground which will not support the weight of hauling equipment, the lower part of the embankment may be constructed by dumping successive loads of suitable material in a uniformly distributed layer of a thickness not greater than that necessary to support the equipment while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

Unless specified herein, or in the special provisions, the construction of dikes, the placing and compacting of approved material within the right-of-way where unsuitable material has been removed, and the filling of holes, pits and other depressions within the right-of-way, shall conform to all of the requirements herein specified for compacting fills. Trenches, holes, depressions and pits outside of areas where fills are to be constructed shall be graded to provide a presentable and well-drained area.

Areas over which fills are to be placed shall be cleared and scarified to a depth of 6 inches to provide a bond between the existing ground and the material to be deposited thereon. Unless otherwise specified, the original ground area upon which fills are to be constructed shall be compacted to a uniform density of not less than 95 percent.

The loose thickness of each layer of fill material before compacting shall not exceed 8 inches, except as provided in the following paragraph for rocky material. Each layer shall be compacted in accordance with the following requirements to a uniform density of not less than 90 percent, except that where a new or widened roadway and appurtenances are required, density of the upper 2 feet and when the fill is within 2 feet of the above shall be not less than 95 percent.

When fill material contains by volume over 25 percent of rock larger than 6 inches in greatest dimension the fill below a plane 3 feet below finished grade may be constructed in layers of a loose thickness before compaction not exceeding the maximum size of rock in the material but not exceeding 3 feet in thickness.

The interstices around the rock in each layer shall be filled with earth or other fine material and compacted. Broken portland cement concrete and bituminous type pavement obtained from the project excavations will be permitted in the fill with the following limitation:

(A) The maximum dimension of any piece used shall be 6 inches.

(B) Pieces larger than 4 inches shall not be placed within 12 inches of any structure.

(C) Pieces larger than 2½ inches shall not be placed within 12 inches of the subgrade for paving.

(D) Nesting of pieces will not be permitted.

At the time of compaction, the moisture content of fill material shall be such that the specified relative compaction will be obtained and the fill be firm and unyielding. Fill material which contains excessive moisture shall not be compacted until the material is dry enough to obtain the required relative compaction. Full compensation for any additional work involved in drying fill material to the required moisture content shall be considered as included in the contract price paid and no additional compensation will be allowed therefore.

Embankments shall be constructed so that each layer shall have a cross fall of at least 2 percent but no more than 5 percent.

211.4 TESTS:

Unless otherwise provided in the plans or special provisions the fill shall be thoroughly compacted to not less than the stated densities when tested and determined by AASHTO T-99, Method A, and T-191 or ASTM D-2922 and D-3017 with the percent of density adjusted in accordance with the rock correction procedure for maximum density determination, standard detail, to compensate for the rock content larger than that which will pass a No. 4 sieve.

211.5 MEASUREMENT:

The quantities of fill construction used to construct embankments or dikes will be those of the completed bid item, in place, within the limits of dimensions shown on the plans.

The Engineer will compute the quantities of fill by a method which in his opinion is best suited to obtain an accurate determination.

211.6 PAYMENT:

Quantities of fill construction will be paid for at the contract unit price per cubic yard of fill as stipulated in the proposal. Such price shall include placing and compaction and all related work as specified above, unless an alternate basis of payment is stipulated in the proposal.

Unless otherwise provided in the special provisions, no payment will be made for fill construction to replace unsuitable material or for fill for holes, pits, and other depressions. The cost thereof shall be included in the price bid for the construction of the items to which such fill is incidental or appurtenant.

SECTION 215

EARTHWORK FOR OPEN CHANNELS

215.1 DESCRIPTION:

Earthwork for open channels shall consist of clearing, stripping, excavation, fill, backfill, grading and disposal of excavated and removed material.

Open channels for the purpose of this section shall mean open rectangular concrete channels and lined or unlined trapezoidal channels.

215.2 STRIPPING:

When stripping is indicated on the plans or specified in the special provisions, the Contractor shall strip the soil from the designated areas to the depths shown or specified or as directed by the Engineer.

The material obtained from stripping operations shall be disposed of away from the site unless otherwise specified, shown on the plans or authorized by the Engineer.

Soil loosened below the stripping depth specified or designated by the Engineer, shall be compacted. Soil removed below stripping depth shall be replaced with approved material and compacted up to the designated grade. All such filling and compacting shall be done by the Contractor at no additional cost to the Contracting Agency.

215.3 EXCAVATION:

Excavation in open cut for lined channels may be made so as to place concrete directly against the excavated surfaces providing the faces of the excavation are firm and unyielding; are such as will stand or can be made to stand without sloughing and are, at all points outside the concrete lines shown on the plans.

Excavation to provide a subgrade for lined channels, or subdrainage material, shall be to the lines indicated on the plans; and, excavation made below subgrade shall be backfilled and compacted to a uniform density of not less than 90 percent or, if approved by the Engineer, with concrete or other materials being placed. However, no payment will be made for such over-excavation or material used for such backfill.

Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, the voids remaining after the removal of such boulders or interfering objects shall be backfilled as specified below, or as otherwise approved by the Engineer.

(A) When the void is below the subgrade for reinforced concrete channel, it shall be filled with suitable material, as approved by the Engineer, and compacted to a uniform density of not less than 90 percent. With the approval of the Engineer, concrete of the same mix as used in the concrete channel, may be used.

(B) When the void is in the side of the excavation, it shall be filled with suitable material as approved by the Engineer, placed in the manner and to the same uniform density as the backfill in the vicinity of the void. With the approval of the Engineer, concrete of the same mix as used in the concrete channel may be used. If concrete is placed prior to lining, a lower grade concrete may be used only if approved by the Engineer.

It shall be understood that the removal of boulders or other interfering objects and the backfilling of voids caused by such removals shall be done by the Contractor at no additional cost to the Contracting Agency. The cost of such work shall be included in the prices bid for the various items of work.

If during the progress of excavation, material is encountered, which, in the opinion of the Engineer, is unsuitable for subgrade for the channel to be constructed on, the Engineer may direct the Contractor to excavate beyond the pay lines shown on the plans. However, the suitability of subgrade shall be determined by the Engineer on the basis of its ability to withstand the load of the proposed channel and not upon the capacity to withstand the loads which may be placed upon it by the Contractor's equipment. Should the Contractor be directed to excavate beyond the pay lines shown on the plans, said pay lines will be extended to include such ordered excavation; and the pay lines for subdrainage material, if used, will be adjusted accordingly.

Materials used or work performed by the Contractor, to stabilize the subgrade so it will withstand loads which may be placed upon it by his equipment shall be accomplished by the Contractor at no additional cost to the Contracting Agency.

215.4 FILL AND BACKFILL:

Unless otherwise specified in the special provisions, material obtained from the project excavations may be presumed to be suitable for use as fill or backfill provided that all organic material, rubbish, debris, and other objectionable material is first removed. However, stone, broken portland cement concrete and bituminous type pavement obtained from the project excavations will be permitted in the backfill or fill with the limitations as specified in Section 211.

Unless otherwise specified in the special provisions, the density of fills and backfills shall be at least 90 percent.

215.5 GRADING:

Grading of unlined channels, levees and access roads shall conform to the following tolerances:

(A) A vertical tolerance of none above and 3 inches below the specified grade will be allowed on:

(1) Channel bottom

(2) Channel side slopes in both cut and fill

(3) Levee and access road side slopes in cut

(B) A vertical tolerance of none below and 3 inches above the specified grade will be allowed on:

(1) Top surface of levee and access road in both cut and fill

(2) Levee and access road side slopes in fill

Regardless of the construction tolerances specified, excavation and grading shall be performed so that finished surfaces are in uniform planes with no abrupt breaks in the surface.

Construction tolerances specified above for grading are solely for purposes of field control.

215.6 TESTS:

Density tests shall be made in accordance with Section 211.

215.7 MEASUREMENT:

If compensation for stripping is included in the price paid for other items of work the Contractor shall notify the Engineer sufficiently in advance of excavation or other work so that cross section elevations and measurements of the ground surface may be taken upon completion of stripping.

The Engineer will compute the quantity of excavation by a method which in his opinion is best suited to obtain an accurate determination.

215.8 PAYMENT:

Earthwork for open channels will be paid for on a lump sum basis or at the contract unit price per cubic yard of excavation as stipulated in the proposal. Such price shall include clearing, stripping, excavation, fill, backfill, compaction, grading, hauling, removal and disposal of excess excavated material and debris unless an alternate method of payment is stipulated in the proposal.

SECTION 220

RIPRAP CONSTRUCTION

220.1 DESCRIPTION:

The construction of riprap shall consist of furnishing and placing stone, with or without grout, or sacked concrete riprap. The depth and type of riprap shall be as shown on the plans or specified in the special provisions.

220.2 MATERIALS:

Materials furnished for riprap shall conform to the requirements of Section 703.

220.3 PREPARATION OF GROUND SURFACES:

The bed for the riprap shall be shaped and trimmed to provide even surfaces. A footing trench shall be excavated along the toe of the slope as shown on the plans.

220.4 PLAIN RIPRAP:

When the required riprap is less than 20 inches in depth, stone shall be placed by hand. Stone shall be placed to provide a minimum of voids. The larger stone shall be placed in the toe trench, foundation course, and on the outer surface of the riprap. Stones shall be placed with their longitudinal axis normal to the face of the embankment and so arranged that each stone above the foundation course has at least a 3 point bearing on the underlying stones. Bearing on smaller stones used to chink voids will not be acceptable. Interstices between stones shall be chinked with small stones and spalls. The finished surface shall be even and tight and shall not vary from the planned surface by more than 3 inches per foot of depth.

When the required riprap is 20 inches or more in depth, the stone may be placed by dumping and spread in layers by bulldozers or other suitable equipment.

220.5 GROUTED RIPRAP:

Riprap shall be placed as specified and grouted with portland cement mortar. The grout shall consist of 1 part cement and 3 parts by volume of aggregate. The portland cement shall be Type II as specified in Section 725 and the aggregate shall be 2 parts sand and 1 part gravel passing a ⅜ inch square mesh screen. The quality of the sand and gravel shall be as specified in Section 701.

The amount of water shall be such as to permit gravity flow into the interstices with limited spading and brooming. The consistency of the grout shall be as approved by the Engineer.

Except when hand mixing is permitted by the Engineer, grout shall be mixed in an approved machine mixer for not less than 1½ minutes. Should hand mixing be

permitted, the cement and aggregate shall be thoroughly mixed in a clean, tight mortar box until the mixture is of uniform color after which clean water shall be added in such quantity as to provide a grout of the specified consistency.

220.6 SACKED CONCRETE RIPRAP:

Slopes on which the sacked concrete riprap is to be placed shall be finished within 0.2 foot of the designated grades. The first course shall be a double row of stretchers laid in a neatly trimmed trench. The second course shall be a single row of headers. The third and remaining courses shall be stretchers or headers as shown on the plans or specified in the special provisions and shall be placed so that joints between courses are staggered. Dirt and debris shall be removed from the tops of sacks before the next course is laid thereon. Headers shall be placed with the folds upward. Not more than 4 vertical courses shall be placed in any tier until the initial set has taken place in the first course of any such tier.

When, in the opinion of the Engineer, there will not be proper bearing or bond due to delays in placing succeeding layers or the hampering of work by storm, mud or for any cause, a small trench shall be excavated back of the row of sacks already in place and this trench filled with fresh concrete before more sacks are placed. Payment for excavating the trenches shall be considered as included in the payment for the concrete in the trench.

Sacked concrete riprap shall be cured by sprinkling with a fine spray of water every 2 hours during daylight for not less than 3 days.

220.7 MEASUREMENT:

The quantities of riprap construction shall be those of the completed bid item, in place, within the limits of dimensions shown on the plans.

The Engineer will compute the quantities of riprap by a method which, in his opinion, is best suited to obtain an accurate determination.

220.8 PAYMENT:

Payment for riprap will be made for the number of cubic yards of riprap in place, on the basis of unit prices stipulated in the proposal and shall include preparation of ground surfaces and trenching, unless an alternate basis for payment is stipulated in the proposal.

SECTION 225

WATERING

225.1 DESCRIPTION:

Water for compacting embankments, constructing subgrade, placement of screened gravel and crushed surfacing, and for laying dust caused from grading operations or public travel, shall be applied in the amounts and places as directed by the Engineer.

225.2 WATER SUPPLY:

Water shall consist of providing a water supply sufficient for the needs of the project and the hauling and applying of all water required.

The Contractor shall make arrangements for and provide all necessary water for his construction operation and domestic use at his own expense.

If the Contractor purchases water from a water utility at a fire hydrant on or near the project, all arrangements shall be made by him at his own expense and payment made direct to the water utility as agreed upon.

The Contractor shall use only those hydrants designated by the water utility in charge of water distribution and in strict accordance with its requirements for hydrant use.

The Contractor shall furnish all connections, wrenches, valves and small tools that may be necessary to meet the requirements of the water utility pertaining to hydrant use.

225.3 CONSTRUCTION EQUIPMENT:

The tank truck and/or trailer shall meet all safety and licensing regulations and the water shall be applied by sprinkling with tank trucks equipped with spray bars and suitable apparatus.

225.4 MEASUREMENT:

No measurement will be made of water, unless otherwise provided for in the special provisions or proposal.

225.5 PAYMENT:

The cost of watering will be included in the price bid for the construction operation to which such watering is incidental or appurtenant, unless otherwise provided for in the special provisions or proposal.

PART 300

STREETS AND RELATED WORK

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STREETS AND RELATED WORK

SECTION 301

SUBGRADE PREPARATION

301.1 DESCRIPTION:

This section shall govern the preparation of natural, or excavated areas prior to the placement of sub-base material, pavement, curbs and gutters, driveways, sidewalks or other structures. It shall include stripping and disposal of all unsuitable material including existing pavement and obstructions such as stumps, roots, rocks, etc., from the area to be paved.

301.2 PREPARATION OF SUBGRADE:

With the exception of areas where compacted fills have been constructed as specified in Section 211 in the areas where new construction is required the moisture content shall be brought to that required for compaction by the addition of water, by the addition and blending of dry, suitable material or by the drying of existing material. The material shall then be compacted to the specified relative density.

301.3 RELATIVE COMPACTION:

The subgrade shall be scarified and loosened to a depth of 6 inches. When fill material is required, a layer of approximately 3 inches may be spread and compacted with the subgrade material to provide a better bond. The subgrade cut and fill areas shall be constructed to achieve a uniform soil structure having the following density when tested in accordance with AASHTO T-99, Method A, and T-191 or ASTM D-2922 and D-3017 with the percent of density adjusted in accordance with the rock correction procedures for maximum density determination, standard detail, to compensate for the rock content larger than that which will pass a No. 4 sieve.

(A) Major Streets ..... 95 percent

(B) Other streets and traffic ways ..... 90 percent

(C) Curbs, gutters and sidewalks ..... 85 percent

301.4 SUBGRADE TOLERANCES:

Subgrade upon which pavement, sidewalk, curb and gutter, driveways, or other structures are to be directly placed shall not vary more than ¼ inch from the specified grade and cross-section. Subgrade upon which sub-base or base material is to be placed shall not vary more than ¾ inch from the specified grade and cross-section. Variations within the above specified tolerances shall be compensating so that the average grade and cross-section specified are met.

301.5 GRADING OF AREAS NOT TO BE PAVED:

Areas where grade only is called for on the plan shall be graded to meet the tolerances for the subgrade where sub-base or base material is to be placed. The surface shall be constructed to a straight grade from the finished pavement elevations shown on the plans to the elevation of the existing ground at the extremities of the area to be graded.

301.6 PROTECTION OF EXISTING FACILITIES:

The Contractor shall exercise extreme caution to prevent debris from falling into manholes or other structures. In the event that debris should fall into a structure it shall immediately be removed.

SECTION 301

301.7 MEASUREMENT:

Measurement for grading under pavement will be by the square yard.

301.8 PAYMENT:

Payment for this grading work will be made only when it is performed for street or roadway paving projects. Payment for necessary grading for items outside of the lip of gutter shall be included in the cost of those items.

Payment will be made at the unit price bid per square yard, and such payment shall be compensation in full for the item complete in place, including stripping, excavating, hauling, filling, compacting, and disposing of excess or unsuitable materials, together with all costs incidental thereto.

SECTION 310

UNTREATED BASE

310.1 DESCRIPTION:

Untreated base, i.e., select or aggregate base course, shall comply with Subsection 702.2 unless the use of a different type of material is specifically authorized in the special provisions.

310.2 PLACING:

Untreated base 6 inches or less in compacted thickness may be placed in a single layer and those more than 6 inches in thickness shall be built up in successive layers of approximately equal compacted thickness not to exceed a maximum thickness of 6 inches. The requirements which follow are applicable to all types of material.

After distributing, the base material shall first be watered and then immediately bladed to a uniform layer that will net, after rolling, the required thickness. If the materials deposited are not uniformly blended together, the blading operation shall be continued to such extent as may be necessary to eliminate segregation. The quantity of water applied shall be that amount which will assure proper compaction resulting in a relative density of not less than 100 percent as determined under Section 301. Care shall be exercised in connection with watering operations to avoid wetting the subgrade or any lower base course to detrimental extent.

Upon completion, the base surface shall be true, even and uniform conforming to the grade and cross-section specified.

Untreated base may vary not more than ½ inch above or below required grade and cross-section.

310.3 DEFICIENCY:

When in the opinion of the engineer there is reason to believe that a deficiency in thickness, or an excess of plasticity exists, cores will be taken in the same pattern as that defined in Section 321. If the base has been covered or it is otherwise impractical to correct the deficiency, the following corrective measures shall be taken by the Contractor at no additional cost to the Contracting Agency.

TABLE 310		
Type	**Deficiency**	**Corrective Measure**
I	½″ or more but less than 1″ in thickness	Place a precoated chip seal in accordance with Section 331 for the full roadway width over the area involved but for not less than 660 feet or one City block in length.
II	1″ or more in thickness	Place an additional asphalt concrete overlay, Type E-⅜,, of ½ the thickness of the deficiency in thickness for the full roadway width over the area involved, not less than 660 feet or one City block in length.
III	A plasticity index of 5 to 7 inclusive	Place an asphalt concrete overlay ½ inch in thickness over the same total area as required for Type I and II.
IV	A plasticity index of over 7	Remove deficient material from affected area and replace with material complying with the specifications.

310.4 PAYMENT:

Payment for untreated base will be made on the basis of the price bid per ton unless an altemate basis of payment is provided in the proposal.

SECTION 311

SOIL CEMENT BASE COURSE

311.1 DESCRIPTION:

This item shall consist of a base course composed of a mixture of local soil, portland cement, and water compacted at optimum moisture content.

311.2 MATERIALS:

Portland cement and water shall comply with Sections 225 and 725. The soil for the mixture shall consist of the material in the area to be paved. The material shall not contain more than 5 percent gravel or stone retained on a 3 inch sieve. It shall be demonstrated by laboratory tests that the plasticity and hardening characteristics of the soil will be adequately modified by the specified cement content.

311.3 EQUIPMENT:

An ample number of machines, combination of machines and equipment shall be provided and used to produce the completed soil cement base course meeting the requirements for soil pulverization, cement distribution, water application, incorporation of materials, compaction, finishing, and for application of the curing material as provided in these specifications.

Mixing shall be accomplished by means of multiple-pass soil-cement mixer, single-pass soil-cement mixer or central plant mixer.

Water may be applied through the mixer or with water trucks equipped with pressure sprays. Water trucks providing fine fog-type sprays shall be furnished for finishing and curing. Properly adjusted garden type nozzles on a pressure bar may be used to produce fog spray if approved by the Engineer.

Cement spreader shall be a specially constructed device to distribute bulk cement uniformly at rate specified either in windrows or on the flat as determined by method of mixing.

311.4 CONSTRUCTION METHODS:

Before undertaking construction of the soil cement base course, the area to be paved shall be brought to a compacted condition, true to line and grade as directed by the Engineer or as shown on the plans. During this process any unsuitable soil or material, including excess material retained on a 3 inch sieve, shall be removed and replaced with acceptable material. The compacted surface shall be at the proper elevation as specified, shown on the plans, or as directed by the Engineer, for the top of the soil cement base. At completion of this phase, the material and surface shall be approved by the Engineer before proceeding with the next step.

The material shall be scarified, pulverized, mixed with water and cement, compacted and finished and cured in lengths permitting the full roadway width to be completed in not more than 4 hours from the time that cement is exposed to water. Such lengths will generally be not less than 600 feet or the length of one City block and preferably more. Where a gutter section exists the material shall be pulled back from the gutter face for the full depth of the course before processing.

311.4.1 Pulverizing: Before application of cement, soil to be processed shall be scarified to depth of base. The material should be damp at time of scarifying to reduce the dust to a minimum and to aid in pulverization. If the soil contains clods, it shall be pulverized until not less than 80 percent, exclusive of gravel or stone, will pass a No. 4 sieve.

311.4.2 Application of Cement: The quantity of cement shall be by weight as a percentage of the dry weight of the soil as determined by the laboratory and/or as directed by the Engineer and shall be applied uniformly on the soil in a manner satisfactory to the Engineer. The allowable deviation in uniformity shall not exceed 10 percent. The entire operation of spreading and mixing shall be conducted in such a manner as will result in a uniform soil cement and water mixture for the full design width and depth.

The percentage of moisture in the soil, at the time of cement application, shall not exceed the quantity that will permit a uniform and intimate mixture of the soil and cement during mixing operations, and it shall not exceed the specified optimum moisture content for the soil cement mixture.

311.4.3 Mixing: Mixing with addition of water as required shall be continued until the product is uniform in color and at optimum moisture content. Any mixture of soil and cement which has not been compacted and finished shall not remain undisturbed for more than 30 minutes but shall be agitated by remixing.

311.4.4 Optimum Moisture: Optimum moisture requirements and field tests of moisture density shall be determined in accordance with AASHTO T-134, T-191,

T-217, or ASTM D-558, D-2922, D-3017 on representative samples of soil cement mixture obtained from the area being processed. At time of laydown, the moisture content shall not be below optimum moisture, and shall be less than that quantity which will cause the base course to become unstable during the compaction and finishing process. Any area which becomes so unstable shall be removed and replaced with new cement stabilized material.

311.4.5 Compaction: After mixing is complete, the mixture shall be carefully placed in a uniform loose depth which will provide a surface true to grade and section when compacted. Unless otherwise directed by the Engineer, initial compaction shall be by means of a tamping, grid, or pneumatic roller. After the tamping roller has partially walked out, pneumatic rollers shall be used. Density of final product shall be not less than 95 percent as determined by AASHTO or ASTM as specified above.

311.4.6 Finishing: As compaction nears completion, the surface of the base course shall be shaped to required lines, grades and cross-section. When required, the surface shall be lightly scarified with spike tooth harrows or other approved equipment to remove imprints left by equipment or to prevent slippage planes. During the finishing process the surface shall be kept moist by means of fog-type sprays. Surface finish and final compaction shall be completed in not more than 2 hours from time of laydown. The completed base course shall be true to line, grade, cross-section and shall not vary more than ½ inch in thickness and not more than 1 inch in surface tolerance when tested with a 10 foot straight edge. It shall be free of surface cleavage planes, cracks, or loose material. As a final operation, the surface shall be very lightly scalped with a motor grader, wet with a fog spray and rolled with a pneumatic roller as directed by the Engineer.

311.4.7 Deficiency: When in the opinion of the Engineer there is reason to believe that a deficiency in thickness exists, cores will be taken in the same pattern as that defined in Section 321. If the base has been covered or it is otherwise impractical to correct the deficiency, the corrective measures, listed in Table 310 for Type I or II deficiencies, shall be taken by the Contractor at no additional cost to the Contracting Agency.

311.4.8 Curing: After completion of the final finishing process, the soil-cement shall be cured with a bituminous curing seal applied at the end of each construction day. This seal may be either an emulsion or cut-back asphalt applied at a minimum rate of 0.20 gal./sq. yd. The finished soil-cement shall be kept continuously moist until the bituminous cure seal is applied, using fog or gravity bar spray. The spray equipment shall be approved by the Engineer before construction is begun.

311.4.9 Construction Joints: At the end of each day's work, a construction joint shall be made transverse to the centerline of the road by cutting back into the work to provide a full depth vertical joint. Except where specifically authorized by the Engineer, no other construction joints will be permitted. Where authorized, such joints shall be full depth vertical joints.

311.4.10 Maintenance: The Contractor shall maintain the surface until it has been covered with the designated bituminous wearing course. In case it is necessary to replace any soil cement, it shall be for the full depth. No skin patches of soil cement will be permitted. Minor surface pits may be filled with compacted bituminous surfacing, if authorized by the Engineer. Immediately prior to the placing of the bituminous wearing course, the surface shall be broomed to remove all loosened material from the surface.

SECTION 311

311.5 MEASUREMENT:

Measurement of soil cement will be the number of square yards constructed to the required depth, completed and accepted.

Measurement of portland cement will be the number of tons of cement mixed with the local soil.

311.6 PAYMENT:

Payment will be made for the applicable items at the contract unit prices bid in the proposal, and shall constitute full payment for furnishing all material, equipment, tools, labor and incidentals necessary to complete the work and for carrying out the maintenance provisions.

No measurement or payment will be made for any imported earth materials.

SECTION 312

CEMENT TREATED BASE

312.1 DESCRIPTION:

Cement treated base shall consist of a combination of base material as specified in Section 705 and portland cement.

312.2 GENERAL:

When the mixing of cement treated base in a stationary mixer is required, it will be so specified. Otherwise, cement treated base may be mixed in either a traveling plant or in a stationary plant, at the option of the Contractor.

If the cement treated aggregate is mixed in a central plant, it shall not contain moisture in excess of 1 percent above or below optimum at the time of delivery on the grade. Certain types of transit mixers will not discharge such material unless it is greatly in excess of optimum moisture. Use of such mixers will not be permitted.

If the material is mixed in place, the machine or combination of machines used shall be capable of thoroughly mixing the cement and aggregate, when using the granular material specified, in a single pass. No lift thickness shall exceed 8 inches. If the thickness required is in excess of 8 inches, it shall be mixed in 2 separate lifts of equal thickness.

312.3 CONSTRUCTION METHODS:

Mixing of materials, regardless of the type of mixer used or method employed, shall be continued until the cement and water are evenly distributed throughout the aggregate, and a mixture of uniform appearance is obtained.

The amount of cement used shall conform to requirements of Section 705. Cement delivered in standard sacks from commercial producers will be assumed to weigh 94 pounds per sack and need not be weighed. Bulk cement or fractional sacks of cement shall be weighed.

The amount of water used shall be that required to give optimum moisture content. A portion of the required water may be added to the aggregate prior to the addition of the cement, if approved.

After spreading, the cement treated base shall be compacted to a density of at least 95 percent of the maximum density as determined by AASHTO T-134, T-191, T-217 or ASTM D-558, D-2922, D-3017.

After compaction, the surface of the cement treated base course shall not deviate at any point more than ⅜ inch from the lower edge of a 10-foot straightedge laid parallel to the centerline of the roadway.

A construction joint shall be made at the end of each day's construction by trimming the end of the compacted mixture to a straight vertical plane, normal to the centerline of the roadway and with the vertical edge in thoroughly compacted material.

Cement shall not be added to more material than will be mixed, compacted and sealed that same day. Cement treated base shall not be mixed or placed when either the aggregate or subgrade is frozen. The air temperature shall be at least 40°F. in the shade and rising at the time of mixing.

In areas which are inaccessible to the mixing, spreading or compacting equipment designated herein, other methods and equipment acceptable to the Engineer may be utilized.

The mixed material shall not remain undisturbed on the subgrade for more than 30 minutes and not more than 3 hours shall elapse between the time water is added to the mixture and final compaction is accomplished.

The mixed materials shall be spread for the full width of the base under construction, either by one spreader or by several spreaders operating in a staggered position across the subgrade, unless permission is granted to do part-width construction. Should permission be granted for part-width construction, not more than 30 minutes shall elapse between the times of placing the material in adjacent lanes at any location, and the longitudinal joint against which additional mixed material is to be placed shall be trimmed to a straight vertical plane parallel to the centerline of the roadway. Trimming shall be done in such a manner as to cause the least possible loosening of the compacted base material and to leave no loose material on the subgrade. The material cut away in trimming may be used in the construction of the shoulders or the adjacent lanes if approved, or shall be disposed of in a satisfactory manner.

During mixing, spreading and compacting and until the application of the curing seal, any moisture lost by evaporation shall be replaced by the addition of water by means of a light fog or fine spray.

The mixed base materials shall be covered as soon as possible after final compaction and shall be cured in accordance with this specification.

312.4 TRAVELING PLANT MIXING:

312.4.1 Placing Aggregate: The aggregate to be treated shall be placed on the roadway either as a uniform layer which, when compacted, will produce a base of the depth and width shown on the plans or as one or more windrows which, when spread, will yield a uniform layer which will compact to the prescribed dimensions. If the aggregate is placed in one or more windrows, a windrow sizer will be required. The number and size of the windrows may vary, depending on the width and depth of treatment and on the capacity of the machine, but regardless of size, the windrow shall be uniform in cross-section and shall not be larger than can be handled by the plant.

Care shall be exercised during the placement of the aggregate to prevent segregation of the fine and coarse portion of the aggregate.

312.4.2 Placing Cement: Cement shall be added to the uniform layer or windrow of aggregate by means of mechanized equipment which will spread the cement in correct and uniform quantities. For any section of roadway, the quantity of cement placed by mechanical spreaders shall not deviate more than 10 percent from the computed quantity for the section. When cement is applied to a windrow, the top of the windrow shall be slightly trenched to retain the spread of cement.

If storm winds cause a loss of spread cement, spreading operations shall be halted until such winds subside and, at the first indication of losses, prompt action shall be taken to avoid further losses. If cement losses are deemed excessive the deficient quantity shall be furnished and added in the proper amount by the Contractor at no additional cost to the Contracting Agency.

312.4.3 Mixing: Mixing shall be accomplished by means of an approved single pass traveling continuous mixing machine, or combination of machines, of the pug or auger type. The machine shall be so constructed that the device for picking up or mixing the aggregate can be controlled and during the mixing operations it shall be set to mix the aggregate, cement and water to the design depth without cutting into or disturbing the subgrade or picking up any material other than that material to be processed. The machine shall be equipped so that water may be introduced at the time of mixing through a metering device which will accurately and uniformly control and measure the amount of water being used.

The cement and aggregate shall be mixed in the machine simultaneously with the adding, through the machine, of the additional amount of water required.

The material shall be spread immediately after mixing, in reasonably close conformity to the lines, grades and dimensions established or shown on the plans.

312.4.4 Stationary Plant Mixing: If the stationary plant method of mixing is employed, the aggregate, cement and water shall be mixed at a central plant using either a batch pug mill type or a continuous type mixer. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected, either by a reduction in the weight of materials or by other adjustments.

312.4.5 Batch Mixing: If a batch pug mill type mixer is used, the aggregate and cement shall be proportioned by batch weights. Cement shall be weighed on separate scales from the aggregate batching scales.

The weight of the charge in a batch mixer shall not exceed that which will permit complete mixing of all materials. The period of mixing shall not be less than 30 seconds from the time all materials are in the mixer. Water may be proportioned by volume or by weight.

312.4.6 Continuous Mixing: If a continuous type mixer is used, the materials shall be proportioned by volume.

The continuous type mixer shall be equipped with metering devices and feeders which will introduce the cement, aggregate and water into the mixer in the specified proportions. The water pump shall be equipped with a means of varying the rate of delivery. The metering devices and feeders shall be interlocked and so synchronized as to maintain a constant ratio of cement and water to the aggregate.

The rate of feed to a continuous type mixer shall not exceed that which will permit complete mixing of all the material.

312.4.7 Spreading: The treated material shall be transported from the plant to the prepared subgrade in approved equipment.

The surface on which the material is to be placed shall be thoroughly moistened and kept moist, but not excessively wet, until covered by the material.

Plant mixed cement treated base shall be spread by approved spreader boxes or finishing machines. The machines shall be constructed and operated so as to produce a layer of uniform density and cross-section and in sufficient quantity to provide a compacted base reasonably conforming to the lines, grades and cross-sections established or shown on the plans.

312.4.8 Compacting: Initial compaction shall begin immediately after mixing and spreading. Successive passes of compacting equipment shall overlap the previous adjacent pass by at least 25 percent of its width. Following initial compaction and before final compaction, the treated material shall be bladed with a motor grader or a planing machine to obtain a surface reasonably true to the lines, grades and cross-sections established or shown on the plans. During and immediately following the shaping operations, if required, the Contractor shall lightly scarify the surface with a nail drag or other approved equipment to prevent the formation of surface compaction planes.

Extreme care shall be exercised by the Contractor during the blading operation so that no more material than is necessary is disturbed and so that this operation can be completed as quickly as possible. Material thus cut shall be wasted if so directed. Compaction shall proceed without interruption, except as stated above, until the required degree of compaction is obtained.

312.5 INVERTED SECTION:

Where the cement treated base is to be covered with an aggregate base material to prevent shrinkage crack reflection and overloading of the cement treated base, the minimum thickness of the aggregate base shall be 4 inches, unless otherwise specified in the special provisions. In order to provide for free internal drainage of the aggregate base course overlying the cement treated material, it shall be non-plastic and the percentage of material passing the No. 200 sieve shall not exceed 8. The cement treatment shall be held back approximately 1 foot from each curb line so as to permit drainage of any water that may become trapped between the cement treated base material and the bituminous surfacing.

312.6 CURING:

The mixed cement treated base materials shall be covered as soon as possible after final compaction with a bituminous curing seal. Application shall be by means of a pressure distributor in accordance with the requirements of Section 712. The approximate quantity of bituminous material to be used shall be as specified; however, the exact amount will be determined by the Engineer at the time of application.

After the bituminous curing seal has been applied, the cement treated base course shall be kept free of equipment and traffic for a period of at least 7 days or until it will not pick up under traffic. Curing seal shall conform to the requirement of Section 712 or 713 for the type specified.

In lieu of the curing seal, the Contractor may, at his option, keep the surface of the compacted base continuously moist until overlaid with the aggregate base course. The aggregate base or the surfacing, may be placed as soon as the cement treated base has

been compacted. The spray equipment on the water truck shall be approved by the Engineer prior to the use of this equipment to spray the soil cement base course. The spray equipment must produce a fine, even spray to prevent washing of the surface of the base course. A cement treated section may be opened to all traffic immediately after placement and compaction of the surfacing.

312.7 DEFICIENCY:

When, in the opinion of the Engineer, there is reason to believe that a deficiency in thickness exists in the cement treated base, cores will be taken in the same pattern as that defined in Section 321. If the base has been covered or it is otherwise impractical to correct the deficiency of ½ inch or more in thickness, the corrective measure listed in Table 310 for Type II deficiency shall be taken by the Contactor at no additional cost to the Contracting Agency.

312.8 PAYMENT:

Payment for the portland cement will be made by the tons of cement complete in place.

Payment for base material will be made by the tons of aggregate complete in place including mixing, spreading, and compacting.

No separate payment will be made for curing.

SECTION 313

BITUMINOUS TREATED BASE COURSE

313.1 DESCRIPTION:

Bituminous treated base course shall consist of a mixture of aggregate and emulsified or liquid asphalt.

313.2 AGGREGATES:

The aggregates shall consist of soil or mineral aggregates, or blends thereof, which, when stabilized and allowed to cure, will meet the requirements specified in the special provisions. The Contractor shall notify the Engineer if he intends to import material, in sufficient time to allow for the testing thereof to determine the suitability of the material and quantity and stabilizer required.

313.3 ADVANCE TESTS:

When mixing is to be done on the site, a representative sample of the aggregates shall be taken from each 10,000 square feet to be stabilized. When mixing is done in a central mixing plant, samples which are representative of the aggregate to be used, shall be taken for tests.

The stabilizer and aggregates for the work shall meet the requirements of the special provisions. The quantity of stabilizer shall be as specified. In the case of emulsified asphalt, the Engineer will determine the quantity of water to be added.

313.3.1 Application of Emulsified or Liquid Asphalt:

(A) The addition of emulsified asphalt shall not be made when the aggregate contains more than 4 percent moisture.

(B) The addition of liquid asphalt shall not be made when the aggregate contains more than 2 percent moisture.

In special cases, when the aggregate is unusually porous, a moisture content in excess of the above may be permitted at the discretion of the Engineer, when laboratory tests indicate that such increased moisture content will not produce an unstable mixture.

313.4 MIXING:

The aggregate and asphalt shall be thoroughly mixed in a central pug mill type mixing plant, or on the roadbed by traveling mixer or blade method. The mixture shall be uniform and contain the percent, by weight or volume of dry aggregate and asphalt as specified. If necessary, water shall be added to the aggregate in a quantity sufficient to completely disperse the emulsified asphalt and produce a plastic mixture free from balled fines or balled asphalt.

313.4.1 Central Plant Mixing: The aggregate and asphalt shall be mixed in a pug mill. Material shall be weighed and mixed in such proportions that the combined aggregates shall meet the grading limits specified.

The asphalt shall be added to the weighed aggregate in the mixer. Additional water, when needed, shall be added simultaneously with emulsified asphalt. Mixing shall continue until the asphalt is uniformly and thoroughly distributed throughout the mass. The minimum mixing time shall be 35 seconds.

313.4.2 Travel Mixing: The traveling mixing machine shall be of the pug type or auger type. The traveling mixer shall have provision for introducing the asphalt and water at the time of mixing through a metering device or other approved method. Both the asphalt and the water shall be applied by means of separate controls which will supply a uniform ratio of asphalt and/or water to the amount of aggregate passing through the mixer, and produce a complete mixture with a uniform moisture content. The controls shall be mechanically synchronized with the forward movement of the mixer. Leakage of asphalt and/or water from equipment will not be permitted and care shall be exercised to avoid the addition of asphalt or water by spilling or any other means not under the control of the Engineer.

Prior to mixing in the traveling mixer, the aggregate shall be placed in such a manner that all the material will be passed through the mixing machine in one mixing operation. If aggregate is brought to the site in separate sizes, each of the sizes in proper amount shall be deposited by means of approved spreading device equipped with a readily adjustable strike off device.

The rate of movement of the mixing machine, the amount of material mixed, and the number of passes shall be so regulated that a mix satisfactory to the Engineer will result. The material shall be mixed so that a uniform mixture of unchanging appearance is obtained and all particles of aggregate are coated with asphalt.

313.4.3 Blade Mixing: Unless otherwise permitted by the Engineer, the aggregate shall be thoroughly blended with the necessary additional water with a blade grader and uniformly spread over the site preparatory to application of the asphalt. Asphalt shall be spread by an approved pressure distributor in the number of applications directed by the Engineer. After each application, the aggregate shall be mixed. As needed, additional water shall be added by pressure distributor in the amount directed by the Engineer. After the final application, the material shall be bladed into a windrow and the windrow bladed back and forth across the site with a heavy blade

grader having a wheelbase not less than 16 feet long, until a satisfactory mixture of uniform and unchanging appearance has been obtained. After having been mixed and deposited in the final windrow, the mixture shall not be allowed to remain in the windrow for more than 24 hours unless otherwise permitted by the Engineer. Mixing equipment must be of a type and in good working condition as approved by the Engineer. The maximum lift for mixing and laying by blade mix methods shall not exceed 1 cubic yard per running foot.

313.5 PLACING THE MIXTURE:

The mixed base material shall be laid and rolled to the thickness shown on the plans in layers not to exceed 4 inches in compacted thickness.

If the aggregate and asphalt have been mixed in a central mixing plant, the treated base material shall be transported to the site in trucks and spread. Dumping in piles on the subgrade will not be permitted. If necessary, spreading shall be completed by blading the mixture to proper cross-section with a self-propelled pneumatic-tired blade grader. An approved spreading, screeding, and tamping machine may be used.

313.6 COMPACTING THE MIXTURE:

Rolling of the mixture shall commence immediatley after it has been placed on the subgrade.

After the specified compaction has been secured in the top layer with the pneumatic-tired rollers, the roadway shall be thoroughly rolled with self-propelled tandem rollers with smooth steel wheels.

Each base course layer shall be rolled until it is compacted and true to grade and cross-section.

Areas inaccessible to the roller shall be compacted by power tamping to the same density as the rolled portion.

The surface of each layer shall be free of foreign material prior to placing the succeeding layer of material.

313.7 FLUSH SEAL:

After the top layer is compacted, cleaned and dried to the percent of moisture required, the surface shall be given a light uniform application of emulsified asphalt. It shall be mixed and applied in accordance with Section 333. After the seal has dried, the base shall be ready for final pavement surface.

313.8 DENSITY AND TOLERANCES:

Rolling shall be continued until at least 100 percent relative density is obtained as per AASHTO T-99, Method A, and T-191 or ASTM D-2922 and D-3017. The thickness of stabilized base compacted in place may deviate not more than ±½ inch from that specified. The surface shall not show any deviation in excess of ¼ inch when tested with a 10 foot straightedge applied parallel with the center line of the roadway.

313.9 DEFICIENCY:

When in the opinion of the Engineer there is reason to believe that a deficiency in thickness exists, cores will be taken in the same pattern as that defined in Section 321.

If the base has been covered or it is otherwise impractical to correct the deficiency, the corrective measures, listed in Table 310 for Type I or II deficiencies, shall be taken by the Contractor at no additional cost to the Contracting Agency.

313.10 MEASUREMENT:

Bituminous treated base course will be measured by the ton or square yard. Measurement by the ton will include imported materials and asphalts. Certified weight slips of all materials shall be delivered to the Engineer before the materials are applied. Measurements for determining the square yard area will be made horizontally unless otherwise specified.

313.11 PAYMENT:

The price bid per ton or square yard for work covered by this section shall include full compensation for all labor, material, and equipment required for the construction complete in place, of bituminous treated base course.

SECTION 315

BITUMINOUS PRIME COAT

315.1 DESCRIPTION:

Bituminous prime coat shall consist of furnishing bituminous material and applying this bituminous material to a prepared base course, in accordance with these specifications.

315.2 MATERIALS:

Bituminous material shall conform to the requirements of Section 712 for the type and grade specified.

315.3 CONSTRUCTION METHODS:

315.3.1 Preparation of Surface: The surface on which the bituminous prime coat is to be placed shall be uniformly smooth and firm and reasonably true to grades and cross-sections as shown on the plans, and shall be so maintained throughout the period of placing the prime coat. In no event shall a prime coat be placed on a soft, uneven base. Any holes, depressions or irregularities shall be repaired by the removal of all loose and unsuitable material and replacement by suitable material, which shall be compacted to produce a dense surface conforming to the adjacent area. Uniformity of surface texture is of the utmost importance.

When required, the surface on which the prime coat is to be placed shall be lightly bladed and rolled immediately prior to the application of bituminous material.

315.3.2 Application of Bituminous Material: Bituminous material shall be applied only when the surface is either slightly damp or dry. For extremely dry areas, a light application of water may be required prior to the application of bituminous material.

The approximate quantity of bituminous material to be used will be specified; however, the exact amount used will be determined by the Engineer at the time of

application. The bituminous material shall be uniformly applied to the prepared surface at the rate so designated and in one application.

The application of bituminous material and distributing equipment shall conform to the requirements of Section 712.

When it is deemed necessary, areas having excess bituminous material shall be blotted with material as directed.

When so directed, the surface of the completed prime coat shall be rolled with a pneumatic-tired roller.

315.3.3 Maintenance of Surface: Traffic shall be kept off the bituminous material until it has penetrated the base or subgrade and cured sufficiently.

The integrity of the prime coat shall be maintained at all times until the next course is placed or until final acceptance. In the event traffic has caused holes or breaks in the surface, such holes or breaks shall be satisfactorily repaired by the Contractor.

315.4 MEASUREMENT:

The accepted quantities of bituminous material for bituminous prime coat will be measured by the ton undiluted for the bituminous material used.

No measurement or direct payment will be made for rolling.

Materials necessary for repair of holes or breaks in the surface after the prime coat has been accepted, when such holes or breaks are caused by traffic other than that of the Contractor, will be measured for payment under the respective contract item for the materials used.

315.5 PAYMENT:

Payment for the bituminous material will be on the basis of the price bid per ton, undiluted, complete in place.

Payment for furnishing, applying and removing blotter material will be paid for as an extra work item.

SECTION 320

ROAD-MIXED SURFACING

320.1 DESCRIPTION:

Road-mixed surfacing shall consist of a mixture of mineral aggregate and bituminous binder mixed on the roadbed or other area, spread and compacted on a prepared subgrade or base course in conformity with the lines, grades, and dimensions shown on the plans or typical cross-section, or as specified in the special provisions.

320.2 MATERIALS:

Materials shall conform to the requirements of Sections 710 and 712 for the type and grade specified on the special provisions.

320.3 PRIME COAT:

When a prime coat is required it shall be applied as specified in Section 315.

320.4 SPREADING AGGREGATE:

The mineral aggregate shall be deposited in a windrow along one side of the roadbed by means of approved spreader box equipped with a readily adjustable strike off device or other suitable equipment. The maximum lift for blade mixing and laying shall not exceed 1 cubic yard per running foot. If the mineral aggregate is delivered to the roadbed in separate sizes, each size of aggregate shall be spread in a windrow of the required quantity for that size of material, after which the windrows of various sizes shall be blended into one windrow alongside of the roadbed.

The aggregate shall be so spread that the windrows will be uniform and equal in size and will contain the proper quantity of material to provide surfacing of the required width and thickness. Care shall be exercised to prevent the aggregate from becoming mixed with earth or shoulder material. Preparatory to applying the liquid asphalt, a portion of the material from the windrow shall be spread uniformly over ½ the width of the roadbed.

Unless permitted by the Engineer, no more aggregate shall be spread on any one day than can be mixed with liquid asphalt within 72 hours. If traffic conditions require, the Engineer may require spread or flattened windrows.

320.5 APPLICATION OF LIQUID ASPHALT:

The temperature of the liquid asphalt, when applied, shall be in accordance with Section 712, and 16 to 22 gallons shall be applied for each cubic yard of road-mix material, in not less than 2 approximately equal applications.

Unless otherwise approved by the Engineer, no liquid asphalt shall be spread when weather conditions are unsuitable, or when the moisture content of the mineral aggregate exceeds 3 percent by weight of the dry aggregate. When the aggregate is unusually porous, the permissable moisture content may be increased and liquid asphalt spread at the discretion of the Engineer, when laboratory tests indicate that such increased moisture content will not produce an unstable mixture.

Liquid asphalt shall be prevented from spraying upon adjacent pavements, structures, guard rails, guide posts, culvert markers, trees and shrubbery, adjacent property and improvements, and other highway improvements or facilities not specifically mentioned herein, or that portion of the traveled way being used by traffic.

320.6 MIXING:

Immediately following each succesive application of liquid asphalt, the surfacing material shall be thoroughly mixed by means of a blade. After the final application, the material shall be bladed into a windrow and the windrow bladed back and forth between the center and the edge of the area to be surfaced with a heavy blade grader having a wheel base not less than 16 feet long, until a satisfactory mixture of uniform appearance is obtained.

Should the mixture show an excess or deficiency of liquid asphalt, or uneven distribution thereof, prior to spreading and compacting, the condition shall be corrected by adding mineral aggregate or liquid asphalt, as the need may be, and remixing the material to produce a satisfactory mixture. If necessary, all compressed masses of material shall be broken up.

After mixing, the material shall be placed in a windrow prior to spreading.

After the material has been mixed as above specified all of the mixed material shall be bladed into a single windrow in the center of the roadbed and the entire mass of treated

material turned not less than 4 complete times by blading first to one side of the road and then to the other.

In lieu of mixing the material as above specified, a road-mixing machine or any equipment other than that required above may be employed which will produce a completed mixture equal to that which would be produced by means above specified. The Engineer reserves the right to order the use of any equipment discontinued which, in his opinion, fails to produce a satisfactory mixture.

Road-mixing machines shall be of the pug mill or auger type or other suitable equipment capable of picking up the loosened material completely from the roadbed, leaving practically no loose material on the ground, and which will introduce the liquid asphalt through a metering device at the time of mixing. The machine shall be equipped with the positive control of the amount of liquid asphalt introduced into the mix which can be readily adjusted to changes in grading of the road material.

The rate of movement of the machine along the roadway, the amount of material mixed and the amount of mixing shall be so regulated that a uniform mixture of unchanging appearance is obtained and all particles of aggregate are thoroughly coated with liquid asphalt. Before mixing on the roadbed the loosened material shall be placed in windrows or in a blanket of uniform cross-section and of such size that all the material in the windrow or blanket can be passed through the mixing machine at each mixing operation. Sufficient material, as determined by the Engineer, shall be placed in windrows or in a blanket in advance of mixing.

No mixed material shall be spread and compacted until the mixture has been approved by the Engineer.

The amount of material mixed on any one day shall not be more than can be spead and compacted on the following day, except that when directed by the Engineer mixed material shall remain in the windrow for a longer period.

Mixing the liquid asphalt with the mineral aggregate prior to delivery on the roadbed will be permitted, provided that the complete mixture is uniform in characer and the same consistency with respect to grading, asphalt content and moisture as that specified for road-mixing.

Liquid asphalt added to mineral aggregate at a central mixing plant shall be accurately weighed by means of dial scales or other approved weighing devices. Liquid asphalt added to mineral aggregate in a traveling mixing plant shall be accurately measured by means of meters or other approved measuring device. Weighing or measuring liquid asphalt being added to mineral aggregate at mixing plants in accordance with the above specified methods shall be for the purpose of properly proportioning the material and not for determining the pay quantities of liquid asphalt.

320.7 SPREADING AND COMPACTION:

Spreading shall be in increments not exceeding 1 inch in thickness.

Rolling shall be continuous throughout the spreading operations until all the loose material has been laid and consolidated.

Segregation of coarse or fine particles shall be avoided and the surfacing as spread shall be free from lumps or pockets of coarse or fine material. Segregated materials or lumps shall be remixed by blading.

After spreading on the roadbed, should the moisture content of the mixture exceed 3 percent it shall be reduced by blading and reblading the mixture and allowing it to dry

before the final spreading. Should blading and reblading of the mixture fail to reduce the moisture content below that above specified, the mixture shall be scarified, turned and respread until the moisture content does not exceed 3percent by weight of the dry aggregate, with the exception, however, that in certain special cases, when the mineral aggregate is unusually porous the permissible moisture content may be increased at the discretion of the Engineer, when laboratory tests indicate that such increase will not result in an unstable mixture.

During blading and rolling, all lumps or compressed masses of the mixture shall be remixed and again rolled. On completion of the blading operations all loose stones shall be swept to the outside of the surfaced area and incorporated with the shoulder material or picked up and disposed of.

The edges of the completed surfacing shall be trimmed uniformly to the required cross-section and width before the shoulders are finally rolled and shaped.

The completed surface, when ready for acceptance, shall be thoroughly compacted, smooth and even, true to grade and cross-section, and free from ruts, humps, depressions, or irregularities. When a 10 foot straightedge is laid on the finished surface and parallel with the center line of the road, the surface shall vary in no place more than ⅛ inch from the lower edge of the straightedge.

Should pneumatic-tired roller be used, the final finishing shall be done with a tandem roller. Sufficient blading and rolling equipment shall be furnished.

Where shown on the plans or specified in the special provisions, road-mixed material shall be placed and compacted around spillway assemblies, drop inlets and manholes outside the area to be surfaced, upon road approaches and connections, over gutter, ditch and dike areas, and over other areas, to the thickness shown on the plans or ordered by the Engineer.

At locations where the surfacing is to be placed over areas inaccessible to the required spreading and compacting equipment or over areas where the use of required spreading and compacting equipment would be impractical, the mixed material may be spread and compacted by other methods when approved or so ordered by the Engineer. Road-mixed surfacing placed on road approaches and connections shall be placed to the thickness and as specified for surfacing to be placed on the roadbed.

After final rolling the finished surface course shall have a density of at least 92 percent of the theoretical maximum density possible to obtain with the same materials in like proportions when computed without voids by specific gravity tests.

320.8 MEASUREMENT:

Measurements for determining the area to be paid for will be made horizontally unless otherwise specified.

320.9 PAYMENT:

Payment for road-mixed surfacing will be made on the basis of the price bid per square yard unless an alternate basis of payment is provided in the proposal. The price bid per square yard shall include the furnishing of all labor, materials, tools, compaction, asphalt and the dressing of the subgrade, or base course necessary to complete the work. Prime coat, when required, will be paid for by the ton, undiluted, complete in place.

SECTION 321

ASPHALT CONCRETE PAVEMENT

321.1 DESCRIPTION:

This item shall consist of leveling, suface and/or base courses and curbs placed upon the previously prepared base or subgrade in accordance with these specifications to the compacted thickness and design shown on the plans or ordered in writing by the Engineer.

321.2 MATERIALS AND MANUFACTURE:

Materials and manufacture shall conform with Section 710 for the type specified.

321.3 WEATHER AND MOISTURE CONDITIONS:

Asphalt concrete shall be placed only when the surface is dry, and when the atmospheric temperature in the shade is 40°F. or above. No asphalt concrete shall be placed when the weather is foggy or rainy, or when the base on which the material is to be placed contains moisture in excess of the optimum. Asphalt concrete shall be placed only when the Engineer determines that weather conditions are suitable.

321.4 TACK COAT:

A bituminous tack coat shall be applied to all existing and to each new course of bituminous surfaces prior to the placing of a succeeding layer of bituminous mixed material. The tack coat may be deleted when a succeeding layer of asphalt concrete is being applied over a freshly laid course that has been subjected to very little traffic when approved by the Engineer.

The tack coat shall consist of a mixing type emulsion SS-1h, as specified in Section 713, diluted in the proportion of approximately 50 percent water and 50 percent emulsion, and applied at a rate of approximately 0.05 to 0.10 gallon per square yard of the diluted material.

The tack coat shall be applied only so far in advance of placing the asphalt concrete as ordered by the Engineer; however, in any event, no more tack shall be applied in any one day than will be covered by the asphalt concrete during the day.

The same material that is specified above for the tack coat shall be applied to the vertical surfaces of existing pavements, curbs, and gutters, against which asphalt concrete is to be placed.

Asphalt treated areas to be surfaced shall be cleaned of all loose material by means of power brooms supplemented by hand brooming or washing if necessary, and patched as required.

321.5 PLACING, SPREADING, AND FINISHING:

Asphalt concrete shall be delivered and placed at a temperature no higher than necessary for placing, finishing and spreading, but shall be high enough to accomplish this work. Tarpaulins shall be furnished and used to cover all loads during transportation if difficulties in spreading, finishing, or compacting, as determined by the Engineer, are experienced and the temperature of the mixture taken at a point 6 inches below the exposed top surface is below 200°F. at the point of delivery in the truck. No free treating fluid shall be present in the truck bodies at the time of asphalt concrete loading.

The handling of the completed mixture shall at all times be such as to prevent segregation, and the material as spread shall be free from areas of excess coarse, or fine material. Float rock developed in the process of raking shall be placed on an underlying course or otherwise disposed of. In no case shall it be scattered over the surface of a final course.

Placing shall begin on pavement at points farthest from the source of supply, and progress continuously toward the source of supply, unless otherwise ordered by the Engineer, and no more than ½ day's delivery to the project shall be placed in any one lane in advance of the other lanes. The end of each lane shall be staggered in relation to the adjacent lane.

At locations where the mixture is to be placed over areas inaccessible to the required spreading or compacting equipment or over areas whre the use of the required spreading and compacting equipment would not be practicable, the mixture may be spread or compacted by other methods as approved by the Engineer.

321.5.1 Base Preparation: The base prepared by the Contractor, on which the asphalt concrete is to be placed, shall be smooth, firm, and true to grade and cross-section as shown on the plans, and shall be so maintained throughout the period of placing asphalt concrete. If necessary, in order to obtain the above specified base condition, and if ordered by the Engineer, a leveling course of asphalt concrete compacted in layers not exceeding 2 inches in thickness or aggregate base shall be spread to level irregularities such as dips, depressions, and sags. All irregularities such as humps or highspots shall be removed in order to provide a smooth base of uniform grade and cross-section, so that subsequent surfacing will be of uniform thickness.

No additional compensation will be allowed for furnishing and placing these materials, and full compensation for all materials and for all work incidental to the correcting of irregularities will be considered as included in the contract price for asphalt concrete.

321.5.2 Spreading and Finishing Equipment: Self-propelled mechanical spreading and finishing equipment shall be provided with a screed or strike off assembly capable of distributing not less than the full width of a traffic lane. The term screed includes any strike off device operating but cutting, crowding, or other practical action which is effective on mixtures at workable temperatures without tearing, shoving, or gouging, and which will produce a finished surface of the smoothness and texture required. The screed shall be adjustable to the required template and elevation. The forward speed of operation of self-propelled mechanical spreading and finishing equipment shall be so regulated that no irregularities will result in the surface texture or smoothness of the mat due to excessive forward speed of the spreading machine. The forward speed of operation shall not exceed 55 feet per minute unless the contractor can demonstrate to the satisfaction of the Engineer that higher speeds will not affect the smoothness of the mat.

Motor graders shall have a wheel base of not less than 16 feet and be equipped with a blade not less than 12 feet long. Motor graders shall be free from appreciable lost motion in the blade control.

Use of spreader boxes will be permitted only under certain conditions, such as in alleys and on narrow paving projects where it is not practical to use a standard blade or laydown machine.

Self-propelled mechanical spreading and finishing equipment shall be equipped with a control system capable of automatically maintaining the screed elevation as specified herein.

The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. When directed, the transverse slope control system shall be made inoperative and the screed shall be controlled by sensor directed automatic mechanisms which will independently control the elevation of each end of the screed from reference lines or surfaces.

The controls shall be capable of working in conjunction with any of the following attachments:

(A) Ski-type device of not less than 30 feet in length.

(B) Taut stringline or wire set to grade.

(C) Short ski or shoe.

The Contractor shall furnish the long ski, the short ski or shoe and all required stakes and wire required for 5000 feet of taut stringline. Should the automatic control system become inoperative during the day's work, the Contractor may be permitted to finish that day's work using manual controls; however, work shall not be resumed thereafter until the automatic control system has been made operative.

When trucks are backed into the paver, it shall be in such a manner that the paver will not be jarred excessively or moved out of line and the trucks shall be securely attached to the paver during spreading and finishing.

When the Engineer deems that the automatic screed control operation is not practical under a particular set of conditions, he may order the use of manual control in lieu thereof. However, the machine shall be equipped with the automatic device.

321.5.3 Leveling Course: A leveling course shall be used when specified, or as directed in writing by the Engineer, to bring existing pavement to a uniform grade prior to placing an overlay or other course.

After the prime coat or tack coat has been applied, the leveling course mixture shall be spread to the proper width and to such depth as will compact to the required thickness. Actual quantities of the mixture required will be determined by the Engineer.

The distance to which a leveling course may be spread in advance of covering it with the following course shall be as ordered by the Engineer.

The leveling course material shall be placed in layers, 2 inches maximum thickness, prior to finishing, by a motor grader, by means of approved spreader boxes equipped with readily adjustable strike off blades, or by means of self-propelled spreading equipment.

Finishing by means of a motor grader shall be done in accordance with the following:

The leveling course shall be placed with a self-propelled pneumatic-tired blade grader equipped with an automatic leveling device capable of accurately maintaining the transverse slope of the blade at a pre-set angle. In lieu of this, the Contractor shall be permitted to use any method at his discretion as long as the finished surface does not vary from the designed surface by more than the amount specified below.

The placing of the leveling course shall be for not less than ½ the street or roadway width at a time, and for the longest practical length for any one lay, preferably not less than 1200 feet.

The spreading of the leveling course in any one lane in this ½ width shall not proceed in advance of the adjacent lane to the extent that cooling of material will not permit proper manipulation with the motor grader.

A pneumatic-tired roller shall be operated concurrently with the operation of the blade during the laydown of the leveling course. Finishing by means of self-propelled mechanical spreading and finishing equipment shall be done in accordance with the following:

In order to obtain a smooth surface, manipulation of controls of the paver shall be at a minimum. Unless otherwise permitted by the Engineer, adjustments shall not be made in less than 50 foot intervals and any adjustment shall not result in a change in thickness of the pavement in excess of ⅛ inch, except where the machine is equipped with electronic grade controls.

Finishing by means of approved spreader box shall be done in accordance with the following:

In order to obtain a smooth surface, manipulation of controls of the spreader box shall be held to a minimum.

Trucks shall be backed into the spreader box in such a manner that the spreader box will not be jarred excessively or moved out of line, and the trucks shall be securely attached to the spreader box during spreading and finishing.

Rolling shall be accomplished by use of a pneumatic-tired roller, and shall proceed concurrently with the laydown of the leveling course.

The leveling course shall be thoroughly compacted, smooth, and true to grade and cross-section, and free from ruts, humps, depressions or irregularities. An acceptable suface shall not vary more than ½ inch from the lower edge of a 25 foot straightedge when the straightedge is placed parallel to the centerline of the roadway. The straightedge shall be furnished by the Contractor and shall be constructed of such lightweight materials that it can be handled by the inspector without assistance.

When deviations in excess of the above tolerance are found, such places as humps; or depressions shall be corrected to meet the specified tolerance. Materials and work necessary to correct such deviations shall be at no additional cost to the Contracting Agency.

321.5.4 Asphalt Base and Surface Course: Asphalt base and surface courses shall be spread and finished by means of self-propelled mechanical spreading and finishing equipment as described and specified above, except that base course material may be laid with a motor grader, if approved in writing by the Engineer. The compacted thickness of layers placed shall not exceed 4 inches for base course or 2 inches for surface course except as otherwise provided in the plans and specifications if approved in writing by the Engineer.

When more than one course is placed, longitudinal joints of each course shall be staggered not less than 6 inches with relation to the longitudinal joints of the underlying course.

Before a surface course is placed adjacent to cold transverse construction joints, such joints shall be trimmed to a vertical face by cutting the material back for its full depth so as to expose a fresh surface. The joint formed when the fresh mixture is placed shall be dense and well sealed. The transverse surface joints shall be tested with a 25 foot straightedge and shall conform to the requirements herein for surface smoothness. An

approved joint heater shall be used on cold transverse or longitudinal joints where conditions are such that it is deemed necessary by the Engineer. The joint heater shall be capable of heating the joint to a minimum temperature of 200°F. for a minimum depth of ¼ inch at a speed commensurate with that of the laydown machine.

If it is deemed necessary by the Engineer to seal the joints, a light coat of asphalt emulsion shall be applied to the exposed edge before the joint is made.

Sufficient rolling equipment shall be furnished to compact and finish satisfactorily the amount of mixture being placed. A minimum of 2 rollers and 2 operators shall be provided for production of 150 tons or less per hour where the thickness of layer to be placed is over 1 inch. Where the thickness of lift to be placed is 1 inch or less, the minimum pieces of rolling equipment shall be 3 rollers consisting, unless otherwise directed by the Engineer, of 1 smooth wheel and 2 pneumatic rollers, and 3 operators. In all cases 1 additional roller and operator shall be provided for each additional 100 tons, or fractional part thereof, per hour. All rollers shall be operated continuously from the breakdown through finish rolling.

In lieu of smooth steel wheel and pneumatic rollers specified herein, the Contractor may utilize one (1) vibratory steel wheel compactor in compaction of asphalt concrete for production of 325 tons or less per hour. In all cases one (1) additional vibratory roller and operator shall be provided for each additional 300 tons, or fractional part thereof, per hour. Vibratory steel wheel compactor shall be self-propelled, with a minimum weight of 8 tons, equipped with an automatic device capable of properly moistening the wheel or wheels without adding an excess of water or other approved material. Vibratory compactor shall be operated with the larger wheel in the forward position. Rolling procedures, surface tolerance and compactive results when utilizing vibratory compactor shall be as specified herein.

The 6 inch strip adjacent to the area on which future material is to be laid shall not be rolled until such material has been placed, but shall not be left unrolled more than 2 hours after being placed, unless the 6 inch unrolled strip is first heated with a joint heater.

After the first strip or width has been compacted, the second width shall be placed, finished, and compacted as provided for the first width, except that rolling shall be extended to include the 6 inches of the first width not previously completed.

All rollers used in compaction of asphalt concrete shall be self-propelled and reversible, with a minimum weight of 8 tons. All rollers shall be equipped with an automatic device capable of properly moistening the wheels without adding an excess of water or other approved material. Pneumatic-tired rollers for use in breakdown rolling shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the rolling process.

Pneumatic-tired rollers shall be of the 2 axle tandem type, having a rolling width of not less than 5 feet. All tires shall be of the same size and shall have treads satisfactory to the Engineer. The roller shall be so constructed that the operating weight per tire shall not be less than 2000 pounds and the tires shall be spaced so that the entire gap between adjacent tires will be covered by the tread of the following tire. Except as otherwise specified, each tire shall be inflated to 90 psi and at all times the air pressure in each tire shall not vary more than 5 psi from the specified pressure.

There shall be 1 pneumatic-tired roller and 1 smooth-wheel power roller on the project at all times. The required rollers shall be on the project and in acceptable operating condition, prior to the placement of any asphalt material.

Breakdown rolling shall begin as soon as the mixture will bear the roller without undue displacement. Rolling shall be longitudinal, overlapping on successive trips by at least ½ but not more than ¾ the width of the rear wheels. Alternate trips of the roller shall be of slightly different lengths. The motion of the roller shall at all times be slow enough to avoid displacement of the mixture. Final compaction and finish rolling shall be done by means of a tandem power roller. Rolling shall continue until the specific gravity of the compacted mixture is not less than 95 percent of the specific gravity of specimens composed of the same materials in similar proportions or composed of the same mixture compacted in the laboratory by the 75 blow method of ASTM D-1559.

At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers and finished, where necesary, with a hot smoothing iron to provide a uniform and smooth layer over the entire area compacted in this manner.

The completed surfacing shall be thoroughly compacted, smooth, and true to grade and cross-section, and free from ruts, humps, depressions or irregularities. An acceptable surface shall not vary more than ¼ inch from the lower edge of a 25 foot straightedge when the straightedge is placed parallel to the centerline of the roadway. The straightedge shall be furnished by the Contractor and shall be acceptable to the Engineer.

When deviations in excess of the above tolerance are found, such places as humps or depressions shall be corrected to meet the specified tolerance, or shall be cut out along neat straight lines and replaced with fresh hot mixture and thoroughly compacted to conform with and bond to the surrounding area. Materials and work necessary to correct such deviations shall be at no additional cost to the Contracting Agency.

In order to alleviate the problem of raveling resulting from oil drippings between wheel paths of automobiles adjacent to stop lights, the surface of the Open Grade G-⅜ course shall be densified by an application of sand at each traffic signal or stop sign on a major street.

The sand application shall be in the amount of 10 to 15 pounds per square yard, and shall be applied immediately after initial rolling of the Open Grade G-⅜ course and then rolled, concurrent with final rolling. The application shall extend through the intersection for the full width, and for 200 feet on each side of the centerline of the intersecting street. Throughout other areas a light application of 2 to 3 pounds of sand shall be applied, after final rolling, to minimize pickup by traffic. The grading for sand shall be as follows:

TABLE 321-1

Sieve Size	Percent Passing
No. 4	100%
No. 8	90–100%
No. 30	40–75%
No. 200	0–10%

321.5.5 Preservative Seal: An asphalt concrete preservative seal shall be used on all new asphalt concrete pavement and shall comply with Section 334. The engineer will make a field determination and provide the actual application rate or delete the requirement. This seal is not required for pavement matching and surface replacement over pipe trenches, etc., unless specified in the special provisions.

321.6 CORRECTIVE REQUIREMENTS FOR DEFICIENCIES:

When, in the opinion of the Engineer, there is reason to believe that the pavement may be deficient in thickness, cores will be taken by the Engineer at random locations, with 1 core for each 8 feet or portion thereof of width and for every 500 feet of lineal distance, with a minimum of 1 core per 8 feet of width between intersecting streets or portions thereof. When a deficiency of more than ¼ inch is found, 2 additional cores will be taken not closer than 100 feet apart nor closer than 100 feet to the original core, and the average of these 3 cores will be used to determine the amount of the deficiency. Further cores may be taken by the Contractor if he so chooses, to determine the limits of the deficiency, and shall be at no additional cost to the Contracting Agency but shall not be used in determining the average thickness of the pavement. Thickness of the cores shall be determined by average caliper measurement. Where pavement thickness if deficient by ¼ inch or less, it will be paid for at the contract price.

Where the pavement is deficient in thickness by more than ¼ inch but not more than ½ inch, payment will be reduced as follows:

TABLE 321-2

Specified Mat Thickness	Reduction in Payment
1″	50%
1½″	33%
2″	25%
2½″	20%
3″ or over	17%

When the deficiency of the pavement thickness exceeds ½ inch, the pavement shall be overlayed on the area affected, but in no case less than one City block or 660 feet whichever is less in length, for the full width of pavement, with a new mat of material specified by the Engineer, equal in thickness to the deficiency but not less than ½ inch in any instance. This is to be done at no additional cost to the Contracting Agency.

The monetary compensation shown in Table 321-2 will apply when a public agency is the Contracting Agency. When the contract is directly with a party other than a public agency, as in the case of permits, etc., the Contractor shall place a precoated chip seal complying with Section 331 when the pavement is deficient by more than ¼ inch but not more than ½ inch in lieu of the monetary consideration. The area covered shall be as specified in the preceeding paragraph.

When the pavement is deficient in thickness by more than ¼ inch, all coring done to establish this premise shall be at the expense of the Contractor.

When, in the opinion of the Engineer, there is reason to believe that the compaction of the mixture is deficient, cores will be taken in the same pattern as that defined in the first paragraph of this subsection, except that the figure 1 percent will be substituted for ¼ inch, and tested for specific gravity.

Where the specific gravity is deficient by 1 percent point or less, it will be paid for at the contract price.

Where the specific gravity is deficient by more than 1 percent point, and the Contractor is unable to correct the deficiency, payment will be reduced as follows:

TABLE 321-3

Deviation Below Specification	Reduction in Payment
2 % points	2%
2 to 3% points	5%
3 to 5% points	10%

When the deviation is more than 5 percent points, the Contractor shall place a standard precoated chip seal complying with Section 331 over the area involved but for not less than one City block or 660 feet whichever is less.

The monetary compensation shown in Table 321-3 will apply when a public agency is the Contracting Agency. When the contract is directly with a party other than a public agency as in the case of permits, etc., the following applies in lieu of the monetary consideration above: When the deviation is 2% to 5% points inclusive, the Contractor shall place a standard pre-coated chip seal complying with Section 331 over the area involved, but for not less than one City block or 660 feet, whichever is less.

When the asphalt cement content exceeds the limits established in Section 710, 2 additional core tests will be made for each deficient test taken, and the average of all 3 tests made shall be used to determine the asphalt cement content.

When the asphalt cement content is in excess of that permitted, the Contractor shall remove any areas of bleeding, but in no case less than the specified roller width, as directed by the Engineer, and replace the affected material with new material meeting the specification requirements for the mix type involved. This shall be done, any time within a period of 1 year until the bleeding has been corrected, at no additional cost to the Contracting Agency. Should the stabiity of the mix be effected by the excess asphalt cement to such an extent that the pavement is displaced under normal traffic loads, within a period of 1 year, the areas affected shall be removed and replaced with new material, at no additional cost to the Contracting Agency.

When the asphalt cement content is from 0.0 to 0.2 percent points, weight of the total mixed material less than the minimum permitted in section 710, payment to the Contractor for asphalt concrete pavement will be reduced as follows:

TABLE 321-4

Deviation from that Permitted	Payment Reduction
0.0 to 0.1% points	2%
Over 0.1 to 0.2% points	5%

When the deviation is more than 0.2 percent points, greater than the permitted deviation, the Contractor shall place a standard pre-coated chip seal complying with Section 331 over the area involved but not for less than one City block or 660 feet whichever is less.

The monetary compensation shown in Table 321-4 will apply when a public agency is the Contracting Agency. When the contract is directly with a party other than a public agency, as in the case of permits, etc., the following penalties apply in lieu of the

monetary considerations listed in Table 321-4. When the deviation is in the range of 0.0 to 0.2% points, not inclusive, greater than the permitted deviation, a separate absorption test shall be made to determine the proper application rate for the preservative seal for this specific section. The Engineer shall make the decision as to the rate of application for this section. When the deviation is 0.2% points or more greater than the permitted deviation, the Contractor shall place a standard precoated chip seal in accordance with Section 331 over the area involved for not less than one City block or 660 feet, whichever is less.

When the mineral aggregate gradation, or plastic index of the aggregate, deviates from the requirements of this specification in an amount which, in the opinion of the Engineer will affect the stability or durability of the mix, the Contractor shall, as directed by the Engineer, either; remove the asphalt concrete and replace it with material which meets the requirements of this specification, or place an additional mat of such thickness and gradation as required by the Engineer which will, in the opinion of the Engineer, correct the deficiency.

The above corrective work, due to deviations from the requirements for mineral aggregate, shall be done at no additional cost to the Contracting Agency.

321.7 CURBS:

The curb shall be placed by an approved extrusion type machine. In the event the Contractor wishes to utilize a template which varies from the cross-section shown on the plans, such change must meet the approval of the Engineer. Mineral aggregate shall be Dense Grade E-⅜, except that the asphalt cement content shall not be more than 7½ percent or less than 7 percent by weight of the total mixture. One percent by weight of the total mixture shall consist of a granulated synthetic resin stiffner, Lexite or equal, complying with the following characteristics:

Softening Point (Ring & Ball)	ASTM D-2398	210°F. minimum
Acid Number	ASTM D-465	Less than 1.00
Saponifiable matter	ASTM D-464	Less than 1%
Iodine Number	ASTM D-29	175–185

321.8 MEASUREMENT:

Asphalt concrete pavement will be measured by the ton, computed to the nearest 0.10 or square yard, for the mixture actually used as allowed above, which shall include the required quantities of mineral aggregates, filler material, asphalt cement, and sand. Measurement shall include any tonnage used to construct intersections, roadways, streets, or other miscellaneous surfaces indicated on the plans or as directed by the Engineer.

Weighmaster's Certificates, in accordance with Section 109, will be provided regardless of method of measurement.

The bid price per ton or square yard for asphalt concrete shall include the cost of the asphalt cement in the percentages as specified in Section 710.

Asphalt concrete curbs will be measured by the linear foot, parallel to the base or foundation, unless otherwise specified.

Preservative seal for asphalt concrete pavement will be measured by the gallon diluted, unless otherwise indicated in the special provisions.

321.9 PAYMENT:

The asphalt concrete measured as provided above, will be paid for at the contract price per ton or square yard, which price shall be full compensation for the item complete, as herein described and specified.

Payment for the SS-1h emulsified asphalt bituminous tack coat will be by the ton, undiluted, based on the rate of application, as directed by the Engineer.

The quantities of preservative seal, measured as provided above will be paid for at the contract bid price per gallon diluted or as specified, which price shall be full compensation for the item complete as herein described or as specified.

No payment will be made for any overrun in quantity of asphalt concrete in excess of 10 percent based on actual field measurement of area covered, design thickness, and a unit weight of 145 pounds per cubic foot. The calculations and payment for overrun will be by individual bid item. To compensate or adjust for a thickness deficiency in an underlying asphalt concrete course, the Engineer may authorize a quantity increase in excess of 10 percent for a subsequent asphalt concrete course. In such cases, the quantity in excess of 10 percent will be paid for at the lowest unit bid price.

Payment for the curbs will be at the contract unit price bid per linear foot, which price shall be full compensation for the curb complete in place, including all necessary labor, equipment and material.

Except as otherwise specified in the special provisions, no separate payment will be made for work necessary to construct miscellaneous items or surfaces of asphalt concrete.

SECTION 322

ASPHALT CONCRETE OVERLAY

322.1 DESCRIPTION:

Asphalt concrete overlay consists of the placing and compaction of plant mix asphalt concrete over existing asphalt concrete paving. The thickness of the overlay shall be as shown on the plans or as specified in the special provisions. Preliminary preparation of existing surfaces will be required except when accomplished by the Contracting Agency, and it is so stipulated in the special provisions. With the exception of those which have been preheated and remixed only, existing surfaces shall receive a tack coat.

322.2 MATERIALS:

The tack coat, asphalt concrete mix and transportation of the mix shall be as specified in Sections 710 and 321, except for the maximum size of aggregate and percentage of binder which shall be as specified in the following paragraph.

322.3 ASPHALT CONCRETE:

The aggregate gradation and percentage of asphalt binder shall be in accordance with Section 710 using Type D-½ for overlay more than 1 inch in thickness and Type E-⅜ for overlay 1 inch or less in thickness, unless otherwise shown or specified in the special provisions.

SECTION 322

322.4 PREPARATION OF SURFACES:

Except when they have been preheated and remixed, surfaces shall be prepared as follows:

Before placing asphalt concrete overlay, severely raveled areas or cracked areas that are depressed more than ¾ inch from the adjoining pavement shall be cut out and patched at least 48 hours prior to the resurfacing operation. Over-asphalted areas or rough high spots shall be removed by burning or blading. Large shrinkage cracks shall be filled with asphalt sealing compound acceptable to the Engineer. The entire surface shall be cleaned with a power broom. Raveled areas that do not require removing shall be cleaned by hand brooming. The above are incidental, and the cost thereof shall be included in the bid items.

After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat as specified in Section 321. Traffic will not be permitted over surfaces which have received a tack coat. When the overlay is to extend onto the concrete gutter, the gutter shall be thoroughly cleaned of loose dust and cement particles and shall be tack coated.

322.5 CONSTRUCTION METHODS:

Placing and rolling of the asphalt concrete and the smoothness of the surface shall be as specified in Section 321.

322.6 MANHOLES:

Manholes shall be built up and the frames set flush with the finished surface of the new paving, and tops of valve boxes, clean-outs and other existing structures shall be adjusted to finish grade. In the event the base course and original paving have been removed or disturbed in order to build up the manhole, they shall be replaced with approved materials which shall be thoroughly compacted. The asphalt concrete around the manhole frame shall be completed and made flush with the adjacent overlay.

322.7 PAYMENT:

Payment for tack coat and asphalt concrete will be as specified in Section 321 except as noted above.

SECTION 323

HEATER REMIX RESURFACING

323.1 DESCRIPTION:

Heater remix resurfacing consists of heating and remixing existing asphalt concrete paved surfaces, and unless otherwise specified in the special provisions, followed by the application of a rejuvenating agent and an asphalt concrete overlay.

323.2 COORDINATION:

There shall be close coordination between those performing the heating and remixing operation and those placing the asphalt concrete overlay.

323.3 WEATHER CONDITIONS:

Heater remix resurfacing shall not be done when it is raining or there is a threat of rain. The ambient temperature shall be at least 50°F. and rising and the application shall cease when the temperature is 55°F. and falling.

323.4 SURFACE PREPARATION:

The pavement to be treated shall be cleaned of trash, debris, earth or other deleterious substances present in sufficient quantity to interfere with the work to be performed.

323.5 HEATER REMIX EQUIPMENT:

The heater remixer shall consist of an insulated 8–12 foot minimum adjustable width heating furnace chamber with ports to inject fuel and air for satisfactory combustion without excessive smoke. The use of highly volatile fuels for heating, such as gasoline, will not be permitted within the boundaries of any incorporated City. Use of said highly volatile fuels for heating may be permitted in unincorporated areas only if authorized in writing by the Engineer prior to such use. The burners shall be rated at 10,000,000 BTU per hour minimum. The hourly production shall be not less than 1100 square yards of heated and remixed surface. Movable exhaust ducts shall be provided and equipped with shields to protect trees and adjacent shrubbery. The heating chamber and scarifier shall be positively controlled by side shifting and rear wheel steering to heat areas divergent from the central axis of the machine at intersections and along existing structures. The scarifier shall be sectioned and spring tensioned to insure continuous and undiminished pavement contact. It shall be equipped with automatic release mechanism to protect manholes and valve boxes from damage.

323.6 HEATING AND REMIXING:

Prior to heating and remixing, all manholes in the path of the heater shall be checked for presence of explosive gases and ventilated, if necessary. The existing surface shall be evenly heated and remixed to a depth of from 0.05 to 0.08 foot by a continuously moving surface heater remixer machine. The remixed surface shall be left in an evenly spread condition and aggregate shall not be pulverized, spalled or broken. At least 80 percent of the aggregate shall be remixed by spinning or tumbling and heated to a minimum temperature of not less than 250°F. measured within 3 minutes following heating. The asphalt binder shall not be charred in excess of 0.10 of 1 percent. No uncontrolled heating causing differential softening of the upper surfaces without affecting the underlying structure will be permitted. The remixed layer shall be uniformly and evenly heated throughout. Following the mixing operation, an asphalt rejuvenating agent, or emulsion, if required, of the type designated in the contract, shall be applied at the rate hereinafter specified, by a pressure distributor while the remixed material is still hot. The pressure distributor shall be as specified in Section 712.

323.7 ASPHALT REJUVENATING AGENTS:

Where the contract requires the use of an asphalt rejuvenating agent, or emulsion, it will designate one of the following types:

(A) Type I asphalt rejuvenating agent, a cationic oil and resin emulsion, shall comply with Section 718 and shall be applied at the rate of 0.07 to 0.15 gallons of undiluted concentrate per square yard. However, the exact quantity shall be as directed by the Engineer.

The Contractor shall furnish the Engineer with the brand name and name of the manufacturer of the Type I asphalt rejuvenating agent he proposes to use and the material shall be approved by the Engineer before it is used. The Contractor shall also furnish the Engineer with a manufacturer's certificate of compliance indicating quality and specification control.

(B) Type II asphalt emulsion shall be SS-1 or SS-1h emulsified asphalt as specified in Section 713 and shall be applied at the rate of 0.10 to 0.20 gallons per square yard undiluted. However, the exact quantity shall be as directed by the Engineer.

323.8 ASPHALT CONCRETE OVERLAY:

Asphalt concrete overlay shall be in accordance with applicable requirements specified in Section 322.

The asphalt concrete overlay shall be placed within 48 hours after the heating and remixing operation, unless otherwise specified in the special provisions.

The overlay shall cover existing pavement over areas not accessible to the heater remixer. Such areas including edges of adjoining concrete, shall receive a tack coat and joints shall be finished as specified in Section 321.

323.9 PAYMENT:

Payment for heater remix surfacing will be made on the basis shown below:

(A)	Heater Remix Only	Square Yard
(B)	Type I Asphalt Rejuvenating Agent	Ton (Undiluted)
(C)	Type II Asphalt Emulsion	Ton (Undiluted)
(D)	Asphalt Concrete Overlay	Ton or Square Yard
(E)	Tack Coat	Ton (Undiluted)

SECTION 330

CHIP SEAL COAT

330.1 DESCRIPTION:

Chip Seal coat in bituminous paved surfaces shall consist of the application of liquid or emulsified asphalt and screened aggregate.

330.2 TIME OF APPLICATION AND WEATHER CONDITIONS:

Chip seal coat shall not be applied for at least 30 calendar days after completion of new bituminous paving.

When a fog seal is required on new pavement, it shall be applied at least 4 days before the application of the chip seal coat. The fog seal shall be as specified in Section 333. Sand blotter will not be required.

The liquid or emulsified asphalt shall be applied only when the surface is dry and there is no threat of rain. The ambient temperature at the time of application of the asphalt shall be at least 70°F. and rising and the application shall cease when the temperature is 75°F. and falling.

330.3 MATERIALS:

330.3.1 Liquid Asphalt or Emulsified Asphalt: Unless otherwise specified in the special provisions, liquid asphalt shall be type RC and grade as directed by the Engineer and as specified in Section 712. Emulsified asphalt shall comply with grade CRS-2h as specified in Section 713.

330.3.2 Aggregate: The aggregate shall conform to Section 716, ¼ inch nominal size.

Aggregate shall not contain more than 2 percent moisture when liquid asphalt is used. It shall be wet but free from running water when emulsified asphalt is used.

330.4 PREPARATION OF SURFACES:

Immediately before applying the asphalt the area to be surfaced shall be cleaned of dirt and loose material by means of power brooms, supplemented by hand brooms, if necessary. The asphalt shall not be applied until an inspection of the surface has been made by the Engineer and he has determined that they are suitable for application of the asphalt.

330.5 APPLICATION OF ASPHALT:

The asphalt shall be applied as soon as possible after preparation of surfaces. At the time of application, temperatures of the asphalt shall be as directed by the Engineer, within the ranges specified in Sections 712 and 713. The quantity of liquid asphalt shall be between 0.20 and 0.25 gallons per square yard and between 0.25 and 0.35 gallons per square yard for emulsified asphalts. The exact quantity shall be as directed by the Engineer. The asphalt shall be applied by means of a pressure distributor as specified in Section 712 and shall be so applied that uniform distribution is obtained at all points of the surface to be sealed. Unless the distributor is equipped so as to obtain satisfactory results at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application so that flow through the sprays may be started and stopped on the paper, and so that all sprays will be operating at full force on the surface to be treated. Immediately after the application, the building paper shall be removed. Any spots missed by the distributor shall be properly treated with a hand spray.

330.6 PLACING AGGREGATE:

The aggregate shall be uniformly and immediately spread over the asphalt and in no case more than 3 minutes after application of the asphalt. Spreading shall be by means of a self propelled continuous feed chip spreader. The quantity of aggregate to be placed shall be between 20 and 25 pounds per square yard and shall be increased or decreased within this range as directed by the Engineer. In any event, the aggregate shall be uniformly placed in sufficient quantities to prevent pick up. Areas having insufficient cover shall be back-spotted or sprinkled with additional aggregate by hand during the operations whenever necessary.

330.7 ROLLING AND BROOMING:

Rolling with pneumatic rollers shall begin immediately after sufficient aggregate is spread to prevent pick up, and continue until at least 4 complete coverages have been obtained. Each roller shall weigh not less than 8 tons. The number of rollers required

shall be as specified in the special provisions. Surplus aggregate shall be swept off the surface and stockpiled in the location indicated on the plans or as directed by the Engineer prior to final acceptance. In no event shall surplus aggregate be left on the pavement for more than 2 days.

330.8 PROTECTION TO ADJACENT PROPERTY:

Care shall be taken to prevent the spraying of asphalt upon adjacent pavements and that portion of the pavement being used for traffic, on structures, guard rails, guide posts, markers, trees, shrubs, and adjacent property, improvements and facilities of all kinds. All structures, such as detector boxes, manhole covers, etc., within the paved area shall be protected by the application of paper or oil treated as directed by the Engineer.

330.9 PROTECTON AGAINST TRAFFIC:

Traffic of all types shall be kept off the seal coat until it has had time to set properly and the minimum period shall be 3 hours. Necessary Contractor's equipment shall not exceed a speed of 15 miles per hour over seal coat during the setting period.

330.10 MEASUREMENT:

Certified weight slips of all material shall be delivered to the Engineer before the materials are applied. Certified weight slips of any material being weighed back in for credit shall be delivered to the Engineer before starting the next days work.

330.11 PAYMENT:

Payment for chip seal coat will be made on the basis shown below. Materials placed in the absence of the inspector, or material rejected due to improper placing, improper proportioning or found to be defective, will not be paid for.

(A)	Asphalt Cement	Ton
(B)	Stone Chips	Ton

SECTION 331

PRECOATED CHIP SEAL

331.1 DESCRIPTION:

This work shall consist of one application of bituminous material, followed by an application of precoated stone chips, smoothed and compacted, on existing pavement, in accordance with this specification.

The precoated chip seal construction shall conform to the widths shown on the plans, stated in the special provisions, or as designated by the Engineer.

331.2 CONSTRUCTION METHODS:

All surfaces to be chip sealed shall be cleaned, patched, and given a bituminous tack coat prior to sealing. The tack coat shall consist of a mixing type emulsion SS-1h, diluted to approximately 50 percent water and 50 percent emulsion, and applied at a rate of approximately 0.10 gallons per square yard of the diluted material. The exact rate of application and percentage of dilution shall be as directed by the Engineer.

Asphalt cement binder shall be applied to the pavement surface at a rate of 0.20 to 0.22 of a gallon per square yard when using the ¼ inch nominal sized chip and 0.29 to 0.31 of a gallon per square yard when using the ⅜ inch nominal sized chip, based on an asphalt temperature of 60°F. The exact rate will be set by the Engineer as required by existing conditions.

The grade of asphalt used shall be dependent upon ambient temperature conditions and traffic volume and speed. In general, the following table shall apply except that for high volume and/or high speed traffic, AR-8000 grade only shall be used.

TABLE 331

Min. Pavement Temp. F.	Min. Ambient Temp. F.	Asphalt Grade	Asphalt Application Temp. F.
85°	70°	AR-8000	325° to 375°
85°	70°	AR-4000	375° to 450°

Any binder applied in excess of the maximum limits provided by this specification for the respective materials shall be at no additional cost to the Contracting Agency.

The bituminous binder shall not be applied in advance of spreading the precoated stone chips over a greater distance than can be finished before setting of the binder occurs. The distance over which the binder is spread in advance of spreading chips shall be determined by the Engineer.

The pavement temperature shall be taken with a standard pavement thermometer in either the sun or the shade, depending upon which condition is the controlling factor at the time of application as determined by the Engineer. When required pavement temperatures prevail for only a few hours during the day, kerosene or other approved diluent shall be added to the asphalt binder to facilitate wetting of the aggregate with the binder. The kerosene shall be in the amount of 3 to 6 percent, by volume, of the asphalt binder as directed by the Engineer.

The surfaces of structures, trees and shrubbery adjacent to the areas being seal coated shall be protected in such a manner as to prevent their being spattered with bituminous material or marred. The Contractor shall be responsible for all damage to such structures, trees and shrubbery, and excessive amounts of material splashed on the existing structures shall be removed by the Contractor.

Immediately following the application of the binder material, precoated stone chips shall be spread with a self-propelled mechanical spreader similar and equal to a Flaherty Spreader. The self-propelled requirement may be waived for projects involving less than 10,000 square yards.

Prior to placing, the stone chips shall be heated and precoated with asphalt cement. The quantity of the bituminous material used in the precoating shall be not over 0.75 percent of the combined weight of the bituminous material and the chips. The final percentage quantity of asphalt used for coating shall be as directed by the Engineer. The precoating shall be done in a pug mill type mixing facility for a minimum of 50 seconds or until the aggregate is thoroughly coated, whichever is greater. The end result shall produce a uniformly coated, dust free product. The heated and precoated

aggregates shall be within a temperature range of between 290°F. and 350°F. at the time of placing on the pavement. Canvas, or similar covers, that completely cover each load shall be used whenever it is found that the temperature of the top 3 inches of the chip load is dropping below the minimum requirement at the time of application.

Stock piling or reheating of chips after precoating shall not be permitted.

The precoated stone chips shall be applied at a rate of 17 to 19 pounds per square yard of the ¼ inch nominal size or 25 to 27 pounds for the ⅜ inch nominal size as directed by the Engineer.

Any precoated chips spread in excess of the maximum limits provided by this specification for the entire number of square yards sealed, shall be at no additional cost to the Contracting Agency.

Immediately following the application of the stone chips, the surface shall be rolled with pneumatic-tired rollers. Four complete coverages shall be made with each pneumatic roller. Each roller shall carry a minimum of 5000 pounds on each wheel and a minimum of 100 psi in each tire, and shall not travel in excess of 4 miles per hour. The minimum number of rollers shall be 3 self-propelled pneumatic rollers, except that one roller will be acceptable for projects involving less than 10,000 square yards, provided it performs a comparable number of coverages.

When so directed by the Engineer, within 48 hours after application of the precoated chips all chipped surfaces on major streets shall receive a flush coat. The flush coat shall consist of a mixing type emulsion, SS-1h, undiluted and applied at a rate of approximately 0.10 gallons per square yard. The exact rate of application shall be as directed by the Engineer.

Traffic control will be covered in Section 401 and the special provisions where required.

331.3 MEASUREMENT:

Certified weight slips of all materials shall be delivered to the Engineer before the materials are applied.

Certified weight slips of any bituminous material being weighed back in for credit, shall be delivered to the Engineer before starting the next day's work.

331.4 PAYMENT:

Quantities of materials for this work will be paid for at the contract price for each of the following pay items, as indicated in the proposal:

(A) SS-1h Emulsified Asphalt	Ton (Undiluted)
(B) Asphalt Cement	Ton
(C) Precoated Stone Chips, Heated	Ton
(D) Kerosene	Gallon

Payment shall be full compensation for furnishing and placing all materials specified in the proposal, with no allowance for waste, and shall include labor, equipment, tools, and incidentals necessary to complete the work as prescribed and as directed by the Engineer.

Asphalt cement for precoating chips will be included in the price per ton for precoated stone chips, except that if the Engineer orders precoating material in excess of 0.75 percent of the combined weight of the bituminous material and the chips, the additional asphalt required will be paid for at the unit price bid for the item under asphalt cement.

Materials placed in the absence of the inspector, or materials rejected due to improper placing, improper proportions of materials or materials found to be defective, will not be paid for.

SECTION 332

SLURRY SEAL COAT

332.1 DESCRIPTION:

Slurry seal shall be a mixture of asphalt emulsion, mineral aggregate, mineral fillers, and water properly proportioned, mixed, and spread on the pavement surface in accordance with this specification or as directed by the Engineer.

332.2 MATERIALS:

The bituminous material and mineral aggregates shall be as specified in Section 715.

(A) Type I — This is the recommended type for thin applications and for airfield usage.

(B) Type II — This is the recommended type when surfaces contain shallow voids and when it is desired to provide a minimum wearing surface.

(C) Type III — This is the recommended type for use on roads where it is intended to provide a moderate wearing surface.

Care shall be exercised to prevent segregation of aggregate in storage and handling; if segregation occurs, the material shall be rehandled, prior to mixing, in a manner to correct the segregation.

332.3 DETERMINATION OF JOB MIX:

Trial mixes shall be prepared to determine proportions. Measured wear on accepted trial mix shall not exceed 25 percent when tested by California Test Method No. 355A. Surface texture, tackiness and mix segregation shall be acceptable to the Engineer. Samples of materials to be used on the job shall be used to determine job mix and shall be available in sufficient quantity to produce not less than 30 pounds of emulsified asphalt slurry mixture. The mixture shall have the following characteristic: the dehydrated slurry tested shall not pick up on the roller.

332.3.1 Fluidity: The mixture shall be sufficiently free flowing to fill cracks in the pavement. This shall be accomplished by the addition of water as required.

332.3.2 Non-segregation: The mixture shall not segregate during or after laydown.

332.3.3 Surface Texture: The mixture shall have a non-skid texture.

To establish a starting point for the amount of bituminous material to be added in the trial mix, the percent of residual asphalt may be established by use of the following formula in lieu of the C.K.E. procedure. California Test Method No. 303.

$$P = .03a + .06b + .5c$$

Where P=Percentage of residual asphalt by weight

a=Percentage aggregate retained on No. 8 sieve

b=Percentage aggregate passing No. 8 sieve and retained on No. 200 sieve

c=Percent of aggregate passing No. 200 sieve

332.3.4 Trial Applications: The Contractor shall place a test strip of 60 square yards in the area designated by the Engineer. The test sections shall be placed using the same equipment and methods as will be used on the job. Slurry mixtures placed in test strips shall conform to design mix with minor variations to obtain crack filling, bond to pavement and desired skid resistant texture. In the event that the materials do not meet the requirements for fluidity, non-segregation, or surface texture, a new job mix shall be formulated and tested. Work shall not proceed before approval of a design mix and acceptance following the placing of a test strip.

332.4 EQUIPMENT:

Equipment used in the performance of the work shall be subject to approval by the Engineer and shall be maintained in satisfactory working condition at all times.

Descriptive information on the slurry mixing and applying equipment to be used shall be submitted for approval not less than 7 days before the work starts.

332.4.1 Mixer: The slurry mixing machine shall be a continuous flow mixing unit and be capable of delivering accurately a predetermined proportion of aggregate, water, and asphalt emulsion to the mixing chamber and to discharge the thoroughly mixed product on a continuous basis. The aggregate shall be prewetted immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all ingredients together. No excessive mixing shall be permitted.

The mixing machine shall be equipped with an approved fines feeder that provides an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer at the same time and location that the aggregate is fed. The fines feeder shall be used whenver added mineral filler is a part of the aggregate blend.

The mixing machine shall be equipped with a water pressure system and fog type spray bar adequate for complete water fogging of the surface preceding spreading equipment with an application of 0.05 to 0.10 gallon per square yard.

Sufficient machine storage capacity to mix properly and apply a minimum of 5 tons of the slurry shall be provided. Proportioning devices shall be calibrated prior to placing slurry seal.

332.4.2 Self-contained Slurry Machine: The machine shall be capable of rapid discharge of the mixed materials into a spreader having suitable controls to allow

adjustment for variations in pavement grades and slope. The spreader shall be similar to the spreader box specified below. The spreader box may be either an integral part of self contained slurry machine or a separate towed unit.

The self-contained slurry unit shall be mounted on a truck or other vehicle capable of producing evenly controlled low rates of speed throughout the operation so that the slurry is spread evenly and all cracks are filled.

332.4.3 Slurry Spreading Equipment: Attached to the mixer machine shall be a mechanical type squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry from the distributor. It shall be maintained to prevent loss of slurry on varying grades and crown by adjustments and baffles to assure uniform spread. There shall be a lateral control device and a flexible strike off. The spreader box shall have an adjustable width. The box shall be kept clean, and built-up asphalt and aggregate on the box shall not be permitted. The use of burlap drags or other drags may be approved by the Engineer.

332.4.4 Rollers: Rollers shall be smooth pneumatic-tired, self-propelled or towed type. Rollers shall have a weight of not less than 2000 pounds per wheel and shall have not less than 7 wheels, so spaced that the gap between adjacent tires will be covered by the tread of the following tire. Tires shall be inflated to a minimum of 50 psi. The rollers shall be equipped with water tanks and sprinkler apparatus which shall be used to keep the wheels damp and prevent adherence of the bituminous materials to the wheels. Steel wheeled rollers may be used in supplementary capacity if required by the special provisions.

332.4.5 Cleaning Equipment: Power brooms, power blowers, air compressors, water flushing equipment, and hand brooms shall be suitable for cleaning the surface and cracks of the old surface.

332.4.6 Hand Tools: Hand squeegees, shovels, and other equipment shall be provided as necessary to perform the work.

332.5 CONSTRUCTION METHODS:

332.5.1 General Requirements: The slurry seal shall be applied only when the existing surface is free from puddles of water. Slurry seal shall not be applied when the pavement is wet and shall be applied only when the atmospheric temperature is at least 70°F. and rising, unless otherwise directed. The slurry seal surface shall consist of a mixture of emulsified asphalt, mineral aggregate, mineral filler if required, and water, properly proportioned, mixed, and spread evenly on the surface as specified and as directed. The cured slurry shall have a homogeneous appearance, fill all cracks, adhere firmly to the surface and have skid resistant texture.

332.5.2 Preparation of Surface: Immediately prior to applying the slurry, the surface shall be cleaned of all loose material, including dust, vegetation, and any objectionable material. Any standard cleaning method used to clean pavements will be acceptable, except water flushing will not be permitted in areas where a considerable number of cracks are present in the pavement surface. The Engineer shall give final approval of the acceptability of the surface.

All surfaces shall be cleaned of dirt, clay, or other objectionable material by means of power brooms or blowers, or other approved equipment supplemented with hand

brooms. Surface cracks shall be cleaned and blown out with compressed air, 90 psi at the nozzle, immediately before sweeping or vacuum operations.

332.5.3 Tack Coat Application: Following the preparation for sealing and 2 to 24 hours prior to the application of slurry seal, a tack coat application conforming to Section 321, shall be applied with a distributor at the rate of 0.05 to 0.10 gallon diluted, per square yard of surface.

332.5.4 Mixing of Slurry: The mixing shall be sufficient to produce a uniform mixture, but it shall not continue for more than 4 minutes. If breaking, hardening, segregation, balling, or lumping occurs during the mixing process, the batch shall be discarded.

Suitable methods such as barricades, flagmen, pilot cars, etc., shall be used to protect the uncured slurry surface from all types of traffic. The Engineer shall have final approval of the method used. Any damage to the uncured slurry shall be the responsibility of the Contractor.

332.5.5 Application of Slurry Seal: No mix shall be spread if there is a possibility of rain before the mix has dried, or during periods of abnormally high humidity.

The surface shall be fogged with water directly preceding the spreader. The slurry mixture shall be of the desired consistency when deposited on the surface and no additional elements shall be added. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that complete coverage is obtained.

No segregation of the emulsion and aggregates fines from the coarse aggregate will be permitted. No streaks such as caused by oversized aggregate will be left in the finished pavement. No excessive build-up nor unsightly appearance shall be permitted on longitudinal or transverse joints. Approved squeegees shall be used to spread slurry in areas inaccessible to the slurry mixer. Care shall be exercised in leaving no unsightly appearance from hand work. Treated areas will be allowed to cure until such time as the inspector in charge permits their opening to traffic.

Burlap bags, jute mats, or carpeting suitable to smooth longitudinal joints or laps of adjacent lanes of slurry application shall be provided and shall be used if ordered by the Engineer.

As soon as the asphalt slurry has set sufficiently to prevent any material being picked up, it shall be rolled by a minimum of 4 complete coverages, as directed. Rolling shall continue until all ridges have been ironed out and a uniformly smooth surface is obtained. The slurry seal shall be protected from traffic by barricades and markers for at least 4 hours and longer when the weather condition and thickness of the slurry seal require additional time for proper drying.

332.6 MEASUREMENT:

Quantities of materials for this work will be paid for at the contract price per unit of measurement for each of the following pay items, as indicated in the proposal:

(A) Bituminous Tack Coat	Ton (Undiluted)
(B) Emulsified Asphalt for Slurry	Ton (Undiluted)
(C) Fine Aggregate	Ton
(D) Specified Mineral Filler	Ton

332.7 PAYMENT:

Payment shall be full compensation for furnishing, mixing and placing all materials specified in the proposal, with no allowance for waste, and shall include all labor, equipment, tools, water for dampening the pavement, and incidentals necessary to complete the work as prescribed and as directed by the Engineer.

Any slurry placed in the absence of the Engineer, or any slurry rejected due to improper placing, improper proportion of materials or materials found to be defective, will not be paid for.

Payment for all measures necessary to direct and escort traffic through the area being sealed will be made as specified under Section 401, and the special provisions where required.

SECTION 333

FOG SEAL COATS

333.1 DESCRIPTION:

Fog seal coats on bituminous paved surfaces shall consist of the application of emulsified asphalt, grade SS-1h, and a sand blotter when necessary, or when directed by the Engineer.

333.2 TIME OF APPLICATION AND WEATHER CONDITIONS:

Fog seal coats on new pavements shall be applied the same day the bituminous paving is completed or as soon thereafter as possible.

Emulsified asphalt shall be applied when the surface is dry or damp, but not wet and when there is no threat of rain. The ambient temperature shall be at least 50°F. and rising and the application shall cease when the temperature is 55°F. and falling.

333.3 MATERIALS:

333.3.1 Emulsified Asphalt: Unless otherwise specified in the special provisions, emulsified asphalt shall be grade SS-1h as specified in Section 713, diluted with a minimum of 1 part of water to 1 part of emulsified asphalt.

333.3.2 Sand Blotter: The sand shall be as specified in Section 701 and shall be graded in accordance with the following sieve analysis:

TABLE 333

Sieve Size	Percentage Passing (by weight)
3/8"	100%
No. 4	90 - 100%
No. 200	0 - 12%

SECTION 333

333.4 TESTS, TEST REPORTS AND CERTIFICATES:

Asphalt emulsion shall be tested as specified in Section 713.

Test reports and certificates shall be as specified in Section 711.

333.5 PREPARATION OF SURFACES:

Immediately before applying the emulsion, the area to be surfaced shall be cleaned of dirt and loose material by means of power brooms, supplemented by hand brooms if necessary, except that when the fog seal is applied within 24 hours from the time a bituminous paving is completed, the brooming may be omitted provided the condition of the surface is approved by the Engineer. In any case, the seal coat shall not be applied until an inspection of the surfaces has been made by the Engineer and he has determined that the surfaces are suitable for application of the emulsion.

333.6 APPLICATION OF ASPHALT EMULSION:

The diluted material shall be well mixed before applying. It shall be applied by a distributor truck equipped with fog nozzles, at the approximate rate of 0.10 gallon per square yard. The exact rate shall be as directed by the Engineer. The distributor truck shall be as specified in Section 712.

333.7 SAND BLOTTER:

After the asphalt emulsion has cured to such extent that the emulsion will not be picked up by traffic, a sand blotter shall be applied as directed or required by the Engineer where there is an excess of asphalt. After the treated area has been opened to traffic, any excess asphalt emulsion that comes to the surface shall be immediately covered with additional sand.

333.8 PROTECTION TO ADJACENT PROPERTY:

Care shall be taken to prevent the spraying of asphalt emulsion on adjacent pavements and that portion of the pavement being used for traffic, on structures, guard rails, guide posts, markers, trees, shrubs, and adjacent property, improvements and facilities of all kinds.

333.9 PROTECTION TO SEAL COAT:

The seal coat shall be protected by barricades until the Engineer directs that the pavement is to be opened to traffic.

333.10 PAYMENT:

Payment for asphalt emulsion in place will be by the ton, undiluted.

Payment for furnishing and applying sand blotter in place will be paid for as an extra work item.

SECTION 334

PRESERVATIVE SEAL FOR ASPHALT CONCRETE

334.1 DESCRIPTION:

The asphalt concrete preservative seal shall be composed of a petroleum resin-oil base uniformly emulsified with water.

The asphalt concrete preservative seal shall be used on all new asphalt concrete pavement construction* except where deleted by the Engineer as set forth in these specifications.

*NOTE: This preservative seal is not required where asphalt concrete pavement is replaced over pipe trenches, etc.

334.2 MATERIALS:

The preservative seal shall be as specified in Section 718.

334.3 CONSTRUCTION METHODS:

The material shall be diluted in the ratio of 2 parts of the emulsion to 1 part of water, by volume, and the diluted material applied to the newly constructed asphalt concrete surface at the rate of .05 to .10 of a gallon per square yard, the actual amount to be determined by actual tests on the pavement.

No increase or decrease in the above limiting application shall be made without the approval of the Engineer.

334.4 CONSTRUCTION SEAL:

The application on residential streets shall be made within 1 week after the placing of the asphalt concrete surface course and shall be made on major streets, or residential streets subjected to heavy hauling traffic, within 24 hours after the placing of the asphalt concrete surface course.

The Enginer may authorize limited extensions of these periods in order to meet essential traffic demands. In general, the preservative seal shall be placed as soon as possible after the placing of the asphalt concrete surface course. The purpose of this is to prevent the sealing of the surface by the action of traffic, which reduces the absorption of the preservative emulsion.

Before opening a treated area to traffic, it shall be tested for slipperiness by skid tests on the surface. If the treated portion of the roadway must be opened to traffic prior to the disappearance of slipperiness, the surface shall be slightly sanded with approximately 1½ pounds per square yard of sand to eliminate this slippery condition. No more sand shall be used than necessary, and amount specified shall not be increased without prior approval of the Engineer. All approaches to high volume signalized intersections shall be lightly sanded before opening to prevent pick up by waiting vehicles. Sand blotter shall comply with Section 333.

334.5 MEASUREMENT:

This is a contingent item when used as a construction seal, and may be eliminated altogether, without compensation, if tests on the surface in question indicate that the material will not be absorbed within the time prescribed in the test procedure.

Preservative seal for asphalt concrete will be measured by the gallon diluted, unless otherwise indicated in the special provisions.

334.6 PAYMENT:

Payment will be made at the unit price bid in the proposal, and such payment shall be full compensation for this item complete in place, including furnishing and hauling material and all other work incidental thereto for which no specific pay item is provided in the proposal.

Sand, when required by the Engineer, will be paid for as an extra work item except that if asphalt concrete preservative seal is not placed within time limits set forth herein, the required sanding shall be at no additional cost to the Contracting Agency.

SECTION 335

HOT ASPHALT-RUBBER SEAL

335.1 DESCRIPTION:

This item shall consist of the placing of a hot paving grade asphalt and ground tire rubber combined with heat into a viscoelastic composition. After application, it shall be immediately covered with a cover aggregate.

The work involves furnishing and placing all materials on existing pavement surfaces in accordance with the following specifications.

335.2 MATERIALS:

The asphalt, granulated rubber shall comply with Section 717. The cover aggregate shall comply with Section 716.

335.3 EQUIPMENT:

The equipment used by the Contractor shall include a power broom for sweeping joint edges and a self-propelled aggregate spreading equipment equipped with a classifying screen for dust control that can be so adjusted as to spread accurately the given amounts per square yard. Three pneumatic-tired rollers shall be used. Each roller shall carry a minimum of 5,000 pounds on each wheel and a minimum of 100 psi in each tire and shall not travel in excess of 4 miles per hour. There shall also be a self-powered pressure distributor equipped to pump the specified material at the specified rate. Distributor equipment shall include full circulation spray bars, equipment for heating bituminous material, a tachometer, pressure gages, volume measuring devices, and a themometer for reading temperatures of tank contents. The spray bars on the distributor shall be controlled by one or more bootmen, as required, riding at the rear of the distributor in such a position that operation of all sprays is in full view and accessible for unplugging tips and controlling spread widths. The Contractor shall satisfy the Engineer by actual demonstration, at a location designated by the Engineer, that his spreading equipment will produce the intended results.

The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the Engineer can readily determine the percentage by weight of each of the two materials being incorporated into the mixture.

335.4 MIXING:

The materials shall be intimately combined as rapidly as possible for such a time and at such a temperature that the consistency of the mix approaches that of a semifluid material. The temperature of the asphalt shall be between 325°F and 475°F.

There shall not be less than 20 percent of rubber by weight of the total mixture.

335.5 SPREADING:

Prior to placing the hot asphalt-rubber seal coat, soil and other objectionable materials shall be removed from the pavement surface and a tack coat applied, if necessary, consisting of 0.05 ± gallons per square yard of SS-1h emulsified asphalt, diluted 50-50 with water.

The application rate of the hot asphalt-rubber mixture shall be 0.55 to 0.60 gallons per square yard unless otherwise specified and the application of the cover aggregate shall be as close as possible behind the distributor truck.

The cover aggregate shall be preheated immediately prior to application and precoated with not more than 0.75 percent nor less than 0.60 percent of aged residue asphalt. The temperature of the precoated chips at the place of application shall be between 290°F and 350°F. Stockpiling or reheating of cover aggregate after precoating will not be permitted. Truck bed covers will be required as necessary to maintain the temperature of the cover aggregate prior to placement. Canvas, or similar covers, that completely cover each load shall be used whenever it is found that the temperature of the top 3 inches of the chip load is dropping below the minimum requirement at the time of application.

Hot asphalt rubber seal with hot precoated cover aggregate shall be placed only when the pavement temperature is 70°F or above and rising.

The rate of application of the cover aggregate shall be from 27 to 35 pounds per square yard of the ¼ inch nominal size or 37 to 39 pounds per square yard for the 3/8 inch nominal size as directed by the Engineer. A minimum of 4 complete coverages shall be made with the pneumatic rollers. The rolling of the cover aggregate shall proceed immediately after application in order to insure maximum embedment of the aggregate.

The Contractor shall sweep all joint edges clean of overlapping cover material prior to the adjacent application of asphalt-rubber material. All reasonable precautions shall be taken to avoid skips and overlaps at joints and to protect the surfaces of adjacent structures from being spattered or marred. Correction of any such defects will be required at no additional cost to the Contracting Agency. All transverse joints shall be made by placing building paper over the ends of the previous applications and the joining application shall start on the building paper used. Once the application process has progressed beyond the paper used, the paper shall be removed and disposed of to the satisfaction of the Engineer.

Traffic will not be permitted on the surface until the cover aggregate has set. Traffic control will be covered in Section 401 and the special provisions where required.

At signalized intersections, an application of 5 to 10 pounds per square yard of sand shall be applied after rolling and before opening a lane to traffic, through the intersection and for a distance of 200 feet each way from the near curb returns.

After a final sweeping and prior to stripping a flush coat may be applied, except for 200 feet either side of signalized intersections, to the asphalt-rubber treatment consisting of 0.05 to 0.10 gallons per square yard of undiluted SS-1h emulsified asphalt. The application of the flush coat may be delayed to facilitate curing or to avoid placement under unfavorable high temperature conditions. The flush coat may be deleted if the Engineer determines sufficient chip embedment has been attained.

335.6 MEASUREMENT:

Certified weight slips of all materials shall be delivered to the Engineer before the materials are applied.

Certified weight slips of any bituminous material being weighed back in for credit shall be delivered to the Engineer before starting the next days work.

Quantities of materials for this work will be paid for at the contract price per unit of measurement for each of the following pay items actually ordered and used on the project.

(A)	Hot Precoated Chips	Ton
(B)	Asphalt Rubber	Ton
(C)	SS-1h Emulsified Asphalt	Ton (Undiluted)

335.7 PAYMENT:

Quantities shown in the proposal are for bidding purposes only. Payment will be full compensation for furnishing and placing all materials ordered and used, with no allowance for waste, and shall include labor, equipment, tools, and incidentals necessary to complete the work as prescribed and as directed by the Engineer.

Asphalt cement for precoating chips will be included in the price per ton for hot precoated chips.

No payment will be made for materials rejected due to improper placing, improper proportions of materials, or materials found to be defective.

SECTION 336

PAVEMENT MATCHING AND SURFACING REPLACEMENT

336.1 DESCRIPTION:

Street and alley pavement and surfacing within the Contracting Agency's rights-of-way, removed by construction activities or to be widened or matched in connection with the improvement of Public Works, shall be placed as shown on the plans and applicable standard details, in accordance with this specification and/or the special provisions.

Asphalt concrete pavement replacement shall be constructed in accordance with Type A, B, D or E of standard details, as indicated on the plans, and as required by Sections 321 and 710.

Portland cement concrete pavement replacement shall be in accordance with Type C of the Standard Details, and as required by Sections 505 and 725.

ABC or decomposed granite surface replacement shall be constructed in accordance with Type F of standard details as indicated on the plans and in Section 702.

Temporary pavement replacement shall be constructed as required below.

Pavements to be matched by construction of new pavements adjacent to or at the ends of a project shall be saw cut in accordance with these specifications and where shown on the plans.

Pavement and surfacing replacement within Arizona Highway rights-of-way shall be constructed in accordance with their permits and/or specification requirements.

336.2 MATERIALS AND CONSTRUCTION METHODS:

Materials and construction methods used in the replacement of pavement and surfacing shall conform to the requirements of all applicable standard details and specifications, latest revisions.

336.2.1 Pavement Widening or Extensions: Existing pavements which are to be matched by pavement widening or pavement extension shall be trimmed to a neat true line with straight vertical edges free from irregularities with a saw specifically designed for this purpose. The minimum depth of cut shall be 1½ inches or D/4, whichever is greater.

The existing pavement shall be cut and trimmed after placement of required ABC and just prior to placement of asphalt concrete for pavement widening or extension, and the trimmed edges shall be painted with a light coating of asphalt cement or emulsified asphalt immediately prior to constructing the new abutting asphalt concrete pavements. No extra payment shall be provided for these items and all costs incurred in performing this work shall be incidental to the widening or pavement extension.

336.2.2 Pavement to be Removed: Existing asphalt pavement to be removed for trenches or for other underground construction or repairs shall be cut by a device capable of making a neat, straight and smooth cut without damaging adjacent pavement that is not to be removed. The Engineer's decision as to the acceptability of the cutting device and manner of operation shall be final. If saw cutting, only, is to be utilized, it will be so specified in the plans or special provisions.

Pavement replacement for cuts essentially parallel to the street centerline and greater than 50 feet in length shall be two course pavement replacement as hereinafter specified. For cuts greater than 600 feet in length the entire area shall then be seal coated in accordance with Section 331 or as otherwise specified. This seal coat shall extend from the edge of pavement or lip of gutter to the street centerline except that on residential streets less than 36 feet face to face of curb or where the pavement patch straddles the centerline, the entire width of street shall be seal coated.

In lieu of placing the seal coat as required above, the contractor may deposit with the Contracting Agency for credit to the Street Maintenance Department, the sum of One Dollar per square yard of seal coat. The Street Maintenance Department will incorporate this work into their street maintenance program. The fee per square yard may be changed, as required to reflect changing costs, by the Contracting Agency upon 3 months advanced notification of the proposed change.

Pavement replacement for cuts parallel to the street centerline less than 50 feet in length, transverse cuts, bell holes and similar small areas shall match gradation and thickness of the existing pavement. These one course pavement patches shall be compacted with a vibratory roller to the same density specified for asphalt concrete pavements.

In lieu of cutting pipe trenches across driveways, curbs and gutters, sidewalks, alley entrances, and other types of pavements, the Contractor may, when approved by the Engineer, elect to tunnel or bore under such structures and pavements.

336.2.3 Temporary Pavement Replacement: Temporary pavement replacement, as required in Section 601 may be with cold-mix asphalt concrete of an MC-70 or MC-250 oil, with a minimum thickness of 2 inches, using aggregate grading in accordance with Section 710. The amount of liquid asphalt required will be 5.0 to 6.0 percent.

Temporary pavement replacement shall be used in lieu of immediate placement of single course permanent replacement or the first course of two course pavement replacement only on transverse lines such as spur connections to inlets, driveways, road crossings, etc., when required by the Engineer; by utilities or others who subcontract their permanent pavement replacement, under special prior arrangement; or for emergency conditions where it may be required by the Engineer. Temporary pavement replacement shall be placed during the same shift in which the backfill to be covered is completed.

Rolling of the temporary pavement replacement shall conform to the following:

(A) Initial or breakdown rolling shall be followed by rolling with a pneumatic-tired roller. Final compaction and finish rolling shall be done by means of a tandem power roller.

(B) On small areas or where equipment specified above is not available or is impractical, the Engineer will approve the use of small vibrating rollers or vibrating plate type compactors provided comparable compaction is obtained.

The surface of the temporary pavement shall be finished off flush with the adjacent pavement.

336.2.4 Permanent Pavement Replacement: Laying of single course or the base course of the asphalt concrete pavement replacement where a two course replacement is applicable shall never be more than 600 feet behind the ABC placed for the pavement replacement.

The trench must be compacted to its required density, and required ABC must be in place prior to the placement of the asphalt concrete.

Single course replacement shall consist of Type D-½ or C-¾ dense grade mixes placed and finished as directed by the Engineer.

The base course of two course pavement replacement shall consist of Type C-¾ dense graded asphalt concrete material in accordance with Section 710.

Where the base course is to be placed with non-compactive equipment, it shall be not less than 2 inches in thickness and the material shall be immediately rolled with a pneumatic-tired roller. The surface course shall be of sufficient depth to provide the total required compacted thickness of the two courses, but not more than 1 inch.

Where the trench is 10 feet or more in width all courses shall be laid with self-propelled compacting, spreading equipment. All courses, except the surface course, shall be of a compacted thickness of not less than 1½ inches.

The surface course shall consist of either Type E-⅜ dense graded or Type G-⅜ open graded asphalt concrete material in accordance with Section 710 as specified by the Engineer to match the existing surface. The surface course shall not be placed sooner than 2 weeks after the base course, except where the trench crosses a signalized intersection. In this case the surface course shall be placed within 48 hours, or the crossing pavement replacement shall be single course as specified above.

Placement of the surface course is to be by means which will result in a surface texture satisfactory to the Engineer, and flush with the existing pavement.

Where deep lift asphalt concrete (asphalt concrete base and asphalt concrete wearing course) exists, the base course replacement shall be made in lifts not exceeding 6 inches in compacted thickness to within ½ inch of the finish grade.

336.3 TYPES AND LOCATIONS OF PAVEMENT AND SURFACING REPLACEMENT:

Normally, the type of pavement replacement and backfill required will be noted on the plans or specified in other portions of the contract documents and construction will be in accordance with MAG Standard Detail 200. This detail requires that a 12-inch "T" Top be utilized when normal traffic flow is perpendicular to any one of the four sides of the trench excavation. Therefore, Type A pavement replacement will require a "T" Top whenever the trench crosses a street or goes through an intersection and at the end(s) if they terminate in the street. Type B pavement replacement will require the "T" Top on the sides that are perpendicular to normal traffic flow.

If a type is not noted on the plans or specified in the special provisions, the following criteria will govern:

Type A pavement replacement, including the "T" Top, will be utilized on all streets where the excavation is parallel to the centerline of the street.

Type B pavement replacement, including the "T" Top, will be utilized on all streets where the excavation is transverse to the centerline of the street.

Type C pavement replacement will be used to match existing Portland cement concrete pavement.

Type D pavement replacement may be used when the condition of the existing pavement does not justify construction of Type A or B. Prior written approval of the Engineer is required.

Type F pavement replacement will be utilized to match existing ABC or decomposed granite roadways.

Where a longitudinal trench is partly in pavement, the pavement shall be replaced to the outside edge of the existing pavement, on a straight line, as indicated on the plans. Measurements for payment shall be from the inner limit of pay width allowed below, to the outside edge of the existing pavement as defined herein.

Where no part of a trench is in pavement, surfacing replacement will only be specified where existing surfacing materials have been removed.

When a trench cut is in aggregate surfaced area, the surfacing replacement shall be of a like type and depth as the existing material, compacted to the densities required in Section 601.

336.4 MEASUREMENT:

Measurement for payment of pavement and surfacing replacement will be by the square yard, measured in place, with the following restrictions and provisions:

(A) In computing pay quantities by the square yard, for replacement Types A, B, C, D, and E, the product of the length of pavement or surface replacement measured along the centerline of the trench and the pay width listed below shall be used:

Size of Pipe (I.D.)	Pay Width Internal Diameter of Pipe, Plus
Thru 10″	18″
12″ to 21″	24″
24″ to 33″	30″
36″ to 51″	36″
54″ to 63″	46″
66″ to 75″	54″
78″ to 87″	64″
90″ to 99″	72″
102″ and Over	82″

(B) Where a longitudinal trench is only partly in pavement, computations of pay quantities shall be based on the limitations specified above.

(C) Measurement of Type F surfacing replacement will be measured by the linear foot, constructed to the dimensions shown on standard details and/or the plans.

(D) The length of pavement and surfacing replacement shall be measured through any manhole, valve box, or other structure constructed in the pipe line, and any pavement or surface replacement and/or seal treatment in excess of the above pay widths shall be considered and included in the bid item for such structure.

(E) When special provisions allow deviations from the trench widths specified in Section 601, the above allowed pay widths for pavements remove replacement may be altered where so specified.

(F) Measurement of all pavement and surfacing replacement shall be made along the finished surface of the ground to the nearest foot, and shall be computed to the nearest square yard.

(G) Any pavement replacement in excess of the specified pay widths necessitated by the installation of valves, tapping sleeves and valves, valve by-passes, and concrete thrust blocks shall be included in the bid price for these items.

(H) For areas having a "T" Top replacement, pay widths will be based on the actual trench width (not to exceed max. widths per Section 601.2.2) plus 24" times the length of replacement as measured above.

336.5 PAYMENT

Direct payment for pavement or surfacing replacement will be made only for replacement over main line pipe trenches except as otherwise allowed in the special provisions. Payment for replacements over other work shall be included in the cost of constructing that work, in accordance with the applicable standard details and specifications.

Payment for temporary pavement replacement shall be included in the cost of the pipe.

When a Contractor has the option of either jacking and/or boring or opencut construction, and elects to construct a pipeline by the jacking and/or boring method, he will be paid for the replacement of such items of work as pavement, curb and gutter, sidewalk, driveway, and alley entrances, as allowed for opencut construction.

SECTION 340

CONCRETE CURB, GUTTER, SIDEWALK, DRIVEWAY AND ALLEY ENTRANCE

340.1 DESCRIPTION:

The various types of concrete curb, gutter, sidewalk, driveways, and alley intersections shall be constructed to the dimensions indicated on the plans and standard detail drawings. Joints shall be designated as expansion joints or contraction joints and shall be constructed as per Subsection 340.3.

340.2 MATERIALS:

Concrete shall be class B, conforming to the applicable requirements of Section 725.

Expansion joints filler shall comply with Section 729.

340.3 CONSTRUCTION METHODS:

Existing pavements and concrete, that are joined by new construction, shall be cut in accordance with Section 601.

The subgrade shall be constructed and compacted true to grades and lines shown on the plans and as specified in Section 301. All soft or unsuitable material shall be removed to a depth of not less than 6 inches below subgrade elevation and replaced with material satisfactory to the Engineer. When the Engineer determines that the existing subgrade consists of soils with swelling characteristics, the moisture content shall be brought as close as possible to the optimum required for compaction. This shall be done by the addition of water, by the addition and blending of dry suitable material or by the drying of existing material. The subgrade shall then be compacted to a relative density of 75% minimum to 85% maximum with 80% as ideal.

Material displaced in the construction shall not be placed on the base and/or surfacing material already in place on the roadway nor shall the excavated material be placed in such a manner as to interfere with access to property or traffic flow in the street.

Concrete sidewalks and driveways which are necessarily disturbed by construction shall be removed to a distance required to maintain a slope as indicated by standard details or not to exceed 1 inch per foot where sidewalks are concerned. Sawcutting is required at the match lines and payment will be made under the respective pay items as provided in the proposal.

Concrete curbs, gutters and sidewalks shall be constructed by the conventional use of forms, or may be constructed by means of an appropriate machine when approved by the Engineer.

If machines designed specifically for such work and approved by the Engineer are used, the results must be equal to or better than that produced by the use of forms. If the results are not satisfactory to the Engineer, the use of the machine shall be discontinued and the Contractor shall make necessary repairs at his own expense. All applicable requirements of construction by use of forms shall apply to the use of machines.

Forms conforming to the dimensions of the curb, gutter, sidewalk, driveway, and alley entrance shall be carefully set to line and grade, and securely staked in position. The forms and subgrade shall be watered immediately in advance of placing concrete.

Forms shall be thoroughly cleaned each time they are used, and shall be coated with a light oil, or other releasing agent of a type which will not discolor the concrete.

The concrete shall be thoroughly spaded away from the forms so that there will be no rock pockets next to the forms. The concrete may be compacted by mechanical vibrators approved by the Engineer. Tamping or vibrating shall continue until the mortar flushes to the surface, and the coarse aggregate is below the concrete surface.

Expansion joints, unless otherwise specified, shall be constructed in accordance with the standard details of the appropriate agency, and in a straight line and vertical plane perpendicular to the longitudinal line of the sidewalk or curb and gutter, except in cases of curved alignment, when they will be constructed along the radial lines of the curve. They shall be constructed to the full depth and width of the concrete and shall match the joints in the adjacent pavement sidewalk or curb and gutter. Joints shall be constructed at all radius points, driveways, alley entrances, and at adjoining structures with a maximum interval of 100 feet between joints.

Contraction joints, unless otherwise specified, shall be constructed in accordance with the standard details of the appropriate agency, and in a straight line and vertical plane perpendicular to the longitudinal line of the sidewalk or curb and gutter, except in cases of curved alignment when they will be constructed along the radial lines of the curb. They shall be constructed to a depth of 1", and at 10' intervals on sidewalk widths of five feet and 12' intervals on sidewalks of 4' width.

Sidewalk score marks, at least ½ inch deep, are required every 4 feet or every 5 feet matching the width of the sidewalk.

All edges shall be shaped with a suitable tool so formed as to round the edges to a radius as indicated on the standard details.

The front face form shall not be removed before the concrete has taken the initial set and has sufficient strength to carry its own weight, gutter forms and rear forms shall not be removed until concrete has hardened sufficiently to prevent damage to the edges. Special care shall be taken to prevent any damage. Any portion of concrete damaged while stripping forms shall be repaired or if the damage is severe, replaced at no additional cost to the Contracting Agency. The face, top back, and flow line of the curb and gutter shall be tested with a 10-foot straightedge or curve template, longitudinally along the surface. Any deviation in excess of ¼ inch shall be corrected at no additional cost to the Contracting Agency.

The surface of concrete sidewalk shall be tested with a 5-foot straightedge. Any deviation in excess of ⅛ inch shall be corrected at no additional cost to the Contracting Agency.

When required by the Engineer, gutters having a slope of 0.8 foot per hundred feet or less, or where unusual or special conditions cast doubt on the capability of the gutters to drain, they shall be water tested. Water testing shall consist of establishing flow in the length of gutter to be tested by supplying water from a hydrant, tank truck or other source. One hour after the supply of water is shut off, the gutter shall be inspected for evidence of ponding or improper shape. In the event water is found ponded in the gutter to a depth greater than ½ inch, or on the adjacent asphalt pavement, the defect or defects shall be corrected in a manner acceptable to the Engineer without additional cost to the Contracting Agency.

Any section of the work deficient in depth or not conforming to the plans or specifications shall be removed and replaced by the Contractor at no additional cost to the Contracting Agency.

Finishing and curing of the concrete shall be done in the manner specified in Section 505.

The Contractor shall stamp his name and year on all work done by him, on each end of the curb, gutter, or sidewalk. The letters shall not be less than ¾ inch in height.

340.4 BACKFILLING:

Unless otherwise specified the Contractor shall backfill behind the curbs or sidewalks with soil native to the area to the lines and grades shown on the plans.

340.5 MEASUREMENT:

Concrete curbs and gutters of the various types shown on the plans and in the proposal, will be measured along gutter flow line through inlets, catch basins, etc., by the lineal foot to the nearest foot for each type, complete in place.

Concrete sidewalks, driveways, alley intersections, valley gutters and aprons will be measured to the nearest square foot complete in place. When concrete sidewalk, driveways, alley intersections, valley gutters, and/or aprons are cut during trenching operations, the square foot measurement for payment will be in accordance with Section 336.

340.6 PAYMENT:

Payment for the above named items will be made in accordance with the unit prices or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, material, tools and equipment and accomplishing all work in conformance with the contract documents.

SECTION 341

TERRAZZO SIDEWALKS

341.1 DESCRIPTION:

Terrazzo consists of a mixture of grey or white portland cement, cement color pigments, abrasive aggregate and colored marble chips, with the surface ground to finish grade so as to expose approximately 75 percent of the marble granules.

Cement and concrete shall be in accordance with Section 725.

All applicable portions of Section 340 for construction of concrete sidewalks shall be adhered to.

The Contractor shall furnish all equipment, labor, materials, tools, services, transportation and incidentals necessary to construct a sidewalk with a terrazzo surface course.

341.2 MATERIALS AND COMPOSITION:

Divider strips shall be of half-hard brass, white metal 99 percent zinc or alloy. The strips shall have a minimum thickness of ⅛ inch and shall be provided with proper anchoring devices. Pre-assembled decorative units may be used. Double divider

strips or metal expansion joints shall be used in the terrazzo course directly above the expansion joints in the concrete base or slab.

Cement mortar colors shall be lime-proof non-fading pure mineral pigments.

Abrasive aggregate shall consist of alundum or other approved lime-proof abrasive.

Marble chips shall be of an exterior grade marble that will not weather nor discolor. The granule shall be of such proportions of size Nos. 1, 2, 3 as shall be hereafter determined. Samples of the terrazzo shall be made for approval of the Engineer.

Composition of the terrazzo shall be in the proportion of 200 pounds of marble aggregate to 100 pounds of gray or white portland cement, mixed dry. The marble aggregate shall consist of 4 parts of marble chips, and cement color pigments to 2 parts of abrasive aggregate.

(A) Add sufficient water to make the mixture plastic but not flowing, a water and cement ratio 0.44 to 0.49.

(B) All materials, including water shall be mixed in a mechanical mixer or in a mortar box for not less than 2 minutes. Only amounts shall be mixed which can be placed immediately.

341.3 CONSTRUCTION METHODS:

Concrete base or slab shall be of Class B concrete, 4 inches thick, and reinforced with 6 × 6 inch No. 10 gage wire mesh fabric.

(A) The concrete base shall be separated from the natural ground surface by overlapping 15 pound asphalt impregnated roofing felt, plastic sheeting or other approved water-proofing material. In areas having excessive rise of ground water, the edges of the concrete shall also be water-proofed.

(B) Where a pitch in the finished surface is required, the concrete slab shall be pitched to the required degree.

(C) Premolded expansion joints of the type designated in Section 729, shall be placed in the concrete base or slab at 20 foot intervals and also against buildings and curbs. Double divider strips or metal expansion joints are to be used in the terrazzo course directly above the expansion joints in the concrete base slab.

(D) The top of the base slab shall be broom finished to leave a slightly roughened surface to insure a bond between the concrete and the terrazzo finish.

(E) While the base slab is still in a semi-plastic state, the divider strips shall be placed. The divider strips will form panels not more than 3 feet on a side. Where an expansion joint occurs in the concrete base or the type of construction changes, always use a divider.

(F) The concrete slab shall be cured according to the requirement of Section 505.

Bond between concrete base and terrazzo course: Before the terrazzo Contractor installs his work, he must see that the surface of the concrete slab is thoroughly cleaned of plaster droppings, wood chips, and all other debris. He should thoroughly slush it with neat cement grout to insure a good bond.

341.3.1 Installation: Place the terrazzo mix in the spaces formed by the divider strips in such a manner that the marble chips match the chosen pattern in the National Terrazzo and Mosaic Association, Inc. catalog. The mix shall be rolled into a

compact mass by means of heavy stone or metal rollers until the superfluous cement and water is extracted, after which it must be hand troweled to an even surface, disclosing the lines of the divider strips on a level with the terrazzo finish.

The finished course shall show at least 75 percent of marble granules and shall not vary in any direction more than ⅛ inch when tested with a 10 foot straightedge. The thickness of the terrazzo course shall be 2 inches. The temperature of the mix at time of placing shall be between 60° and 80°F. and shall be maintained above 70°F. for at least 3 days or above 50°F. for at least 5 days when using normal portland cement.

341.3.2 Curing: The terrazzo course must be cured by keeping it moist for at least 6 days by wet sand, paper, or curing mats.

341.3.3 Surfacing: When the terrazzo work has set sufficiently hard, it shall be machine rubbed, using No. 24 grit or finer abrasive stones for the initial rubbing. It shall then be resurfaced using a No. 80 grit or finer abrasive stone, after which a light grouting of neat portland cement of the same kind and color as the matrix shall be applied to the surface, filling all voids. The grouting shall then remain until the time of final cleaning. All grinding shall be done in the presence of an excess of water.

341.3.4 Finishing: The grouting shall be removed by machines, using a stone not coarser than No. 80 grit. This cleaning for fine-stoning shall not take place sooner than 7 days after the surface has been grouted, after which it must be cleaned thoroughly.

341.3.5 Sealing: After cleaning and drying, seal the terrazzo surface with one coat of Hornlux or other sealer approved by the National Terrazzo and Mosiac Association, Inc.

341.4 MEASUREMENT:

Terrazzo sidewalk will be measured to the nearest square foot complete in place.

341.5 PAYMENT:

Payment will be made at the unit price bid per square foot, and shall be compensation in full for all construction equipment, labor, materials, plant, services, transportation, and all incidentals necessary to construct a sidewalk with a terrazzo surface course.

SECTION 345

ADJUSTING FRAMES, COVERS, VALVE BOXES AND WATER METER BOXES

345.1 DESCRIPTION:

The Contractor shall furnish all labor, materials, and equipment necessary to adjust all frames, covers and valve boxes as indicated on the plans or as designated by the Engineer. The frames shall be set to grades established by the Engineer, in a manner hereinafter specified.

The Contractor may elect to remove old frames, covers and valve boxes and to install new frames and/or boxes without any additional cost to the Contracting Agency, in accordance with standard detail drawings.

345.2 ADJUSTING FRAMES:

The Contractor shall loosen frames in such a manner that existing monuments, clean outs or valve boxes will not be disturbed or manholes damaged. Debris shall not be permitted to enter sanitary or storm sewer conduits. All loose material and debris shall be removed from the excavation and the interiors of structures prior to resetting frames.

Frames shall be set to the elevations and slopes established by the Engineer and shall be firmly blocked in place with masonry or metal supports. Spaces between the frame and the old seat shall be sealed on the inside to prevent any concrete from entering the hand hole or manhole. Class B concrete shall be placed around and under the frames to provide a seal and properly seat the frame at the required elevation and slope. Concrete shall be struck off flush with the top of the existing pavement or in accordance with the standard details.

345.3 ADJUSTING VALVE BOXES:

Valve boxes shall be adjusted to the new elevations indicated on the plans, or as established by the Engineer.

Adjustable cast iron boxes shall, if possible, be brought to grade by adjustment of the upper movable section. Any excavated area shall be filled with Class B concrete to the level of the existing pavement, or as directed by the Engineer.

Concrete pipe valve boxes in areas not subject to vehicular traffic shall be adjusted to grades by installing a suitable length of metal or concrete pipe, of the same inside diameter as the present valve box, and reinforcing the outside with a concrete collar extending from at least 2 inches below the joint up to and flush with the top of the valve box extension. This collar shall be of Class B concrete. The dimension from the outside of the box to the outside of the collar shall not be less than 2 inches. This adjustment will be known as Type B.

In areas subject to vehicular traffic and where the existing valve box is a Type B, the adjustment to the new elevation shall be made using the old cover and installing a new 8 inch frame in accordance with the standard detail for installation of valve boxes in vehicular traffic areas. This adjustment shall be known as Type BA.

Adjustment of existing Type A valve boxes to the new elevation shall be as described in Subsection 345.2 above. This adjustment shall be known as Type A.

345.4 MEASUREMENT:

The quantities measured will be the actual number of frames, covers and valve boxes of each type, adjusted and accepted.

345.5 PAYMENT:

The quantities, as determined above will be paid for at the contract price per unit of measurement respectively, for each of the particular items listed in the proposal. The payment shall be compensation in full for all materials, labor, equipment and incidentals necessary to complete the work.

SECTION 350

REMOVAL OF EXISTING IMPROVEMENTS

350.1 DESCRIPTION:

This work shall consist of removal and disposal of various existing improvements, such as pavements, structures, pipes, curbs and gutters, and other items necessary for the accomplishment of the improvement.

350.2 CONSTRUCTION METHODS:

The removal of existing improvements shall be conducted in such a manner as not to injure utilities or any portion of the improvement that is to remain in place. See Section 107.

Sidewalks shall be removed to a distance required to maintain a maximum slope for the replaced portion of sidewalk, for one inch per foot and all driveways shall be removed to a distance as required by standard details.

Existing concrete driveway curbs and gutters shall be removed to the right-of-way line and the new end of curb faced.

Portland cement concrete pavements, curbs and gutters and sidewalks designated on the plans for removal shall be saw-cut at match lines, in accordance with Section 601 and removed.

Asphalt concrete pavements designated on the plans for removal shall be cut in accordance with Section 336.

Removal of trees, stumps, irrigation structures, storm water inlets, headwalls and other items in the right-of-way shall be done in accordance with Section 201.

Backfill and compaction of all excavated areas shall be compacted to the densities as prescribed in Section 601.

All surplus materials shall be immediately hauled from the jobsite and disposed of in accordance with Section 205.

350.3 MISCELLANEOUS REMOVAL AND OTHER WORK:

This work shall include, but not be limited to the following, where called for on the plans.

(A) Relocate existing fence and gate.

(B) Remove and reset mail boxes.

(C) Remove signs and bases in right-of-way.

(D) Remove planter boxes, block walls, concrete walls, and footings.

(E) Install plugs for pipes and remove existing plugs as necessary for new construction.

(F) Remove wooden and concrete bridges.

(G) Remove sprinkler systems and plug.

(H) Remove median island slabs.

(I) Reconstruct berms where disturbed by construction.

(J) Remove pavements and aggregate base where called for outside the roadway prism.

350.4 PAYMENT:

Payment for removals will be made at the unit bid prices bid in the applicable proposal pay items, which price shall be full compensation for the item complete, as described herein or on the plans.

PART 400

RIGHT-OF-WAY AND TRAFFIC CONTROL

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SECTION 401

TRAFFIC CONTROL

401.1 DESCRIPTION:

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

401.2 TRAFFIC CONTROL DEVICES:

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

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

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

*401.3 FLAGMEN OR PILOT CARS:

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

401.4 TRAFFIC CONTROL MEASURES:

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

401.5 GENERAL TRAFFIC REGULATIONS:

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

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

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

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

(B) **On Improvement District Projects:** All existing traffic lanes on major streets shall be maintained open to traffic between the hours of 7:00 a.m. to 9:00 a.m. and

4:00 p.m. to 6:00 p.m. weekdays. All work that enters or crosses a major street must be done at times other than 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. unless otherwise specified in the special provisions.

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

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

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

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

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

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

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

At the request of the Contractor, subject to the approval of the Traffic Engineer, the Traffic Engineering Department will install CONSTRUCTION ZONE SPEED LIMIT 25 MPH signs in the construction area. The Contractor shall maintain the signs erect, clean and in full view of the intended traffic at all times. Should the signs interfere with construction, the Contractor shall relocate the signs as necessary.

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

Special traffic regulation will be listed in the special provisions.

401.6 MEASUREMENT:

No measurement will be made for traffic control devices.

Flagmen, uniformed off-duty law enforcement officers or pilot cars, with driver, will be measured by the hour for each individual, including vehicle and equipment,

required to perform traffic control. When an officer is used less than 3 hours, a minimum of 3 hours will be charged. Anything over 3 hours will be measured by the hour.

401.7 PAYMENT:

Payment will be made at the contract bid price in the proposal for uniformed, off-duty law enforcement officer. If the officer is utilized in excess of 8 hours in any calendar day or in excess of 40 hours in any calendar work week, payment shall be at the rate of 1½ times the contract bid price for all hours worked in excess in either of the above time periods.

SECTION 405

MONUMENTS

405.1 DESCRIPTION;

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

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

405.2 MATERIALS:

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

Concrete shall be Class B.

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

405.3 CONSTRUCTION:

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

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

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

405.4 INSTALLATION:

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

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

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

SECTION 405

405.5 PAYMENT:

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

SECTION 410

PRECAST SAFETY CURBS

410.1 DESCRIPTION:

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

410.2 MATERIALS:

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

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

Dowels shall conform to ASTM A-615 plain, intermediate grade, ½ inch round by 24 inches.

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

410.3 CONSTRUCTION METHOD:

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

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

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

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

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

410.4 MEASUREMENT:

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

410.5 PAYMENT:

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

(A) Safety curbs installed on natural earth or gravel

(B) Safety curbs installed on portland cement concrete

(C) Safety curbs installed on asphalt concrete

SECTION 415

FLEXIBLE METAL GUARDRAIL

415.1 DESCRIPTION:

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

415.2 MATERIALS AND CONSTRUCTION:

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

The rail elements, terminal sections, bolts, nuts and other fittings shall conform to the specifications of AASHTO M-180, except as modified in this specificatioin. The edges and center of the rail element shall contact each post or block. Rail element joints shall be lapped not less than 12½ inches and bolted. The rail metal shall be open hearth, electric furnace, or basic oxygen steel and, in addition to conforming to the requirements of AASHTO M-180, shall withstand a cold bend, without cracking, of 180 degrees around a mandrel of a diameter equal to 2½ times the thickness of the plate.

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

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

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

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

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

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

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

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

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

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

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

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

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

415.3 PAINTING:

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

415.4 MEASUREMENT:

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

415.5 PAYMENT:

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

SECTION 420

CHAIN LINK FENCES

420.1 DESCRIPTION:

This work shall consist of constructing chain link fences at the locations and in accordance with the details shown on the plans, and as provided in these specifications and the special provisions.

420.2 MATERIALS:

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

420.3 CONSTRUCTION METHODS:

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

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

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

All posts shall be set in Class B concrete footings, which footings shall be crowned at the top to shed water. Footings for line posts for 60 inch fabric or less shall not be less than 30 inches deep and 8 inches in diameter, and footings for line posts for fabric more than 60 inches shall not be less than 36 inches deep and 8 inches in diameter. All other footings, unless otherwise indicated on the plans or in the special provisions, shall be not less than 36 inches deep and 12 inches in diameter.

End, corner, slope and gate posts shall be braced to the midpoint of the nearest line post or posts with horizontal braces used as compression members and the said line posts trussed from the brace back to the bottom of the end, corner, slope or gate post with ⅜ inch steel truss rods with turnbuckles used as tension members.

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

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

The fabric shall be fastened to end, corner, slope and gate posts with 3/16 inch x 3/4 inch high carbon steel tension bars and not less than 12 gage x 1 inch steel tension bar bands spaced at 16 inch intervals; and to line posts, top rail and tension wire with 11 gage or heavier tie wires or metal bands. Tie wires or metal bands shall be placed on line posts at intervals of approximately 16 inches, and on top rail and tension wire at intervals of approximately 18 inches.

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

420.3.2 Construction of Gates: The widths of any gates to be installed will be indicated on the plans or in the special provisions. Gates in which the width of the leaf is greater than 6 feet shall be constructed with an internal horizontal or vertical stiffener of the same diameter as the frame; the frame shall be trussed with a ⅜ inch adjustable tension rod. Gates in which the width of the leaf is 6 feet or less will not require a stiffener and will require only 1 truss rod.

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

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

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

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

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

420.4 MEASUREMENT:

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

420.5 PAYMENTS:

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

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

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

SECTION 424

PARKWAY GRADING

424.1 DESCRIPTION:

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

424.2 ROUGH GRADING:

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

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

424.3 FINE GRADING:

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

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

424.4 PAYMENT:

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

SECTION 425

TOPSOILS

425.1 DESCRIPTION:

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

425.2 MATERIALS:

Topsoil shall conform to the requirements of Section 795.

425.3 CONSTRUCTION METHODS:

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

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

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

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

425.4 MEASUREMENT:

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

425.5 PAYMENT:

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

SECTION 430

LANDSCAPING AND PLANTING

430.1 DESCRIPTION:

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

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

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

430.2 GENERAL:

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

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

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

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

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

430.3 LAWN AREAS:

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

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

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

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

The rate of seeding shall be 3½ pounds of bermuda seed or 15 pounds of rye seed per 1000 square feet.

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

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

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

430.4 DECOMPOSED GRANITE AREA:

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

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

430.5 TREE, SHRUB, AND GROUND COVER PLANTING

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

430.6 HEADER INSTALLATION:

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

430.7 CLEAN UP:

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

430.8 PLANT GUARANTEE AND MAINTENANCE:

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

430.9 PLANT ESTABLISHMENT PERIOD:

The Contractor shall request an inspection by the Engineer whenever substantial completion of the planting and related work has been accomplished. After this initial

inspection, and subject to his approval of the work, the Engineer will issue a written field notification to the Contractor setting the effective, beginning date for plant establishment. The plant establishment period shall be for a period of 60 calendar days, but is subject to extension by the Engineer if the landscape areas are improperly maintained, appreciable plant replacement is required, or other corrective work becomes necessary.

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

430.10 MEASUREMENT AND PAYMENT:

Measurement and payment shall be in accordance with Section 109.

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

SECTION 440

SPRINKLER IRRIGATION SYSTEM INSTALLATION

440.1 GENERAL:

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

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

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

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

440.2 TRENCH EXCAVATION AND BACKFILL:

Trenches and other excavations shall be sized to accommodate the irrigation system components, conduit, and other required facilities. Additional space shall be pro-

vided to assure proper installation and access for inspection. Unless otherwise specified, the minimum depth of cover over pipelines and conduits shall be as follows:

(A) Electrical conduit — 18 inches

(B) Waterlines continuously pressurized — 18 inches

(C) Lateral sprinkler lines — 12 inches

(D) Plastic lines under pavement — 24 inches

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

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

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

440.3 PIPE INSTALLATION:

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

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

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

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

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

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

Joints shall be made with a non-toxic non-hardening joint compound applied to the male threads only.

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

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

The pipe shall be protected from damage during assembly. All vises shall have padded jaws and only strap wrenches shall be used. Any plastic pipe which has been nicked, scarred, or otherwise damaged shall be removed and replaced. Care shall be exercised so that stresses on a previously made joint are avoided. Movement of the pipe following assembly, such as lowering the pipe into the trench, shall not occur prior to the set time recommended by the manufacturer of the solvent cement used.

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

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

440.4 VALVES, VALVE BOXES, AND SPECIAL EQUIPMENT INSTALLATION:

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

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

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

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

440.5 SPRINKLER HEAD INSTALLATION AND ADJUSTMENT:

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

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

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

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

440.6 AUTOMATIC CONTROL SYSTEM INSTALLATION:

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

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

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

All service wiring shall be installed in rigid conduit from the service point to the controller at the minimum depth specified in Subsection 440.2. A separate disconnect switch or combination meter socket, as required, shall be installed between the source of power and the controller. The minimum service wire shall be No. 12 AWG copper

600 volt type, TWH or larger as required by the contract documents or controller manufacturer. Wire splices shall be located only in specified pull boxes and shall be made with a packaged kit approved for underground use. Pull boxes shall be plastic with locking covers set to proper elevations on a 12-inch layer of crushed rock or washed gravel.

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

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

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

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

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

440.7 FLUSHING AND TESTING:

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

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

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

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

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

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

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

440.8 MEASUREMENT AND PAYMENT:

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

PART 500

STRUCTURES

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SECTION 501

DRIVING PILES

501.1 DESCRIPTION:

Piles driven under this specification shall be accurately spaced, and driven either vertically or to the prescribed batter, as indicated on the plans; no greater variation from the vertical or specified batter line than ¼ of an inch per foot of length being permitted. Piles otherwise driven, and those seriously damaged in driving shall be removed, or cut off, and replaced with new piles. Should any pile be raised by the subsequent driving of others, it shall be redriven.

The pile tip elevations shown on the plans are approximate, and are to be used as a basis for establishing quantities for piling, including exploratory piles, for bidding purpose only.

When required in the special provisions one pile of the type selected or designated for the work shall be driven in each pier and abutment area as an exploratory pile. The location of these piles shall be determined by the Engineer.

The conditions under which the exploratory piles will be driven shall be as ordered by the Engineer. These exploratory piles shall be furnished and driven by the Contractor, and under normal circumstances shall be left in place and utilized as one of the specified piles.

Exploratory piles shall be driven with the same size and type hammer operating with the same effective energy and efficiency as that to be used in driving the remainder of the piles.

The purpose of driving the exploratory piles is to determine the length and penetration that will be required in the balance of the piles. Therefore, no piles other than the exploratory piles shall be driven at each pier or abutment area until such determination has been made by the Engineer, and has been reported to the Contractor.

The Engineer shall order the tip elevation to which the piling shall be driven for the particular pier or abutment. All piles shall be driven to the tip elevation as established by the Engineer or deeper if necessary to develop the prescribed bearing value as determined by the formula prescribed below.

Required excavations in the areas through which the piles are to be driven shall be made before any pile is driven. No excavation may be made below the bottom of the pile footing elevation, unless approved by the Engineer.

When piles are to be driven through bridge approach embankment and the depth of the embankment at the pile location is in excess of 5 feet, the pile shall be driven in a hole drilled through embankment. The hole shall have a diameter of not less than the butt diameter of the pile plus 6 inches. After driving the pile, the annular space around the pile shall be filled to ground surface with dry sand or pea gravel.

No piles shall be driven within 25 feet of any concrete that has not attained a minimum compressive strength of 2000 psi.

501.2 DRIVING EQUIPMENT:

Pile hammers, shall be an approved type that develop sufficient energy to drive the pile at a penetration rate of not less than ⅛ of an inch per blow at the required bearing

value and shall develop an energy per blow at each full stroke of the piston of not less than one foot pound for each pound of weight driven.

Drop hammers may be used on timber pile only. Drop hammers shall weigh not less than 3,000 pounds and shall be equipped with proper leads and hoisting equipment to handle the work efficiently. The fall of the hammer shall not exceed 10 feet.

Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of steam or air hammers shall be maintained in first class condition so that the length of stroke and number of blows per minute for which the hammer is designed can be obtained at the required bearing value. Steam or air hammers not meeting these specifications, shall be removed from the work.

Other types of pile driving equipment may be used under conditions approved by the Engineer.

When necessary to obtain the specified penetration and with the approval of the Engineer, the Contractor may supply and operate one or more water jets and pumps, furnish the necessary drilling apparatus and drill holes not greater than the diameter of the pile to the proper depth and drive the piles as specified below.

If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing. The use of jets at locations where the stability of embankments or other improvements would be endangered will not be permitted.

The cost of any jetting or drilling that may be required shall be included in the price bid for driving piles, or for other applicable items of work.

The use of followers, underwater hammers, or hammers not in leads will not be permitted unless authorized by the Engineer. When a follower or underwater hammer is used, one pile in each bent or footing shall be furnished sufficiently long to permit being driven without a follower or underwater hammer.

501.3 PREDRILLED HOLES:

When approved by the Engineer, piles may be driven in predrilled holes. The holes shall have a diameter not greater than the diameter of the pile at the ground surface. The depth of the predrilled hole shall be adjusted by the Contractor as directed by the Engineer as the work proceeds in order to maintain adequate bearing. Minimum penetration of the pile below the bottom of the predrilled hole shall be 5 feet unless otherwise authorized by the Engineer.

501.4 DRIVING:

During driving operations, the pile heads shall be protected and held in position by the use of a steel driving block or anvil. Timber piles shall be sound headed and square or shaped to closely fit the driving head. The heads of the piles may be protected by means of heavy steel or wrought iron rings. The heads of timber or concrete piles or casings shall be protected from direct impact of the hammer by a cushion head block. The cushion shall be maintained in good condition during the entire driving operation. This cushion driving block shall be so arranged that any reinforcing bars projecting above the piles will not be displaced or injured in driving. For driving steel H-beam piles, and shells without a mandrel for cast-in-place concrete piles, steel combination driving heads and pilots shall be used. The driving heads shall closely fit the top of the

steel pile or shell and shall extend down the sides of the pile at least 4 inches. Piles materially out of lie as determined by the Engineer, shall be pulled and replaced.

501.5 BEARING VALUE:

Piles shall be driven to the penetration and bearing value shown on the plans as a minimum. Timber piles shall not be driven to a bearing value exceeding 20 tons. The bearing value shall be determined from the applicable formula in the following schedule.

(A) For piles driven with a drop hammer:

$$P = \frac{2WL}{s+1}$$

(B) For piles with a single acting steam or air hammer and open type diesel hammers:

$$P = \frac{2WL}{s+0.1} \quad \text{or} \quad P = \frac{2E}{s+0.1}$$

(C) For piles driven with a double acting steam or air hammer and closed type diesel hammer:

$$P = \frac{2L\,(W+ap)}{s+0.1} \quad \text{or} \quad P = \frac{2E}{s+0.1}$$

(D) For precast concrete piles:

$$P = \frac{2WL}{s+0.1\frac{W}{W}}$$ for single acting steam or air hammer and open type diesel hammers

$$P = \frac{2L\,(W+ap)}{s+0.1\frac{W}{W}} \quad \text{or} \quad P = \frac{2E}{s+0.1\frac{W}{W}}$$ for double acting steam or air hammer or closed type diesel hammer

(E) For piles driven to a batter, the safe bearing value of the pile shall be taken as U times P, the value of U being determined as follows:

$$U = \frac{0.25\,(4\text{-}m)}{\sqrt{1+m^2}}$$ for drop hammers

$$U = \frac{0.1\,(10\text{-}m)}{\sqrt{1+m^2}}$$ for steam or air hammer and diesel hammers

U = a coefficient, less than unity.

P = safe bearing load developed by the pile in pounds.

W = weight of hammer in pounds.

L = length of stroke or height of fall of the hammer in feet.

s = penetration of the pile into the ground per blow in inches, taken as the average over the last 10 blows for drop hammers and 10 to 20 for steam hammers. Penetration shall be measured at a time when there is no appreciable rebound of the hammer and preceding blow was struck upon a sound pile head or driving block.

a = effective area of the piston in square inches.

p = mean effective steam pressure in the case of steam hammers or mean effective pressure in the case of air hammers, in pounds per square inch.

E = manufacturer's rating of energy developed by the hammer in foot-pounds.

W = weight of pile in pounds.

m = tangent at the angle of batter.

501.6 CUTOFF AND EXTENSION:

Timber piles which are to be capped shall be accurately cut off so that true bearing is obtained on every pile without the use of shims. Other timber piles shall be cut off on the square at the elevation designated. Piles inaccurately cut off shall be replaced. Splicing of timber piles will not be permitted, except upon written permission of the Engineer.

The tops of treated piles, after cutoff, except piles that are to be capped with concrete, shall be treated as specified in Section 779.

Concrete piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the plans. Concrete piles may be cast the full length of the reinforcing bars, provided that the concrete is cut off to expose the steel as shown on the plans after the piles have been driven. When it is necessary after driving, to increase the length of precast concrete piles, concrete shall be removed to expose sufficient reinforcing steel to permit a lap of at least 20 diameters. The added length shall be sufficient to reach the elevation of the bottom of the cap and shall be of the same section and the same reinforcement as the pile itself, or as shown on the plans.

When concrete piles are driven or cut off below the elevation of the bottom of the cap, the pile section shall be extended to the elevation of the bottom of the cap by means of a reinforced concrete extension constructed in accordance with the details shown on the plans.

Steel shells or concrete casings for cast-in-place concrete piles shall be cut off at the designated elevations. The work of cutting off precast concrete piles or concrete casings shall be performed in such a manner as to avoid spalling or damaging the pile below cut-off. In case of such damage the pile shall be replaced or repaired as required by the Engineer.

All cut off lengths of piling shall become the property of the Contractor and shall be disposed of outside the project area.

501.7 LOAD TESTING:

A loading test shall consist of the continuous application of a load of twice the design load to the pile being tested. The pile shall be considered to have a bearing value equal to the design load if the permanent settlement produced by such test loading is not greater than ¼ inch.

Unless otherwise permitted by the Engineer the loading tests shall be completed before the remaining piles are cast or driven.

Under normal circumstances, if load tests are required, they shall be performed on the exploratory piles. The loading shall not be applied until 48 hours after the pile is driven and, in the case of cast-in-place piles, the concrete has attained a minimum compressive strength of 2,000 psi.

In order to conduct the prescribed loading test, the Contractor shall provide proper and suitable facilities and equipment by means of which a prescribed test load may be transmitted vertically to each pile to be so tested. Provision for varying the applied load must also be made, and the loads applied must be truly determinate and truly axial with the pile. The loading equipment or device so provided must be so constructed and arranged that any marks, gauges, dials or other instruments required to determine or measure deflection or settlement of the pile may be conveniently installed and observed without endangering either the observer or the instruments so installed.

The test loads shall be applied under the direction of the Engineer and at such rate or in such increments as he may specify. When a load test of a pile is commenced the test shall be continuous, and the Contractor shall furnish all facilities on a 24 hour, 7 day week basis until the test is completed. Forty-eight hours after all deflection and settlement has ceased, or sooner if directed by the Engineer, the test load shall be removed at such rate or in such increments as the Engineer may direct. If the results of the above described operations indicate that excessive permanent settlement of the test pile has occurred the pile shall be driven to such additional depth as the Engineer may specify, and the above described test loading operations then repeated, if so directed by the Engineer. Each complete operation, which shall include loading and unloading as above prescribed, shall be considered as an individual test.

501.8 MEASUREMENT:

Furnishing piles will be measured by the linear foot of piles furnished in accordance with the lengths specified on the plans or ordered by the Engineer, except that no measurement for payment will be made for furnishing piles which are subsequently damaged in handling or driving to the extent that they are unusable.

No measurement for payment will be made for falsework piles.

Driving piles will be measured by the linear foot from the tip to the required cut-off point of all piles satisfactorily driven.

Splicing piles will be measured as a unit for each splice made, when splicing is required because of pile lengths driven in excess of those specified on the plans.

No measurement for payment will be made of splices made to obtain pile lengths in accordance with the plans.

Pile loading tests will be measured as a unit for each test made as specified or as directed.

501.9 PAYMENT:

The accepted quantities of piling, measured as provided above, will be paid for at the contract unit prices for furnishing piles, driving piles, splicing piles and pile loading tests.

When more than one type of piling is shown, each type will be scheduled and paid for separately.

When not otherwise provided, payment for splicing piles will be made at the contract unit price per splice arrived at by multiplying the contract unit price per linear foot for furnishing the pile by the factor five.

When test piles are specified on the plans, the bidding schedule will not contain specific items for furnishing, driving and splicing test piles. Test piles will be measured and paid for as in the case of other piles.

SECTION 505

CONCRETE STRUCTURES

505.1 DESCRIPTION:

Concrete bridges, culverts, catch basins, retaining walls, abutments, piers, footings, foundations and similar structures shall be constructed in conformity with the plans and specifications. Concrete for use in work constructed under this specification shall conform to the requirements of Section 725.

Safe and suitable ladders shall be provided to permit access to all portions of the work.

The compressive strength of the concrete referred to in this specification will be based on the average results of 3 tests from 6 × 12 inch concrete test cylinders made and tested by the Engineer in accordance with ASTM C-31 and C-39.

505.2 SUBGRADE FOR CONCRETE STRUCTURES:

Each subgrade upon which concrete is placed shall be firm and free from water. Ground water shall be kept several inches below subgrade until the concrete has set. When the subgrade is in dry earth, it shall be moistened with water from a spray nozzle immediately before concrete is placed.

When the design details for the project provide for the construction of filter or drain material consisting of gravel or combination of gravel and sand, which material becomes subgrade for concrete, the placing of steel reinforcement and pouring of concrete shall follow the placing of the filter or drain material as closely as practical. The filter or drain material shall be kept dewatered to the extent necessary to prevent any portion of concrete materials being carried away before the concrete has attained its final set. No payment will be made for the work required to keep such materials dewatered, other than such costs as may be included in the prices bid for various items of work or amount bid for dewatering when the schedule provides an item for same.

When concrete is to rest on rock, the rock shall be fully uncovered. The surface of the rock shall be removed to a depth sufficient to expose sound rock. Bedrock shall be roughly leveled off or cut to approximately horizontal and vertical steps. Seams in the rock shall be grouted as directed by the Engineer and the base for structures shall be slush grouted or otherwise treated as the Engineer may direct.

505.3 FORMS:

Forms shall be of suitable material and of type, size, shape, quality, and strength to enable construction as designed. The forms shall be true to line and grade, mortar tight, and sufficiently rigid to resist any appreciable amount of springing out of shape

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. The surfaces of forms shall be smooth and free from irregularities, dents, sags and holes that would appreciably deface the finished surface. Forms previously used shall be thoroughly cleaned of all dirt, mortar and foreign matter before being reused, and the reuse of forms shall be subject to the approval of the Engineer. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent that 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 equally satisfactory. Any lumber or material which becomes badly checked or warped prior to placing concrete may be rejected.

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 NBS, Commercial Standards latest edition. Plywood shall be furnished and placed in 48 inch widths and in uniform lengths of not less than 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. Where plywood is attached directly to the studding or joints, the panels shall be not less than ⅝ inch thick, and the studdings or joints shall be spaced not more than 12 inches, center to center. Plywood less than ⅝ inch thick, otherwise conforming to the requirements specified, may be used with a continuous backing of ¾ inch sheathing. All form panels shall be placed in a neat, symmetrical pattern with the horizontal joints level and continuous.

Wood forms for copings and curbs shall have a thickness of not less than 1⅝ inches and a width of not less than the full depth of coping or curb.

Unless otherwise shown on the plans, all sharp edges shall be chamfered with ¾ inch triangular fillets. Forms for curved surfaces shall be so constructed and placed that the finished surface will not deviate appreciably from the arc of the curve.

Forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portion of forms to remain.

Forms for girders and slabs shall be cambered as may be required by the Engineer.

Forms shall, as far as practicable, be so constructed that the form marks will conform to the general lines of the structure.

Form clamps or bolts, approved by the Engineer, shall be used to fasten forms. The use of twisted wire loop ties to hold forms in position will not be permitted, nor shall wooden spreaders be used unless authorized by the Engineer. Clamps or bolts shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back 1 inch below the finished surface of the concrete. Forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales, all based on the rate of concrete pour.

The Contractor may at his own option, pour such portions of the concrete for the structure directly against the side of the excavation or sheathing without the use of outside forms, provided that the following conditions are met.

(A) If concrete is poured directly against the sides of the excavation, the faces of the excavation must be firm and compact, and be able to stand without sloughing off and be at all points outside the concrete lines shown on the plans.

(B) If concrete is poured against sheathing, such sheathing shall be closely fitted and shall be outside of the concrete lines shown on the plans. Those surfaces against which the concrete is to be poured shall be faced with building paper. Except as otherwise specified all sheathing shall be removed, but not until either at least 7 days after placing concrete or until the concrete has attained a strength in compression of not less than 2,000 psi. Care should be used in pulling sheathing so as to avoid damaging the concrete. Voids left by the removal of sheathing, piles and/or similar sheathing supports shall be backfilled with material having a sand equivalent of not less than 30 and consolidated by jetting as directed by the Engineer. When, in the opinion of the Engineer, field conditions or the type of sheathing or methods of construction used by the Contractor are such as to make the removal of sheathing impracticable, that portion of the sheathing against which concrete has been poured may be left in place.

Regardless of the method used in pouring concrete without outside forms the following stipulations shall hold:

(A) The reinforcing steel shall be accurately set and held firmly in place, to the satisfaction of the Engineer.

(B) No direct payment will be made for building paper, sheeting, gunite or concrete placed outside of concrete lines shown on the plans. The cost thereof shall be absorbed in the prices bid for the various items of work.

(C) The Contractor shall assume all risks of damage to the work or to existing improvements due to any reason whatsoever that may be attributable to the method of construction outlined above.

505.3.1 Removal of Forms: The falsework supporting any span of a continuous or rigid frame structure subject to bending stress shall not be released until after the last concrete placed in the span and in the adjoining spans, excluding concrete above the deck slab, has attained a compressive strength of not less than twice the design unit stress, or 21 days after the concrete is placed, whichever occurs first.

Stairway riser forms shall be removed and the finish of the steps completed on the day the concrete is placed. Metal stairway treads, if required by the plans, shall be installed immediately after the steps have been placed.

Side forms for beams, girders, columns, railings, or other members wherein the forms do not resist dead load bending shall be removed not more than 24 hours after placing concrete, where finishing is required, unless otherwise directed by the Engineer, provided that satisfactory arrangements are made to cure and protect the concrete thus exposed.

Side forms for arch rings, columns, and piers shall be removed before the members of the structure which they support are poured or placed so that the quality of the concrete may be inspected. Such forms shall be so constructed that they may be removed without disturbing other forms which resist direct load or bending stress.

Forms and shoring for box and arch sections of sewers and storm drains may be removed as follows:

(A) Forms for open channel walls — 16 hours.

(B) Outside forms of box sections and inside wall forms of box sections which do not support the slab forms — 16 hours.

(C) Arch sections in open cut — 12 hours.

(D) Slab forms for box sections:

(1) Type II Cement — 48 hours or 6 hours per foot of span between supports, whichever is greater.

(2) Type III Cement — 24 hours or 3 hours per foot of span between supports, whichever is greater.

(3) Type V Cement — 56 hours or 7 hours per foot of span between supports, whichever is greater.

The periods of time at which the Contractor may remove forms, as set forth above, are permissive only and subject to the Contractor's assuming all risks that may be involved in such removals. At his option, except for surfaces to be finished, the Contractor may leave the forms in place for such longer periods as are, in his opinion, required.

505.4 FALSEWORK:

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were poured at one time.

All falsework, staging, walkways, forms, ladders, cofferdams, and similar accessories shall equal or exceed the minimum applicable safety requirements of Section 107. Compliance with such requirements shall not relieve the Contractor from full responsibility for the adequacy and safety of said items.

Falsework shall be founded upon a solid footing safe against undermining and protected from softening. When the falsework is supported on timber piles, the piles shall be driven to a bearing value as determind by the formula specified in Section 501, equal to the total calculated pile loading. The maximum calculated pile loading shall not exceed 20 tons.

Falsework and forms shall be so constructed as to produce in the finished structure the lines and grades indicated on the plans. Suitable jacks or wedges shall be used in connection with the falsework to set the forms to grade or camber shown on the plans, or to take up any settlement in the form work either before or during the placement of concrete. Single wedges for this purpose will not be permitted; it being required that all such wedges be in pairs to insure uniform bearing. Dead load deflection in stringers and joints will be compensated for by varying the depths of the joists or by using varying depth nailing strips.

Arch centering shall be removed uniformly and gradually, beginning at the crown and working toward the springing, to permit the arch to take its load slowly and evenly. Centering for adjacent arch spans shall be struck simultaneously.

Falsework under any continuous unit or rigid frame shall be struck simultaneously; the supporting supports being released gradually and uniformly, starting at the center and working both ways towards the supports.

505.4.1 Falsework Design: Falsework shall be designed by the Contractor to carry all loads and pressures which may be applied to it. The construction loads to be applied are as follows:

Tunnel centering — 100 percent of the concrete load where concrete is placed by pumping. Forms shall be so constructed to provide adequate relief for excessive pump pressure.

All other structures — a live load of 30 pounds per square foot of horizontal area.

Transverse and longitudinal bracing — a horizontal force equal to 2 percent of the vertical load.

The unit stresses for wood falsework shall be those recommended in the West Coast Lumbermen's Association's standard grading and dressing rules increased 25 percent for short time loading.

Falsework may be bolted or spiked at the option of the Contractor, but the use of bolts and spikes shall not be combined in the same connection. The allowable spacings and connection values of bolts and spikes shall be in accordance with the national design specifications for stress-grade lumber and its fastenings as recommended by National Lumber Manufacturers Association except that an additional allowance of 25 percent for temporary use shall be added to the connection values for bolts and spikes.

Ends of columns bearing on wedges shall be tied in both direction by girts.

Unit stresses for steel falsework shall be in accordance with the requirements of the specifications for design, fabrication and erection of structural steel for buildings of the AISC.

505.5 PLACING REINFORCEMENT:

Reinforcing bars shall be accurately placed as shown on the plans and shall be firmly and securely held in position by wiring at intersections with wire not smaller than No. 16 gage and by using concrete or metal chairs, spacers, metal hangers, supporting wires and other approved devices of sufficient strength to resist crushing under full load. Wooden supports shall not be used.

Placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted. Before placing in the forms, all reinforcing steel shall be thoroughly cleaned of mortar, oil, dirt, loose mill scale, loose or thick rust and coatings of any character that would destroy or reduce the bond. No concrete shall be deposited until the placing of the reinforcing steel has been inspected and approved.

Bundle bars shall be tied together at not more than 6 foot centers.

505.5.1 Splicing: Splices of bars shall be made only where shown on the plans or as approved by the Engineer. Where bars are spliced they shall be lapped at least 30 diameters, unless otherwise shown on the plans.

Welding of reinforcing steel will not be permitted unless specifically authorized by the Engineer.

505.5.2 Bending Reinforcement: Bends and hooks in bars shall be made in the manner prescribed in the ACI, Manual of Standard Practice.

Bars shall not be bent nor straightened in a manner that will injure the material. Bars with kinks or unspecified bends shall not be used.

505.5.3 Welded Wire Fabric: Welded wire fabric shall be held firmly in place and spliced not less than 2 meshes.

505.6 PLACING CONCRETE:

Where a schedule for placing concrete is shown on the plans no deviation will be permitted therefrom unless approved in writing by the Engineer.

The placing of concrete for a given pour shall start at the low point and shall proceed upgrade, unless otherwise permitted by the Engineer.

With the exception of concrete placed in slope paving and aprons, and concrete placed under water, all concrete shall be compacted by means of high frequency internal vibrators of a type, size and number approved by the Engineer. The number of vibrators employed shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. In all cases, at least 2 vibrators shall be available at the site of the structure in which more than 25 cubic yards of concrete is to be placed. The vibrators shall not be attached to or held against the forms or the reinforcing steel. The locations, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface. Fresh concrete shall be spread in horizontal layers insofar as practicable and the thickness of the layers shall not be greater than can be satisfactorily consolidated with the vibrators. if additional concrete is to be placed, care shall be taken to remove all laitance and to roughen the surfaces of the concrete to insure that fresh concrete is deposited upon sound concrete surfaces. Layers of concrete shall not be tapered off in wedge-shaped slopes, but shall be built with square ends and level tops.

Mixed concrete, after being deposited, shall be consolidated until all voids are filled and free mortar appears on the surface. The concrete shall be placed as nearly as possible in its final position and the use of vibrators for extensive shifting of the mass of fresh concrete will not be permitted.

Fresh concrete shall not be permitted to fall from a height greater than 6 feet without the use of adjustable length pipes or elephant trunks.

The use of approved external vibrators for compacting concrete will be permitted when the concrete is inaccessible for adequate compaction provided the forms are constructed sufficiently rigid to resist displacement or damage from external vibration.

During the placing of concrete, care shall be taken that methods of compaction used will result in a surface of even texture free from voids, water or air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface. Spades or broad-tined forks shall be provided and used to produce the desired results if required by the Engineer.

The use of chutes in conveying or depositing concrete will be allowed only at the discretion of the Engineer, and wherever they are used they shall be laid at such

inclination as will permit the flow of concrete of such consistency as is required. The use of additional water in mixing the concrete to promote free flow in chutes of low inclination will not be allowed. Where necessary in order to prevent segregation, chutes shall be provided with baffle boards or a reversed section at the outlet.

Columns shall be poured preferably through pipes of adjustable length and not less than 6 inches in diameter.

Horizontal members or sections shall not be placed until the concrete in the supporting vertical members or sections has been consolidated and a minimum 2 hour period has elapsed to permit shrinkage to occur.

Walkways shall be provided along each side and for the full length of bridge structures outside the deck area. These walkways shall be of sufficient width, and so constructed as to provide for the support of the bridges from which the longitudinal floats specified are to be operated. Inspection walkways and access thereto shall be provided under the deck forms between each pair of girders and outside of each outside girder for the full length of the bridge structure. The walkways shall be not more than 8 feet below the concrete to be inspected.

505.6.1 Joints: The work shall be so prosecuted that construction joints will occur at designated places shown on plans unless specifically permitted otherwise by the Engineer. The Contractor shall complete, by continuous depositing of concrete, section for the work comprised between such joints. The joints shall be kept moist until adjacent concrete is placed.

All construction joints at the bottom of walls or arches, at the top of walls, and all longitudinal construction joints having a keyed, stepped or roughened surface shall be cleaned by sandblasting prior to pouring the adjacent concrete. Any quality of sand may be used which will accomplish the desired results.

The sandblasting operations shall be continued until all unsatisfactory concrete, and all laitance, coatings, stains, debris, and other foreign materials are removed. The surface of the concrete shall be washed thoroughly to remove all loose material. The method used in disposing of waste water employed in washing the concrete surfaces shall be such that the waste water will not stain, discolor, or affect exposed surfaces of the structures. The method of disposal will be subject to the approval of the Engineer.

All horizontal construction joints or those on slight slopes, shall be covered with Class D mortar as specified in Section 776.

Expansion and contraction joints in the concrete structures shall be formed where shown on the plans and as directed. In general, such joints shall have smooth abutting surfaces, painted or separated and sealed as detailed on the plans. No reinforcement shall be extended through the joints, except where specifically noted or detailed on the plans. Concrete or mortar shall not be permitted to lap these joints in such a manner as to effect a tie or bond that would later promote spalling.

Asphalt paint or premolded asphalt filler used in joints shall be as specified in Section 729.

No direct payment will be made for furnishing and placing asphaltic paint, premolded asphaltic filler or other types of joint separators; their costs shall be included in the price bid for the item of work of which they are a part.

505.6.2 ADVERSE WEATHER CONCRETING:

(A) Hot Weather Concreting: Hot weather is defined as any combination of high ambient temperature, low relative humidity, and wind velocity which would tend to impair the quality of fresh concrete. These effects become more pronounced as wind velocity increases. Since last minute improvisations are rarely successful, preplanning and coordination of all phases of the work are required to minimize these adverse effects.

As an absolute minimum, the Contractor shall insure that the following measures are taken:

1. An ample supply of water, hoses, and fog nozzles are available at the site.
2. Spare vibrators are on hand in the ratio of one spare vibrator for each three in use.
3. Preplanning has been accomplished to insure prompt placement, consolidation, finishing, and curing of the concrete.
4. Concrete temperature on arrival should be approximately 60°F. and in any event shall not exceed 90°F. The use of cold water and ice is recommended.
5. The subgrade is moist, but free of standing water.
6. Fog spray is utilized to cool the forms and steel.

Under extreme conditions of high ambient temperature, exposure to the direct rays of the sun, low relative humidity, and wind, even strict adherence to these measures may not produce the quality desired and it may be necessary to restrict concrete placement to early morning only. If this decision is made, then particular attention must be directed to the curing process since the concrete will be exposed to severe thermal stresses due to temperature variation; heat of hydration plus midday sun radiation versus nighttime cooling.

(B) Cold Weather Concreting: Concrete shall not be placed on frozen ground, nor shall it be placed when the ambient temperature is below 40°F. unless adequate means are used to heat the aggregate and/or water and satisfactory means have been taken for protecting and heating the concrete during the curing period.

(C) Wet Weather Concreting: Placing of concrete shall be discontinued when the quantity of rainfall is such as to cause a flow or wash to the surface. Any concrete already placed and partially cured shall be covered to prevent dimpling. A construction joint will be installed prior to shut down.

(D) Replacement of Damaged or Defective Concrete: Upon written notice from the Engineer, all concrete which has been damaged or is defective, shall be replaced by the Contractor at no cost to the Contracting Agency.

(E) Recommended Reference:

1. ACI-305 Hot Weather Concreting
2. ACI-306 Cold Weather Concreting
3. ACI-308 Recommended Practices for Curing Concrete

505.7 CONCRETE DEPOSITED UNDER WATER:

When conditions render it impossible or inadvisable in the opinion of the Engineer to dewater excavation before placing concrete, the Contractor shall deposit under water, by means of a tremie or underwater bottom dump bucket, a layer of concrete of

sufficient thickness to thoroughly seal the cofferdam. To prevent segregation the concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited. Water shall be maintained in a still condition at the point of deposit.

A tremie shall consist of a water tight tube having a diameter of not less than 10 inches with a hopper at the top. The tube shall be equipped with a device that will close the discharge end and prevent water from entering the tube while charging the tube with concrete. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering, when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of the work to prevent water entering the tube and shall be entirely sealed at all times, except when concrete is being placed. The tremie tube shall be kept full of concrete. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is completed and the resulting concrete seal shall be monolithic and homogeneous.

The underwater bucket shall have an open top and the bottom doors shall open freely and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash and shall not be dumped until it rests on the surface upon which the concrete is to be deposited. After discharge, the bucket shall be raised slowly until well above the concrete.

Concrete deposited in water shall have 10 percent extra cement added.

505.8 CURING:

As soon after the completion of the specified finishing operations as the condition of the concrete will permit without danger of consequent damage thereto, all exposed surface shall either be sprinkled with water, covered with earth, sand or burlap; sprayed with a curing compound or sealed with a material conforming with Section 726. All concrete for bridge structures shall be water cured unless otherwise permitted by the Engineer.

Concrete that is water cured must be kept continuously wet for at least 10 days after being placed; preferably being covered, if possible, with at least 2 layers of not lighter than 7 ounce burlap, except that handrail, baserail, railing posts, tops of walls, and similar parts of the structure, if water cured, must be covered with burlap as above prescribed, immediately following the finishing treatment specified therefor, and such covering shall not be removed in less than 4 days. Roadway areas, floors, slabs, curbs, walks, and the like, that are water cured may be covered with sand to a depth of at least 2 inches, in lieu of the burlap as specified above, as soon as the condition of the concrete will properly permit, and such covering must remain wet and in place until the concrete so covered is at least 10 days old unless otherwise directed by the Engineer or provided by special provisions.

When a sprayed impervious membrane is used it shall be applied under pressure through a spray nozzle in such manner and quantity as to entirely cover and seal all exposed surfaces of the concrete with a uniform film. To insure complete coverage, membrane shall be applied in two applications for a total coverage of 150 square feet per gallon. The membrane, however, shall not be applied to any surface until all of the finishing operations have been completed; such surfaces being kept damp, until the membrane is applied. All surfaces on which a bond is required, such as construction joints, shear planes, reinforcing steel, and the like, shall be adequately covered and protected before starting the application of the sealing medium in order to prevent any

of the membrane from being deposited thereon; and any such surface with which the seal may have come in contact shall immediately thereafter be cleaned. Care shall be exercised to avoid and prevent any damage to the membrane seal during the curing period. Should the seal be broken or damaged before the expiration of 10 days after the placing of the concrete, the break shall be immediately repaired by the application of additional impervious membrane over the damaged area.

Should any forms be removed sooner than 10 days after the placing of the concrete, the surface so exposed shall either be immediately sprayed with a coating of the membrane seal, or kept continuously wet by the use of burlap or other suitable means until such concrete has cured for at least 10 days.

When tops of walls are cured by the membrane sealing method the side forms, except metal forms, must be kept continuously wet for the 10 days following the placing of the concrete.

If due to weather conditions, materials used, or for any other reason, there is any likelihood of the fresh concrete checking or cracking prior to the commencement of the curing operations, it shall be kept damp, but not wet, by means of an indirect fine spray of water until all danger of such checking or cracking is past, or until the curing operations are started in the particular area affected.

Since hot weather leads to more rapid drying of concrete, protection and curing are far more critical than in cool weather. Water curing should be used wherever it is practical and should be continuous to avoid volume changes due to alternation of wetting and drying. The need for adequate continuous curing is greatest during the first few hours after placement of concrete in hot weather.

505.9 FINISHING CONCRETE:

Immediately after the removal of forms as provided above, all concrete surfaces shall be finished in accordance with the requirements specified below.

All surfaces scheduled to be covered with backfill shall be finished so as to be free of open and rough spaces.

All surfaces that will remain exposed in the completed work shall be finished so as to be free of open and rough spaces, depressions or projections. All angles and fillets shall be sharp and true and the finished surface shall present a pleasing appearance of uniform color.

All top surfaces of walls, abutments, piers, etc., shall be finished to a smooth surface and shall be cured by an approved method.

If rock pockets or honeycomb are of such an extent and character as to affect materially the strength of the structure and to endanger the steel reinforcement the Engineer may declare the concrete defective and require the removal and replacement of that portion of the structure affected by the Contractor at no additional cost to the Contracting Agency.

If finishing operations are not carried out as set forth below, all placing of concrete shall stop until satisfactory arrangements are made by the Contractor to promptly correct defective finishing work and to carry out finishing operations as specified.

One of the classes of finish as specified shall be applied to the various surfaces as set forth under applicability of finishes.

No finishing or patching shall be permitted until the surface has been inspected by the Engineer.

505.9.1 Finishing Fresh Concrete in Bridge Decks: Upon placing the deck to a uniform and true surface, screed supports shall promptly be removed from the surface and any necessary hand finishing shall be promptly accomplished in the areas where the screed supports have been removed.

After the floating, as specified above, is completed; the concrete surface shall be textured with a burlap drag or a drag boom, as required by the Contracting Agency.

The finished surface will be tested with a 10 foot straightedge furnished by the Contractor. The testing will be accomplished by holding the straightedge in contact with the deck surface and parallel to the centerline. The surface shall not vary more than ⅛ inch from the lower edge of the straightedge. Areas showing high spots of more than ⅛ inch shall be corrected by cutting or planing. The cutting or planing machine shall be a rotary type, equipped with an adjustable cutter and having a minimum wheel base of 10 feet. Areas showing low spots of more than ⅛ inch shall be filled with an approved mixture of sand, cement and epoxy. The mixture shall firmly adhere to the surface and shall match the surrounding concrete. All areas corrected shall not show deviations in excess of ⅛ inch when tested with a 10 foot straightedge.

505.9.2 Finishing Fresh Concrete in Sidewalks and Bridge Sidewalks: After the concrete has been placed and spread between the forms, it shall be thoroughly worked until all the coarse aggregate is below the surface and the mortar comes to the top. Concrete may be consolidated by means of mechanical vibrators approved by the Engineer.

The surface shall then be struck off and worked to grade and cross section with a wood float.

A mechanical finishing machine that will consolidate the concrete and strike off and finish the surface may be used if permitted by the Engineer, provided that the machine produces a sidewalk equal to or better in all respects that that produced by the methods specified herein.

The surface shall be sweat finished by means of a steel trowel or light broom finished.

The sidewalks shall be marked and edged with the proper tools to form the joints, marking and edges shown on the plans.

505.9.3 Finishing Green Concrete: Class I Finish — All bolts, wires and rods shall be clipped and recessed. All holes, honeycomb, rock pockets and other surface imperfections shall be cleaned out, thoroughly moistened and carefully patched with mortar. Mortar shall be composed of 1 part of cement and 2 parts of fine sand. A portion of the required cement for mortar shall be white as required to match the color of the surrounding concrete.

Class II Finish — The surface shall be patched and pointed as specified above for Class I Finish and then promptly covered with polyethylene film, wet burlap or wet cotton mats. If polyethylene film is used, the film shall be held securely to the surface by means of weights, adhesive or other suitable means. Only white polyethylene film for covering will be acceptable.

When the mortar used in patching and pointing has set sufficiently, the surface shall be uncovered and thoroughly rubbed with either a float or a carborumdum stone until

the surface is covered with a lather. Cork, wood or rubber floats shall be used only on surfaces sufficiently green to work up such lather, otherwise a carborundum stone shall be used. During the rubbing process, a thin grout composed of 1 part cement and 1 part of fine sand may be used to facilitate producing a satisfactory lather; however, this grout shall not be used in quantities sufficient to cause a plaster coating to be left on the finished surface. A portion of the required cement for grout shall be white as required to match the color of the surrounding concrete. Rubbing shall continue until irregularities are removed and there is no excess material. At the time a light dust appears, the surface shall be brushed or sacked. Brushing or sacking shall be carried in one direction so as to produce a uniform texture.

Class III Finish — The surface shall be treated as specified above under Class II Finish except that after brushing, the surface shall again be securely covered with polyethylene film, wet burlap or wet cotton mats. In not less than 1 day nor more than 4 days, the surface shall be uncovered and rubbed with a carborundum stone. This rubbing shall continue until the entire surface is of a smooth texture and uniform color. During the process, the use of a thin mixture of equal parts of sand and cement with water will be permitted. At the time a light dust appears, the surface shall be brushed or sacked, care being taken to carry this brushing in one direction so as to produce a uniform texture.

505.9.4 Finishing Hardened Concrete: If for reasons either beyond the control of the Contractor or with the approval of the Engineer, more than 6 days have elapsed between the time of placing concrete and the time of the removal of forms, the concrete shall be considered as hardened. Prior to finishing hardened concrete, the surface shall be covered with burlap or cotton mats and kept thoroughly wet for a period of at least 1 hour. Finishing shall be identical to the respective requirements for Class I, Class II and Class III Finish for green concrete, except that the use of a mechanically operated carborundum stone will be required for Class II and Class III Finishes.

505.9.5 Applicability of Finishes: Surfaces requiring Class I Finish — All formed structures that are to be covered by backfill and those surfaces that are normally not in view of either vehicular or pedestrian traffic such as the surfaces on the inside of barrels of culverts, the under surfaces of decks, surfaces of concrete girders, piers and abutment walls.

Surfaces requiring Class II Finish — All exposed surfaces of headwalls, wingwalls, deck edges on culverts, end of piers on bridges and culverts, retaining walls and those vertical surfaces under highway grade separation structures that are exposed to view of the travelling public, including piers and pier caps, the outside face of outside girders, and other similar surfaces.

When surfaces of uniform texture and pleasing appearance are obtained through the use of first class metal forms, paper tubing or the use of special form coatings and the use of special care, such surfaces may, upon approval of the Engineer, be excluded from the surfaces requiring Class II Finish.

Surfaces requiring Class III Finish for bridge structures — All formed or finished surfaces above the surface of the deck on the roadway side of the handrail and the outside vertical surfaces from the top of handrail and dado to the lower edge of the chamfer at the bottom of the deck.

SECTION 505

505.10 PAYMENT:

Payment for portland cement concrete structures will be made in conformity with the terms of the contract and will be based on unit prices and/or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, materials, tools and equipment, preparation of subgrade for placing of concrete and doing all work required to construct the structures in conformity with the plans and specifications.

Where concrete is scheduled for payment on the basis of cubic yards, the calculation of the quantity of concrete for payment will be made only to the neat lines of the structures as shown on the plans and on the basis of the concrete having the specified lengths, breadths, and thicknesses. However, all concrete shall be placed to line and grade within such tolerances as, in the opinion of the Engineer, are reasonable and acceptable for the type of work involved. The quantity of such concrete will be calculated considering the mortar used to cover construction joints as being concrete and no deductions will be made for rounded or beveled edges, space occupied by reinforcing steel, metal inserts, or openings 5 square feet or less in area. The cost of cement used in mortar for covering construction joints, patching, or other uses in the structure being constructed, in excess of that required for the design mix of the adjacent concrete, shall be absorbed in the item of work of which said mortar is a part.

The quantity of reinforcing steel, when scheduled as a separate item, will be calculated for payment on the basis of the number of each type bar actually placed in accordance with the plans or with the instructions of the Engineer. The weight will be calculated using the theoretical lengths of bars placed and the unit weight per linear foot specified in ASTM A-305.

SECTION 506

PRECAST PRESTRESSED CONCRETE MEMBERS

506.1 DESCRIPTION:

This work shall consist of furnishing and placing precast prestressed concrete members in accordance with the details shown on the plans, and as provided in these specifications and the special provisions.

This work shall include the manufacture, transportation and storage of girders, slabs, piling, and other structural members of precast prestressed concrete and shall also include the placing of all precast prestressed concrete members, except piling which shall be placed as provided for concrete piling.

The members shall be furnished complete including all concrete, prestressing steel, bar reinforcing steel, and incidental materials in connection therewith.

Prestressing may be performed by either pretensioning or posttensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements provided in these specifications.

Prior to casting any members to be prestressed, the Contractor shall submit to the Engineer for review complete details of the method, materials and equipment he purposes to use in the prestressing operations, including any additions or rearrangement of reinforcing steel from that shown on the plans. Such details shall outline the method and sequence of stressing and shall include complete specifications and details of the prestressing steel and anchoring devices, anchoring stresses, type of

enclosures, and all other data of the prestressing steel in the members, pressure grouting materials and equipment. For any rearrangement of prestressing tendons the stress calculations shall be submitted for approval by the Engineer.

506.2 CONCRETE:

Concrete construction shall conform to the provisions in Section 505.

The Contractor shall be responsible for furnishing concrete for prestressed members which contains not less than 611 nor more than 752 lbs., of cement per cubit yard of concrete, which is workable and which conforms to the strength requirements specified. Batch proportions shall be determined by the Contractor.

The compressive strength of the concrete will be determined from concrete test cylinders cured under conditions similar to those affecting the member.

The use of admixtures for the purpose of producing high strength at an early date shall be subject to the approval of the Engineer. In no case shall calcium chloride or any additive containing calcium chloride be used in concrete for prestressed construction.

Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement, enclosures, anchorages, and prestressing steel.

The concrete shall be vibrated internally or externally, or both, as required to consolidate the concrete. The vibrating shall be done with care and in such a manner that displacement of reinforcement, enclosures, and prestressing steel will be avoided.

Holes for anchor bars, and for diaphragm dowels which pass through the member, openings for connection rods, recesses for grout and holes for railing bolts shall be provided in the members in accordance with the details shown on the plans. Where diaphragm dowels do not pass through the member, the dowels may be anchored in the member by embedment in the concrete or by means of an approved threaded insert.

Forms for interior cells or voids in the members shall be constructed of a material that will resist breakage or deformation during the placing of concrete and will not materially increase the weight of the member.

Forms may be removed when permitted by the Engineer provided that the concrete is not damaged in so doing and that adequate curing is provided. The members shall be properly supported to prevent dead load bending at all times prior to initial tensioning. After prestressing, the members shall be handled or supported at or near the final bearing points for storage.

The members shall be supported in transporting in a manner that will allow reasonable conformity to the proper bearing points with consideration for the limitations of adequate hauling equipment. At all times members shall be handled or supported securely in an upright position, avoiding tipping or racking.

Lifting devices shall not project above the surface of the member after erection unless they will be imbedded in a subsequent concrete pour, have a minimum concrete cover of 2 inches and do not interfere with the placement of reinforcing steel or concrete.

The steam curing method or other approved methods may be used for curing precast prestressed concrete members in lieu of water curing. Steam curing, if elected by the Contractor, shall conform to the following provisions:

(A) After placement of the concrete, members shall be held for a minimum 2-hour presteaming period. The initial application of the steam shall be from 2 to 4 hours after the final placement of concrete to allow the initial set of the concrete to take place.

(B) All exposed surfaces of the members shall be kept wet continuously during the holding and curing period.

(C) The steam shall be saturated below pressure and shall be distributed uniformly over all exposed surfaces of the member and shall not impinge on the exposed concrete surfaces.

(D) The steam hood shall be equipped with temperature recording devices that will furnish an accurate continuous permanent record of the temperatures under the hood during the curing period. The position of the temperature devices shall be approved by the Engineer.

(E) During application of the steam the ambient air temperature shall increase at a rate not to exceed 40°F. per hour until a maximum temperature of from 140°F. to 160°F. is reached. The maximum temperature shall be held until the concrete has reached the desired strength.

506.3 PRESTRESSING STEEL:

Prestressing steel shall be high-tensile wire conforming to ASTM A-421, high-tensile wire strand conforming to ASTM A-416, or high-tensile strength alloy bars conforming to the following requirements:

High-tensile strength alloy bars shall be thermal stress relieved to produce a suitable metallurgical structure and shall be individually proof-tested during the process of manufacturing to a minimum of 90 percent of the manufacturer's minimum guaranteed ultimate strength. The mechanical properties of the completed bars shall be as follows:

	Regular Grade	**Special Grade**
Ultimate tensile strength psi. min.	145,000	160,000
Yield strength, measured by the 0.7 percent extension under load method, psi. min.	130,000	140,000
Elongation in 20 bar diameters after rupture, percent, minimum	4.0	4.0
Reduction of area, percent, min.	25.0	20.0
Modulus of elasticity at 70 percent of the manufacturer's minimum guaranteed ultimate strength psi. min.	$25X10^6$	$25X10^6$

Diameter tolerances shall conform to ASTM A-29

Bars of different ultimate strength shall not be used interchangeably in the same member, unless otherwise permitted by the Engineer.

In handling and shipping bars, every care shall be taken to avoid bending, injury from deflection, scraping or overstressing of the bars. All damaged bars will be rejected.

All wire and strand to be post-tensioned shall be:

(A) Protected from corrosion during shipping by a factory treatment or processing.

(B) Protected against abrasion during shipment and handling.

Wires shall be arranged to produce equal stress in all wire of wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the enclosures.

Where wires are to be button-headed, the buttons shall be cold formed symmetrically about the axes of the wires, and shall develop the full strength of the wire. No cold forming process shall be used that causes indentations in the wire.

When the button-headed wire assembly is tested as a unit in tension at least 90 percent of the failures at or above the minimum guaranteed ultimate strength of the wire shall occur in the wire and not in the buttons.

All prestressing steel shall be protected against rust and other corrosion and damage and shall be free of all dirt, scale and pits due to rust, oil, grease and other deleterious substances when finally encased in concrete or grouted in the member.

506.4 ANCHORAGES AND DISTRIBUTION:

All post tensioned prestressing steel shall be secured at the ends by means of approved anchoring devices. The anchors shall be of such nature that they will not kink, neckdown or otherwise damage the prestressing steel.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete.

Anchoring devices for all post-tensioned prestressing steel shall be of the permanent type.

Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts except tendons of the anchoring devices will be at least 2 inches inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with grout, and finished flush.

When headed wires are used, the outside edge of any hold for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate shall not be less than ¼ inch from the root of the thread of the washer or from the edge of the ring or plate.

Distribution plates or assemblies shall conform to the following requirements:

(A) The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed 3,000 psi, and a suitable grillage of reinforcing steel shall be used in the stressed area.

(B) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed design working stress, as determined by the Engineer, in the anchorage plate when 100 percent of the ultimate load is applied.

(C) Materials and workmanship shall conform to the requirements in Section 515.

Should the Contractor elect to furnish anchoring devices of a type which are sufficiently large and which are used in conjunction with a steel grillage imbedded in the concrete that effectively distributes the compressive stresses to the concrete and steel distribution plates or assemblies may be omitted.

506.5 ENCLOSURES:

Enclosures for prestressing steel shall be metallic and mortar-tight and shall be accurately placed at the locations shown on the plans or approved by the Engineer.

In lieu of metallic enclosures, openings for prestressing steel may be formed by means of cores or ducts composed of rubber or other suitable material that can be removed prior to installing prestressing steel.

All enclosures or openings or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

506.6 PRESTRESSING:

All prestressing tendons shall be tensioned by the use of equipment allowing actual elongation to be measured directly and using a hydraulic ram equipped with an accurate method of determining the tensioning force applied using one of the following methods; a gauge measuring the internal hydraulic pressure in the ram, or force exerted by the ram; a spring-type dynamometer used with the tensioning force applied directly; an electronic load cell used with the tensioning force applied directly. Readings taken from any one of these gauges shall be converted to actual tensioning forces through the use of calibrated values taken from a certified chart from a recent calibration. All gauges shall be of sufficient size and adequately made to allow accurate readings to be made of load increments of 1 percent of the total capacity of the ram used, not to exceed 2 percent of the tensioning force used.

The force in each tendon as obtained from the calibrated value shall be compared with the tensioning force obtained from calculation using the modulus of elasticity, cross-sectional area and length of tendon for the actual net elongation measured directly. When there is a difference between the values in excess of 5 percent final anchorage of the tendon shall be delayed until the reason for the discrepancy is found and appropriate correction is made to reduce the difference to 5 percent or less. Within the allowable difference, final anchorage shall be made when the required tensioning force is obtained according to the elongation used in pretensioning and according to the corrected gauge reading in post-tensioning.

The tensioning of prestressing steel in any post-tensioned member and the cutting or releasing of prestressing steel in any pretensioned member shall not be performed until tests on concrete cylinders indicate that the concrete in the member has attained a compressive strength of not less than the value shown on the plans for transfer strength.

Subject to prior approval by the Engineer, a portion of the total prestressing force may be applied to a member when the strength of the concrete in the member is less than the value shown on the plans and the member may then be moved. Approval by the Engineer of such partial prestressing and moving shall in no way relieve the Contractor of full responsibility for successfully constructing the members.

The cutting and releasing of prestressing steel in pretensioned members shall be performed in such an order that lateral eccentricity of prestress will be a minimum. The prestressing steel shall be cut off flush with the end of the member and the exposed ends of the prestressing steel shall be heavily coated with roofing asphalt or coal tar.

Post-tensioning will not be permitted until it is demonstrated to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the enclosure.

The tensioning process as applied to post-tensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times. A record shall be kept of gauge pressures and elongations at all times and shall be submitted to the Engineer for approval.

Draped prestressing steel in post-tensioned members shall be tensioned by simultaneous jacking at each end of the assembly, except where low frictional forces permit tensioning from one and as determined by the Engineer.

Determination of the jacking stresses shall be supported by calculations, or both calculations and field tests when specified, prepared by the Contractor. The Contractor shall submit his calculations to the Engineer for approval, and prior to making field tests shall submit details of his proposed gauges and load devices for determining the jacking load at each end of the test prestressing unit to the Engineer for approval. The stress at the center will be calculated from the average of the end test loads, when tests are required. Jacking stresses within 2 percent of the specified values will be considered satisfactory.

The following friction coefficients shall be used in calculating friction losses. K represents the wobble of the ducts, and U represents the curvature in draped cables:

Type of Steel	Type of Duct	K	U
Bright metal wire or strand	Bright metal	0.002	0.30
	Galvanized	0.0015	0.25
Bright metal bars	Bright metal	0.0003	0.20
	Galvanized	0.0002	0.15

The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 75 percent of the ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans but in no case shall the initial stress exceed 70 percent of the ultimate tensile strength of the prestressing steel.

506.7 BONDING AND GROUTING:

Post-tensioned prestressing steel shall be bonded to the concrete by pressure grouting the enclosures or openings.

All prestressing steel to be bonded to the concrete shall be free of scale and pits due to rust, dirt, oil, grease and other deleterious substances.

Grouting equipment shall be capable of grouting to a pressure of at least 100 psi. The grouting shall consist of neat cement and water conforming to the provisions in Section 725. The grout shall completely fill the enclosure or opening.

All enclosures or openings shall be clean and free of all foreign materials that would impair bonding of the grout. Each enclosure or opening shall be thoroughly flushed out with water and blown out with air or cleaned by other approved methods immediately prior to grouting.

After post-tensioned prestressing steel has been pressure grouted, the member shall not be moved or otherwise disturbed until at least 24 hours have elapsed.

506.8 SAMPLES FOR TESTING:

Sampling and testing shall conform to the specifications of ASTM A-416 and A-421 as provided in this specification.

Samples from each size and each lot of prestressing steel wires and bars, from each manufactured reel of prestressing steel strand, and from each lot of anchorage assemblies and bar couplers to be used shall be furnished for testing.

All wire or bars of each size from each mill lot and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

The following samples of material and tendons, selected by the Engineer from the prestressing steel at the plant or job site, shall be furnished by the Contractor to the Engineer well in advance of anticipated use:

(A) For wire or strand one 7 foot long sample shall be furnished for each heat or reel and for bars one 6 foot long sample shall be furnished for each heat.

(B) If the prestressing tendon is to be prefabricated, one completely fabricated prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies. If the prestressing tendon is to be assembled at the job site, sufficient wire or strand and end fittings to make up one complete prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies.

(C) If the prestressing tendon is a bar, one 6 foot length complete with one end anchorage shall be furnished and in addition if couplers are to be used with the bars two 3 foot lengths of bar equipped with one coupler and fabricated to fit the coupler shall be furnished.

Prestressing systems previously tested and approved need not be furnished as complete tendon samples, provided there is no change whatsoever in the material, design or details previously approved. Shop drawings shall contain an identification of the project on which approval was obtained, otherwise sampling will be necessary.

For prefabricated tendons, the Contractor shall give the Engineer at least 10 days notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect all end fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for all required testing of the material to be shipped to the site.

No prefabrication tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.

Job site or site as referred to herein shall be considered to mean the location where the members are to be manufactured whether at the project site or a removed casting yard.

The release of any material by the engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

506.9 HANDLING:

Extreme care shall be exercised in handling, storing, moving and erecting precast prestressed concrete members to avoid twisting, racking or other distortion that would result in cracking or damage to the members. Precast prestressed members shall be handled, transported and erected in an upright position and the points of support and

directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position.

Precast prestressed concrete members shall be placed in the structure in the conformity with the plans and special provisions for the structure to be constructed.

Precast prestressed concrete piling shall be placed in accordance with the provisions for concrete piling.

506.10 PAYMENT:

Precast prestressed concrete members, except piling, will be paid for at the contract price or prices for furnishing and erecting precast prestressed concrete members of the various types and lengths set forth in the proposal.

The contract price paid for furnishing the member shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all work involved in constructing and furnishing the member at the site of the work complete in place as shown on the plans, and as specified.

Partial payment will be allowed for members which are in the stockpile at the manufacturer's plant.

SECTION 510

CONCRETE BLOCK MASONRY

510.1 DESCRIPTION:

All materials for concrete block masonry shall conform to the requirements of Section 775 and 776.

510.2 CONSTRUCTION:

Proper masonry units shall be used to provide for all windows, doors, bond beams, lintels, pilasters, etc. with a minimum of unit cutting. Where masonry unit cutting is necessary, all cuts shall be neat and regular and edges exposed in the finished work shall be cut with a power driven abrasive saw.

Where no bond pattern is shown, the wall shall be laid up in straight uniform course with regular running bond with alternate header joints in vertical alignment.

Intersecting masonry walls and partitions shall be bonded by staggering the joints to form a masonry bond and the use of ¼ inch minimum diameter ties at 24 inches o.c. maximum.

Where stack bond is indicated on the plans, approved metal ties shall be provided horizontally at 24 inches o.c. maximum.

Where masonry facing is a part of wall construction metal ties shall be furnished and installed as directed by the Engineer.

Mortar joints shall be straight, clean and uniform in thickness. Unless otherwise specified or detailed on the plans, horizontal and vertical joints shall be approximately ⅜ inch thick with full mortar coverage on the face shells; shall have vertical joints buttered well for a thickness equal to the face shell of the block and these joints shall be shoved tightly, so that the mortar bonds to both both blocks. No slushing or grouting of a joint will be permitted, nor shall a joint be made by working in mortar after the units have been laid.

Exposed walls shall have joints tooled with a round bar or V-shaped bar to produce a dense, slightly concave surface well bonded to the block at the edges. Tooling shall be done when the mortar is partially set but still sufficiently plastic to bond. All tooling shall be done with a tool which compacts the mortar, pressing the excess mortar out of the joint rather than dragging it out.

If it is necessary to move a block so as to open a joint the block shall be removed from the wall, cleaned and set in fresh mortar.

510.3 PLACING REINFORCING STEEL:

Reinforcing steel shall be placed as indicated on the plans. Splices shall be lapped a minimum of 40 diameters, except that dowels other than column dowels need to be lapped only 30 diameters. Column dowels shall lap 50 diameters.

Outside horizontal steel shall lap around corners 40 diameters, and be carried through columns unless otherwise shown on the plans. Inside horizontal steel shall extend as far as possible and bend into corner core. A dowel shall be provided in the foundation for each vertical bar. Bending of dowels to fit openings will not be permitted and, where required, new dowels shall be installed by drilling and grouting. All lap joints shall be wired.

Vertical cores containing steel shall be filled solid with grout, and thoroughly rodded.

Where knockout blocks are used, steel shall be erected and wired in place before 3 courses have been laid. Vertical cores at steel locations shall be filled as construction progresses.

Where knockout blocks are not used, vertical cores at steel locations shall be filled in lifts of not more than 4 feet. The maximum height of pour shall be 8 feet. Cores shall be cleaned of debris and mortar and shall have reinforcing steel held straight in place. If ordered by the Engineer, inspection and cleanout holes shall be provided at the bottom of each core to be filled.

Reinforcing steel shall be inspected prior to placing grout.

510.4 CURING:

Newly constructed masonry shall be kept damp for at least 5 days with a nozzle regulated fog spray sufficient only to moisten faces of the masonry but not of such quantity as to cause water to flow down over the masonry.

510.5 MORTAR AND GROUT:

Mortar and grout used for concrete block masonry shall conform to Section 776.

510.6 PAYMENT:

Payment for concrete block masonry will be included in the lump sum price for the structure of which the masonry is a part, unless another basis for payment is included in the proposal.

SECTION 511

BRICK MASONRY

511.1 MATERIALS

Unless otherwise specified, brick masonry shall be constructed of brick conforming to Section 775 and cement mortar as described in Section 776.

511.2 BRICKLAYING:

The amount of wetting will depend on the rate of absorption of the brick at the time of laying. When being laid, the brick shall have suction sufficient to hold the mortar and to delete the excess water from grout, and shall be sufficiently damp so that the mortar will remain plastic enough to permit the brick to be leveled and plumbed after being laid without beaking the mortar bond.

Brick work shall be plumb, level, straight and true to dimensions shown on the plans. Such work shall start, where feasible, at a least important corner of wall and the masonry contractor shall request an early inspection of the work by the Engineer. All pattern work, bonds or special details indicated on the plans shall be accurately and uniformly executed. Face bonding shall be as shown on the plans, but if not shown, shall be running bond for standard size brick and approximately ⅓ bond for oversize brick and approximately ¼ bond for modular brick unless otherwise designated by the Engineer. All bed and head joints shall be solidly filled with mortar at the time of laying.

Unless otherwise shown or detailed on the plans the thickness of mortar joints shall be uniformly ½ inch.

Face bricks shown to be laid in stack bond shall have the center lines of vertical joints plumb and the brick laid equidistant from the center line with not more than ⅛ inch variation in the width of these joints. The brick in each separate stack shall not vary more than ⅛ inch in length, but the separate stacks may vary in width of stacks.

When mortar has slightly stiffened, solidly fill with mortar all interstices between bricks and between bricks and other materials and also fill all line pin holes. Jointing and tooling shall be done before mortar has stiffened.

Masonry to be plastered shall have all mortar joints trowel cut flush.

Masonry to be painted and not shown to be tooled or raked, shall have all joints carefully and evenly struck with a trowel.

Masonry to be left exposed without paint or plaster, shall have all mortar joints carefully and evenly tooled with a metal jointing tool of a type as approved by the Engineer. Masonry shown or indicated to have raked joints shall have the joints raked out ⅜ inch deep, then tooled with a flat jointing tool, then brushed with a stiff non-metallic brush, Sack-rubbing or wiping finished masonry with rags will not be permitted.

511.3 PROTECTION:

Protect all sills, ledges, offsets, other materials, etc., from droppings of mortar during construction. Protect the tops of all unfinished masonry from rain by using water-repellant covering such as roofing felt or tar paper.

Protect the surfaces of wall, piers, etc., from mortar droppings, or splashes at scaffold heights.

511.4 CURING:

Finished masonry shall not be wetted, except when exposed to extreme hot weather or hot wind, and then only by using a nozzle regulated fog spray sufficent only to dampen the face but not of such quantity to cause water to flow down over the masonry.

SECTION 511

511.5 REINFORCED GROUTED BRICK MASONRY:

Mortar in all bed joints shall be held back ¼ inch from edges of brick adjacent to grout space, or shall be beveled back and upward from grout space. The thickness of head and bed joints shall be as hereinbefore specified or shown. Head joints specified or shown to be less than ⅝ inch thick shall be solidly filled with mortar as brick are laid. Head joints ⅝ inch or more in thickness may have mortar sufficient only to form dams to retain the grout. Bed joints shall not be deeply furrowed with the trowel. All brick shall be shoved at least ½ inch into place. One outer tier shall be not more than 12 inches before grouting, but the other tier shall be not more than 4 inches high before placing the grout. Grout shall be thoroughly agitated and mixed to eliminate segregation before being placed. All interior grout spaces shall be filled with grout and immediately puddled or swished with a stick or rod (not a trowel) sufficiently to cause the grout to flow into all interstices between the bricks and to fully encase the reinforcing steel. Wherever possible, grouting shall be done from the inside face of exterior masonry. If any grout contacts the finished masonry, it shall be immediatly removed, and the surface cleaned.

In masonry which is more than 2 tiers in thickness, including pilasters and column, the interior shall be of whole or half bricks placed into grout with not less than ¾ inch of grout surrounding each brick or half brick. Except at the finish course, all grout shall be stopped 1½ inches below the top of both outer tiers. Where necessary to stop off a longitudinal run of masonry, it shall be done only by racking back ½ brick length in each course and stopping grout 2 inches back of the rack. Toothing will not be permitted unless special approval is given by the Engineer.

Reinforcing steel shall be accurately placed in strict accordance with the plans and notes thereon. Vertical steel shall be held firmly in proper position. Where necessary this shall be done by means of frames or other suitable devices. Horizontal steel may be placed as the work progresses.

511.6 PAYMENT;

Payment for brick masonry will be included in the lump sum price for the structure of which the masonry is a part unless another basis for payment is included in the proposal.

SECTION 515

STEEL STRUCTURES

515.1 DESCRIPTION:

515.1.1 Shop Drawings: The Contractor shall prepare and submit to the Engineer for approval, complete shop drawings which shall show details, dimensions, sizes of material, and all information and data necessary for the metal work, including full details of the match markings. Any materials fabricated by the Contractor prior to the approval of the drawings will be at his risk. The Contractor shall be responsible for the correctness of the drawings and for shop fits and field corrections, even though the drawings may have been approved by the Engineer.

515.1.2 Falsework: The Contractor shall be fully responsible for designing and providing falsework capable of supporting all loads which are applied.

515.1.3 As Built Plans: When required by the special provisions, the Contractor shall furnish to the Engineer before formal acceptance of the work detailed plans of

the structure as built. Inasmuch as the plans will be retained by the Contracting Agency as permanent records, they must be in the form of printable transparencies of quality satisfactory to the Engineer.

515.1.4 Methods and Equipment: When requested by the Engineer, before starting erection of any structural members, the Contractor shall inform the Engineer fully as to the methods he proposes to follow and the amount and character of equipment he proposed to use. The use of such methods and equipment shall be subject to the approval of the Engineer. Approval by the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment or for carrying out the work in full accordance with the plans and specifications.

An inspector or other authorized representative of the Engineer may examine the metals and metal items to be fabricated before they are worked in the shop and may exercise constant surveillance over the work during its progress, with full power to reject materials or workmanship not conforming to the plans and specifications.

The Contractor shall give the Engineer sufficient advance notice to permit ample time for the inspection of materials before commencement of the fabricating operations.

The Engineer shall be furnished complete copies in triplicate of all mill reports. The Contractor shall furnish ample means and assistance for sampling all materials. Arrangements shall be made for the Engineer to have free access at all times to any portion of the shops where work is being done.

No fabricating, machining, cutting, welding, assembling, or painting shall be done except with the knowledge of the Engineer. Any work done otherwise will be subject to rejection.

The acceptance of any material or finished member by the Engineer shall not be a bar to subsequent rejection if it is later found to be defective. Rejected material and workmanship shall be promptly replaced.

Samples of materials, except castings, shall be cut from stock designated by the Engineer or will be selected from items furnished. Gray iron, steel, and bronze castings shall be cast with test coupons.

515.2 STEEL BUILDING AND MISCELLANEOUS STEEL STRUCTURES:

Details of design, fabrication and erection of such buildings and structures shall conform to the specifications for the design, fabrication and erection of structural steel for buildings of the AISC except as modified by the special provisions for any conflicts with the applicable building code which may exist.

The design, fabrication and erection of structural steel and all similar work incidental or appurtenant to steel construction for highway bridges shall be performed in accordance with the latest standard specifications for highway bridges adopted by AASHTO. The plans or special provisions will designate the members to be galvanized.

515.2.1 Miscellaneous Metal Fabrication: The provisions of this subsection shall apply to items not intended primarily for structural purposes and which are fabricated from metals.

If straightening of any material is necessary, the straightening shall be done by methods which will restore the material to its original shape or surface without residual blemish. Sharp kinks or bends will be considered a cause for rejection of the materials.

The finish of miscellaneous metal items shall not be less in quality and workmanship than that standard considered to be the commercial standard for the kind of member being furnished. Punched and drilled holes shall be burred and, unless otherwise specified, sheared and machined edges shall be finished by grinding to an appropriate radius. Riser, sprue, or vent marks on castings shall be ground flush with the adjacent surface. Blow holes in castings shall not be repaired by any method except as authorized in advance by the Engineer. Exposed edges of sheet metal shall be dressed with a stone or file to remove the sharp edges or corners. Drilled or punched holes which are improperly located or misaligned shall be cause for rejection and may not be corrected without the prior approval of the Engineer. All parts of assemblies shall be fabricated so that they may be assembled without forcing or drifting.

Welders proposed to be used on miscellaneous metal fabrication will be subject to qualifications.

515.3 WORKMANSHIP:

Workmanship and finish shall be equal to the best general practice in modern bridge shops.

Rolled material before being laid off or worked shall be straight. If straightening is necessary it shall be done by methods approved by the Engineer. Kinks and bends may be cause for rejection of the material.

If straightening is necessary in the field only methods approved by the 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 shall 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.

515.4 COMPUTED WEIGHT:

The computed weight shall be obtained by the use of the following rules and assumptions:

(A) The weight of structural and cast steel shall be assumed at 0.2833 pound per cubic inch. The weight of cast iron shall be assumed at 0.2604 pound per cubic inch. The weight of wrought iron shall be assumed at 0.2776 pound per cubic inch.

(B) The weights of rolled shapes and of structural plates, shall be computed on the basis of their nominal weights and dimensions, as shown on the shop drawings, deducting for copes, cuts, and open holes, exclusive of rivet or bolt holes.

(C) Rivets, bolts, and welds shall be considered as incidentals and their price shall be included in the price of steel shapes and plates.

(D) The weight of castings and fillets shall be computed from the dimensions shown on the shop drawings, deducting for all openings or cuts in the finished casting.

(E) The weight of pins and rollers shall be computed from the dimensions shown on the shop drawings, deducting for all holes, openings, pockets, and metal removed by machine finishing.

Pilot nuts and driving nuts for each size of pin shall be furnished for erection work and the weights of such nuts will not be included in the weight of structural steel to be paid for.

(F) If computed weights are used to determine the pay quantities of galvanized metal, the weight to be added to the calculated weight of base metal for the galvanizing shall be determined from the table of weights of zinc coatings specified by the ASTM A-153.

515.5 PAINTING:

With the exception of items which are to be galvanized, structural steel members and miscellaneous metal items shall have a shop prime coat of approved rust-inhibitive paint. Application shall be as specified in Section 530. The thickness of the prime coat shall be not less than one mill.

After erection of structural steel uncoated surfaces at connections, surfaces where the shop coat has been abraded or otherwise damaged shall be touched up. Match marks and identification marks shall be properly cleaned off and painted over. The paint shall be identical to that used for the shop prime coat.

515.6 MEASUREMENT:

Steel structures will be paid for at a lump sum price or at a price per pound for structural steel, and at prices per pound for cast steel and cast iron. The pay quantities will be determined by computed weights or, by scale weights obtained as provided in this specification. Only material actually used in the completed structure will be paid for.

The pay quantities will be determined by computed weights for rolled sections and scaled weights for castings except as otherwise specified.

Computed weights will be used to determine pay quantities of alloy and carbon steel when members contain both alloy and carbon steel.

The weight of erection bolts, paint, boxes, crates, and other containers used for packing and the materials used for supporting members during transportation will not be included in the weights of material to be paid for.

The weight of structural steel to be paid for will not exceed the computed weight by more than 1½ percent. The weight of cast steel or cast iron to be paid for will not exceed the computed weights by more than 7½ percent. If the scale weight of any member is less than 99½ percent of the computed weight of that member, the member will be rejected and will not be paid for.

If computed weights are used, the weight to be paid for will be the calculated weight as established by the Engineer and no allowance will be made for weight in excess thereof.

515.7 PAYMENT:

Unless otherwise provided in the proposal, the basis of payment for steel structures shall be as follows:

The price paid per pound for structural steel including full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing, fabricating, delivering, erecting and prime coating the steel

work, complete in place, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

The prices paid per pound for cast steel, cast bronze and cast iron shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing the materials, complete in place, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

Full compensation for furnishing and placing sheet packing, preformed fabric pads, elastomeric or elastic bearing pads, and red lead paste, and for grouting masonry or bearing plates as shown on the plans shall be considerd as included in the price paid for structural steel and no separate payment will be made therefore. Where the specifications or plans require metal to be galvanized, the price paid per pound for the metal, including the weight of zinc coating, shall be considered as full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing the galvanized metal complete in place, as shown on the plans, and as specified in the specifications and the special provisions, and as directed by the Engineer.

SECTION 520

STEEL AND ALUMINUM HANDRAILS

520.1 DESCRIPTION:

Metal handrail shall consist of furnishing all materials and constructing handrail of steel or aluminum, including railing, posts, fittings and anchorages. Metal handrail shall be fabricated, installed and painted, when required, in accordance with the details shown on the plans and these specifications.

520.2 FABRICATION:

Prior to beginning any work on the fabrication of the railing, the Contractor shall submit shop drawings for approval, showing complete railing details.

Materials furnished for metal handrail shall conform to the requirements specified on the plans.

The Engineer shall be furnished complete, copies in triplicate of all mill reports on steel and aluminum materials furnished.

Railings shall be fabricated from welded or seamless members of the size and thickness shown on the plans. Steel members shall conform to the requirements of ASTM A-53. Grade B structural steel conforming to ASTM A-36, or tubular sections of hot rolled mild steel, as shown.

Welding shall be performed by the electric arc process and shall be done in conformance with Specifications for Welded Highway and Railway Bridges of the AWS. All butt welds on exposed surfaces shall be ground flush with adjacent surfaces.

Railing panels shall be straight and true to dimensions.

For structures on curves, either horizontal or vertical, the railing shall conform closely to the curvature of the structure.

The completed steel railing units shall be galvanized in accordance with the requirements of Section 771 unless otherwise specified.

520.3 ERECTION:

The railing shall be carefully erected, true to line and grade. Posts and balusters shall be vertical and parallel with the deviation from the vertical for the full height of the panel not exceeding ⅛ inch. After erecting the railing, any abrasions or exposed steel shall be repaired in accordance with Section 771 or Section 530.

520.4 MEASUREMENT:

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

520.5 PAYMENT:

The price paid per linear foot for handrailing shall include full compensation for furnishing all labor, materials, tools, and equipment and doing all work involved in constructing the railing complete in place as shown on the plans and specified herein.

SECTION 525
PNEUMATICALLY PLACED MORTAR

525.2 DESCRIPTION:

Pneumatically placed mortar shall consist of furnishing all materials and placing by means of suitable equipment and competent operators, premixed portland cement and aggregate, to which water is applied immediately prior to discharge from the nozzle. The mixture shall be placed at the locations shown on the plans in accordance with the details shown on the plans, these specifications, the special provisions, and as directed by the Engineer.

525.2 COMPOSITION OF MORTAR:

General: Pneumatically placed mortar shall consist of a mixture of portland cement, sand and water placed under pneumatic pressure. It is contemplated that 1 part, by weight, of cement will be used with the equivalent of 4 parts, by weight, of surface dry sand. The proportions may be modified, by not more than 20 percent, by the Engineer to suit the work of the nature of the materials used, and the Contractor shall be entitled to no extra compensation by reason of such modifications. The sand and cement shall be mixed thoroughly before being fed into the placing machine. The percentage of free moisture in the sand as it is fed into the placing machine shall be controlled within such limits as may be necessary for the maintenance of uniform feed and to avoid choking in the gun or discharge hose. Any moistening or drying of the sand that may be required to make the sand conform to this requirement shall be done by and at the expense of the Contractor. Machine mixing will be required. The mixing machine and its operation shall be subject at all times to the approval of the Engineer. The Contractor shall provide such means and equipment as are required to control accurately the relative amounts of cement, sand, and water entering the mortar, and such means and the equipment and its operation shall be subject at all times to the approval of the Engineer. The mortar shall be accurately proportioned by either the volume or weight method or by a combination of both. Any method used in the proportioning of the mortar shall be approved by the Engineer. The weighing equipment shall be in first-class operating condition. The amount of water used shall be that required to produce mortar of suitable consistency, quality, and uniformity with the minimum amount of rebound.

Pneumatically applied mortar, damaged from any cause, and any mortar which shall be found defective by reason of the Contractor's operations, at any time before the completion and acceptance of the work, shall be repaired or shall be removed and replaced by the Contractor with acceptable mortar as directed, at no additional cost to the Contractng Agency.

525.3 MATERIALS:

Cement for mortar shall be furnished by the Contractor, and shall conform to ASTM C-150 for portland cement, Type II, low alkali, and shall be free from lumps and damaged cement.

The water used for mortar shall be furnished by the Contractor, and shall be free from objectionable quantities of silt, organic matter, alkali, salts, and other impurities.

Sand for mortar shall be furnished by the Contractor from any approved source, and shall be natural sand. Any royalties or other charges required to be paid for materials taken from sources not owned or operated by the Contracting Agency shall be paid for by the Contractor. The Contractor will be held responsible for the specified quality of all such materials used in the work. Sand as delivered to the mixer, shall have a uniform moisture content of not more than 6 percent of the dry weight of this aggregate. The sand as batched shall be well graded and shall conform to the requirements of ASTM C-33.

Reinforcement shall be 4 × 4 inch No. 12 gage electric welded wire fabric placed so that it shall be not less than ¼ inch from the unexposed surface nor less than ¾ inch from the exposed surface of the mortar. Adjacent sheets shall overlap at least one square of the mesh and be securely tied with wire.

525.4 JOINTS:

Joints shall be placed in accordance with the details shown on the plans. The spacing shall be such that they will match any adjacent curb and gutter joints.

525.5 PLACING THE MORTAR:

When the mortar is placed on earth slopes, the Contractor shall, upon completion of the rough grading, remove all loose, sandy material that will not, in the opinion of the Engineer, adequately compact. This material shall be replaced by material having sufficient binder to insure compaction and consolidation, Prior to placing the mortar, the surface shall be compact and true to line and grade.

Pneumatically placed mortar shall be placed only in the presence of a duly authorized inspector. The temperature of the mortar when it is being placed shall be not more than 90°F. and not less than 40°F. as determined by the Engineer. All absorptive surfaces against which pneumatically placed mortar is to be placed shall be moistened so that moisture will not be drawn from the freshly placed mortar. The type of equipment used for applying the pneumatically placed mortar and the operation of the equipment will be subject to the approval of the Engineer. At the time of application, there shall be no free water on surfaces upon which mortar is to be placed but surfaces shall be moist. The mortar shall be placed by pneumatic pressure from a nozzle held about 3 to 5 feet from the surface and unless otherwise directed by the Engineer, in a stream as nearly normal as possible to the surface being covered. The pressure in the placing machine shall be maintained uniformly at not less than 35 psi for hose lengths up to 100 feet, and shall be increased as approved by at least 5 psi for each additional 50 feet of hose or fraction thereof. The Contractor shall furnish; install, and maintain

in satisfactory operation suitable pressure gages for indicating air and water pressures and a suitable meter for indicating the amount of water being fed to the nozzle. Care shall be taken to prevent the formation of sand pockets, and should sand pockets be formed, they shall be removed immediately and replaced with suitable mortar by the Contractor at no additional cost to the Contracting Agency. Hand patching will not be permitted. The length of section placed in one continuous operation shall be subject to the approval of the Engineer.

525.6 FINISHING MORTAR:

The finished surface shall be equivalent, in evenness, smoothness, and freedom from rock pockets and surface voids, to that obtained by effective use of a long-handled burlap trowel.

The method of obtaining the desired finish shall be at the discretion of the Contractor, subject to the approval of the Engineer.

525.7 CURING MORTAR:

As soon as the pneumatically placed mortar has hardened sufficiently, it shall be cured by membrane curing. Membrane curing shall be by application of a white-pigmented sealing compound which shall be furnished by the Contractor, and shall conform to the requirements under ASTM C-309 for Type 2. Sealing compound shall be applied to the pneumatically placed mortar surfaces by spraying, in 2 coats, to provide a continuous uniform, white membrance over all the area. Coverage shall not exceed a total of 110 square feet per gallon, and shall be decreased as necessary to obtain the required continuous membrane.

525.8 TESTS:

During the application of the pneumatically placed mortar the Contractor shall cooperate with the Engineer in making compressive tests required to determine the quality of mortar being placed in the work. The tests shall be conducted in conformity with requirements of ASTM C-39. Test specimens shall be made so as to represent the quality of mortar being placed in the work by each nozzleman. Separate test specimens made at the same place and time shall be tested at the age of 7 days and 28 days. The specimens at the age of 7 days shall develop a minimum compressive strength of 2,400 psi and at the age of 28 days the specimens shall develop a minimum compressive strength of 3,500 psi. In lieu of the above tests the Engineer may elect to core tests. A minimum of three cores shall be taken for each 250 cubic yards or fraction thereof.

Cores shall be obtained and tested in accordance with ASTM C-42. One core shall be removed and tested at an age of 14 days, the other 2 cores at an age of 28 days.

Fourteen day cores shall develop a minimuim strength of 2,440 psi. Twenty-eight day cores shall develop a minimum strength of 3,500 psi.

If cores show deficient strength, additional cores shall be taken at the Contractor's expense from adjacent areas. Two cores shall be required for each deficient core. Should such deficiency be evident in 14 day cores, on approval of the Engineer, the Contractor may proceed with the work on his own responsibility until the 28 day cores are tested.

Where conditions preclude the possibility of obtaining cores in place, the Engineer may approve cores taken from a representative test panel made at the same time and under the same conditions as the structural pneumatically placed mortar.

SECTION 525

525.9 PAYMENT:

Payment for pneumatically placed mortar will be made in conformity with the terms of the contract, will be based on unit prices and/or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, materials, tools and equipment and doing all work required to complete the work in conformity with the plans and specifications.

SECTION 530

PAINTING

530.1 DESCRIPTION:

This work shall consist of furnishing paint and other necessary materials and painting metal, wood or other surfaces in accordance with the details shown on the plans and these specifications.

530.2 MATERIALS:

Materials used in paint for painting shall conform to the requirements of Section 790.

530.3 WEATHER CONDITIONS:

Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather. Except as provided below, painting will not be permitted when weather conditions during application are such that the atmospheric temperature will drop below 35°F. during the drying period. If fresh paint is damaged by the elements, it shall be replaced by the Contractor at no additional cost to the Contracting Agency.

Subject to the approval of the Engineer, the Contractor may provide suitable enclosures to permit painting during inclement weather. Provisions must be made to control atmospheric conditions artificially inside the enclosures within limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work and no additional payment will be made therefore.

530.4 APPLICATION:

Painting shall be done in a neat and workmanlike manner. Unless otherwise specified paint shall be applied either by brush, roller, or spray methods.

If brushes are used, they shall have sufficient body and length of bristle to spread the paint in a uniform coat. In general, the primary movement of the brush shall be such as to fill thoroughly all irregularities in the surface, after which the coating shall be smoothed by a series of parallel strokes. Paint shall be evenly spread and thoroughly brushed out. If a considerable amount of brush marks appear, it will be considered that the paint has been improperly applied. If rollers are used they shall be of a type that do not leave a stippled texture in the paint film.

On all surfaces which are inaccessible for brushing, the paint shall be applied by spray or by sheepskin daubers especially constructed for the purpose, or by other means approved by the Engineer.

If spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush.

A water trap acceptable to the Engineer shall be furnished and installed on all equipment used in spray painting.

Mechanical mixers shall be used to mix the paint. The paint shall be mixed a sufficient length of time, prior to use, to thoroughly mix the pigment and vehicle together. Paint shall be kept thoroughly mixed while being applied.

530.5 THINNING PAINT:

Paints specified are formulated ready for application and no thinning will be allowed. If the paint becomes thick in cool weather, it shall be heated in the container immersed in hot water.

530.6 PROTECTION OF WORK:

The Contractor shall protect all parts of the structure against disfigurement by spatters, splashes, and smirches of paint or of paint materials. The Contractor shall be responsible for any damage caused by his operations to vehicles, persons, or property, and shall provide protective means to guard against such damage at his expense.

Paint stains which might result in an unsightly appearance shall be removed or obliterated by the Contractor.

When ordered by the Engineer, if traffic causes an objectionable amount of dust, the Contractor shall sprinkle the adjacent roadbed and shoulders with water for a distance on each side of the location where painting is being done sufficient to abate the dust nuisance. The Contractor shall furnish and post at his own expense DRIVE SLOWLY signs and take other necessary precautions to prevent dust and dirt from accumulating on freshly painting surfaces.

530.7 SAFETY PRECAUTIONS:

The following safety precautions shall be observed in addition to those prescribed by law in Section 107.

The applicable sections of NACE, A Manual for Painter Safety.

530.8 SURFACE PREPARATION FOR PAINTING:

530.8.1 Steel: Surface preparation for painting steel shall conform to the surface preparation specifications of the Steel Structures Painting Council.

Unless otherwise specified the commercial blast method shall be used.

530.8.2 Galvanized Surfaces:

(A) Hand Cleaning: Concrete spatter, heavy grease, and other foreign matter shall be removed from galvanized surfaces by hand scraping or wire brushing.

(B) Solvent Cleaning: After hand cleaning, all galvanized surfaces shall be cleaned by the solvent cleaning procedures prescribed under steel above to remove oil, grease and other detrimental foreign matter.

(C) Pretreatment: After hand and solvent cleaning, the cleaned areas shall then be painted by brushing on at least 1 full coat of paint No. 1. Unless otherwise directed by the Engineer, the second coat shall be applied within 24 hours after the primer is applied.

530.8.3 Wood Surface: Wood surfaces shall be prepared for painting by removing all cracked or peeled paint, loose chalky paint, dirt, and other foreign matter by wire

brushing, scraping, sanding, or other approved means immediately prior to painting. All surfaces shall be wiped or dry brushed to remove any dust or chalky residue that may result from cleaning operations. All wood designated to be painted shall be thoroughly dry before paint is applied.

530.9 PAINTING:

530.9.1 Structural Steel:

(A) Paint: Unless otherwise required on the plans or in the special provisions, the paints to be applied to structural steel surfaces shall consist of a shop prime coat, as specified in Section 515, a second coat, and a finish coat. The total dry film thickness of the prime and second coat shall be not less than 3 mills. The dry thickness of the paint will be measured in place with a calibrated magnetic film thickness gauge.

Excessively thick coats of paint will not be permitted. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.

Unless specified otherwise on the plans or in the special provisions, the paint coats shall be as specified for general use on structural steel in Section 790. Succeeding coats of paint, not otherwise materially different in color, shall have carbon black mixed into the paint in accordance with Section 790 to produce a perceptable color difference between the paint coat being applied and the preceding coat.

(B) Cleaning: After erection and riveting or welding, all surfaces of structural steel which will be exposed to air in the completed structure and the repainting of existing steel structures where partial cleaning is required, the method of cleaning will be as directed by the Engineer or as specified in the special provisions.

Any damage to sound paint on areas not designated for treatment, resulting from the Contractor's operations, shall be repaired as directed by the Engineer.

(C) Application of Paint: Painting of structural steel, except for shop applied prime coats and sections which will be inaccessible after erection as described below, shall be done after erection unless otherwise specified in the special provisions. Requests to do any additional painting prior to erection shall be submitted by the Contractor and approved by the Engineer in writing before such work is started. Painting prior to erection will be limited to a prime coat of paint, except that surfaces exposed to the atmosphere which would be inaccessible for painting after erection shall be painted the full number of coats prior to erection. Any deficiencies in the prime coat of paint, or any second coat shall be corrected to the satisfaction of the Engineer prior to the application of the finish coat of paint.

The surface of the paint coat being covered shall be free from moisture, dust, grease, or any other deleterious material which would prevent the bond of the succeeding coat. In spot painting, any old paint which lifts after application of the touch-up coat, shall be removed by scraping and the area repainted before application of the next coat.

The finish coat shall not be applied until the required total film thickness of the undercoats of paint, as described above is obtained.

Open seams at contact surfaces of built-up members which would retain moisture shall be caulked with red lead paste before applying the second coat of paint.

Except for anchor bolt assemblies, steel embedded in concrete need not be painted. Anchor bolt assemblies shall be painted or dipped with 1 coat of paint prior to installation.

With the exception of abutting chord and column splices and column and truss shoe bases, machine finished surfaces shall be coated with a rust inhibitor which can be easily removed. Surfaces of iron and steel castings which have been machine finished shall be painted with a coat of shop paint.

530.9.2 Machinery: Prior to installation, all surfaces of machinery exposed to the atmosphere which are subject to corrosion and are normally painted, shall be painted with 2 coats of paint. Unless otherwise specified, after installation of the machinery, such surfaces shall be painted with a finish coat. All coats shall be as specified for structural steel.

530.9.3 Galvanized Surfaces: Unless otherwise provided on the plans or in the special provisions, galvanized surfaces shall be left unpainted. Areas of galvanized coating damaged due to welding after fabrication or handling shall be prepared as specified above and then painted with 1 full coat of paint No. 15.

530.9.4 Metal Guard Rails: Metal guard rails when required to be painted shall be painted with 2 coats of paint No. 11.

530.9.5 Wood Surfaces:

(A) Paint: The surface shall be prepared as specified above and painted with paint No. 6 or 7. The number of coats of paint will be specified in the special provisions.

(B) Application of Paint: When permitted in writing by the Engineer, the prime coat of paint may be applied prior to erection. After the prime coat has dried and the timber is in place, all cracks, checks, nail holes, etc., shall be puttied flush with the surface and allowed to dry before the second coat is applied.

Skips, holidays, and thin areas or other deficiencies in any 1 coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The surface of the paint coat being covered shall be free of any deleterious material before any additional paint is applied.

530.10 TESTING:

Paint and paint materials shall be sampled and tested prior to use. Tests shall be conducted in accordance with methods specified by ASTM or by methods set forth in Federal Standard 141. In the absence of any such methods, other suitable methods may be designed and utilized by the Engineer. Lots or batches of paint of proprietary brand, as defined in Section 790, which have been previously sampled and tested by the Contracting Agency, and approved, may be used without further testing, if permitted by the Engineer.

530.11 PAYMENT:

Payment for the preparation of surfaces, shop prime coat and field touch-up coats on structural steel and miscellaneous metal items shall be considered as included in the prices for the structural steel and miscellaneous metal items. Payment for second and finish coats on structural steel or miscellaneous metal items shall be considered as included in payments for the structures, except that payment for cleaning all painting on miscellaneous metal items shall be considered as included in the price for the item when a separate price therefor is included in the proposal.

Full compensation for preparing surfaces and for painting machinery, galvanized metal, guard rails and wood shall be considered as included in the various prices paid for the contract items or work and no separate payment for such work will be made.

PART 600

WATER AND SEWER

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SECTION 601

TRENCH EXCAVATION, BACKFILLING AND COMPACTION

601.1 DESCRIPTION:

The work covered by this specification consists of furnishing all plant, labor, equipment, appliances and materials, and performing all operations in connection with the excavation and backfilling of trenches in accordance with the plans and special provisions.

Excavation for appurtenance structures, such as manholes, inlets, transition structures, junction structures, vaults, valve boxes, catch basins, etc., shall be deemed to be in the category of trench excavation.

601.2 EXCAVATION:

601.2.1 General: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the plans, and including excavation ordered by the Engineer of compacted backfill for the purpose of making density tests on the lower portion of the lift.

All excavation shall be open cut unless otherwise shown on the plans or approved by the Engineer.

601.2.2 Trench Widths: Trenches for other than cast-in-place concrete pipe shall conform to the following dimensions, unless otherwise specified in the special provisions, indicated on the plans, and/or approved by the Engineer.

TABLE 601-1

Size Of Pipe (I.D.)	Maximum Width At Top Of Pipe Greater Than O.D. Of Barrel	Minimum Width At Springline Each Side Of Pipe
Less than 18″	16″	6″
18″ to 24″ inclusive	19″	7½″
27″ to 39″ inclusive	22″	9″
42″ to 60″ inclusive	½ O.D.	12″
Over 60″	36″	12″

The width of the trench shall not be greater than the maximum indicated above, at and below the level of the top of the pipe. The width of the trench above that level may be made as wide as necessary for sheeting and bracing, and for proper installation of the work.

If the maximum trench width as specified above is exceeded at the top of the pipe the Contractor shall provide, at no additional cost to the Contracting Agency, the necessary additional load bearing capacity by means of bedding, having a higher bedding factor than that specified, higher strength pipe, a concrete cradle, cap or encasement, or by other means approved in writing by the Engineer.

601.2.3 Trench Grade: Alignment and elevation stakes shall be furnished the Contractor at set intervals and agreed upon offsets. On water main projects, elevation stakes will be furnished only when deemed necessary by the Engineer. In all cases where elevation stakes are furnished, the Engineer will also furnish the Contractor with cut sheets.

For all pipe 12 inches or greater in diameter, the Contractor shall excavate for and provide an initial granular bedding at least 4 inches thick or ½ the O.D. of the pipe whichever is greater. This bedding material shall be placed at a uniform density with minimum compaction and fine graded as specified below.

Bell or coupling holes shall be dug after the trench bottom has been graded. Such holes shall be of sufficient width to provide ample room for caulking, banding, or bolting. Holes shall be excavated only as necessary to permit accurate work in the making of the joints and to insure that the pipe will rest upon the prepared bottom of the trench, and not be supported by any portion of the joint.

Depression for joints, other than bell-and-spigot, shall be made in accordance with the recommendations of the joint manufacturer for the particular joint used.

601.2.4 Fine Grading: Unless otherwise specified in the plans and/or special provisions, the bottom of the trench shall be accurately graded to provide uniform bearing and support for each section of the pipe at every point along its entire length, except for portions of the pipe where it is necessary to excavate for bells and for proper sealing of pipe joints.

601.2.5 Overexcavation: Except at locations where excavation of rock from the bottom of the trench is required, care shall be taken not to excavate below the depth indicated.

Unauthorized excavation below the specified grade line shall be refilled at the Contractors expense with ABC material compacted to a uniform density of not less than 95 percent of the maximum density as determined by AASHTO T-99 and T-191 or ASTM D-2922 and D-3017. When AASHTO T-99, method A or B, and T-191 are used for density determination, MAG Detail 190 will be used for rock correction.

Whenever rock is encountered in the trench bottom, it shall be overexcavated to a minimum depth of six inches below the O.D. of the pipe. This overexcavation shall be filled with granular material placed with the minimum possible compaction.

Whenever unsuitable soil incapable of supporting the pipe is encountered, the Contractor will notify the engineer and a field determination will be made as to the depth of overexcavation and the granular fill required.

601.2.6 Excavation for Manholes, Valves, Inlets, Catch Basins and Other Accessories: The Contractor may excavate to place the concrete structure directly against the excavated surface, provided that the faces of the excavation are firm and unyielding and are at all points outside the structure lines shown on the plans. If the native material is such that it will not stand without sloughing or if precast structures are used, the Contractor shall overexcavate to place the structure and this overexcavation shall be backfilled with the same material required for the adjoining pipe line trench and compacted per Table 601.2.

Any excavation below the elevation indicated for the foundation of any structure shall be filled with ABC and compacted to at least 95% at the expense of the Contractor.

601.2.7 Pavement and Concrete Cutting and Removal: Where trenches lie within the portland cement concrete section of streets, alleys, driveways, or

sidewalks, etc., such concrete shall be sawcut to neat, vertical, true lines in such a manner that the adjoining surface will not be damaged. The minimum depth of cut shall be 1½ inches or ¼ of the thickness, whichever is greater.

Asphalt pavement shall be clean-cut, with approved equipment and by approved methods in accordance with the requirements of Section 336.

No ripping or rooting will be permitted outside limits of cuts. Surfacing materials removed shall be hauled from the job site immediately, and will not be permitted in the backfill.

601.2.8 Grading and Stockpiling: All grading in the vicinity of trench excavation shall be controlled to prevent surface water from flowing into the trenches. Any water accumulated in the trenches shall be removed by pumping or by other approved methods.

During excavation, material suitable for backfilling shall be piled in an orderly manner, a sufficient distance back from the edges of trenches, to avoid overloading and to prevent slides or cave-ins. Material unsuitable for backfilling, or excess material, shall be hauled from the job site and disposed of by the Contractor.

The Contractor shall, prior to final acceptance of the work, submit a letter to the Contracting Agency stating the location of each disposal site for all excess or unsuitable material and certify that he has obtained the property owner's permission for the disposal of all such materials.

Where the plans and/or special provisions provide for segregation of topsoil from underlying material for purposes of backfill, the material shall not be mixed.

601.2.9 Shoring and Sheeting: The Contractor shall do such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. The bracing, sheathing, or shoring shall not be removed in one operation but shall be done in successive stages as determined by the Engineer to prevent overloading of the pipe during backfilling operations. The cost of the bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot for the pipe.

All shoring and sheeting deemed necessary to protect the excavation and to safeguard employees, shall be installed. See Section 107.

601.2.10 Open Trench: Except where otherwise noted in the special provisions, or approved in writing by the Engineer, the maximum length of open trench, where the construcion is in any stage of completion (excavation, pipe laying or backfilling), shall not exceed 1320 feet in the aggregate at any one location.

Any excavated area shall be considered open trench until all ABC for pavement replacement has been placed and compacted. With the approval of the Engineer, pipe laying may be carried on at more than one separate location, the restrictions on open trench applying to each location.

Trenches across streets shall be completely backfilled as soon as possible after pipe laying.

Substantial steel plates with adequate trench bracing shall be used to bridge across trenches at street crossings where trench backfill and temporary patches

have not been completed during regular work hours. Safe and convenient passage for pedestrians shall be provided. The Engineer may designate a passage to be provided at any point he deems necessary. Access to hospitals, fire stations and fire hydrants must be maintained at all times.

601.3 PROTECTION OF EXISTING UTILITIES:

601.3.1 Utilities: Unless otherwise shown on the plans or stated in the specifications, all utilities, both underground or overhead, shall be maintained in continuous service throughout the entire contract period. The Contractor shall be responsible and liable for any damages to or interruption of service caused by the construction.

If the Contractor desires to simplify his operation by temporarily or permanently relocating or shutting down any utility or appurtenace, he shall make the necessary arrangements and agreements with the owner and shall be completely responsible for all costs concerned with the relocation or shutdown and reconstruction. All property shall be reconstructed in its original or new location as soon as possible and to a condition at least as good as its previous condition. This cycle of relocation or shutdown and reconstruction shall be subject to inspection and approval by both the engineer and the owner of the utility.

The Contractor shall be entirely responsible for safeguarding and maintaining all conflicting utilities that are shown on the plans (Section 107 and 105 apply). This includes overhead wires and cables and their supporting poles whether they are inside or outside of the open trench. If, in the course of work, a conflicting utility line that was not shown on the plans is discovered, the Contracting Agency will either negotiate with the owner for relocation, relocate the utility, change the alignment and grade of the trench or as a last resort, declare the conflict as "extra work" to be accomplished by the Contractor in accordance with Section 104.

601.3.2 Irrigation Ditches, Pipes and Structures: The Contractor shall contact the owners of all irrigation facilities, and make arrangements for necessary construction clearances and/or dry-up periods.

All irrigation ditches, dikes, headgates, pipe, valves, checks, etc., damaged or removed by the Contractor, shall be restored to their original condition or better, by the Contractor at no additional cost to the Contracting Agency.

601.3.3 Building, Foundations and Structures: Where trenches are located adjacent to building, foundations, and structures, the Contractor shall take all necessary precaution against damage to them. The Contractor shall be liable for any damage caused by the construction.

Except where authorized in the special provisions or in writing by the Engineer, water settling of backfill material in trenches adjacent to structures will not be permitted.

601.3.4 Permanent Pipe Supports: Permanent pipe supports for the various types and sizes of sewer, water and utility lines shall conform to the Standard Details or the details shown on the plans. Such pipe supports shall be erected at the locations shown on the plans and/or at any other locations as necessary as determined by the Engineer.

601.4 FOUNDATION, BEDDING, BACKFILLING AND COMPACTION:

601.4.1 Foundation: The material upon which the conduit or structure is to be placed shall be accurately finished to the grade or dimensions shown on the plans or as directed by the engineer. The bottom portion of the trench shall be brought to grade so that the conduit or structure will be continuously in contact with the material on which it is being placed. If rocky or unsuitable soil is encountered, Subsection 601.2.5 applies.

601.4.2 Bedding: Bedding shall consist of granular material containing no pieces larger than 1½ inches and free of broken concrete, broken pavement, wood or other deleterious material. Open graded rock will not be used without the written approval of the Engineer.

Where water consolidation is used, bedding for conduits, 24 inches or less in I.D., may be placed in one lift. For larger conduits the first lift shall not exceed the springline of the pipe.

Where mechanical compaction is used, the moisture content shall be such that the specified compaction can be obtained. The first lift shall be 8 inches or ⅔ of the distance to the springline whichever is greater. Succeeding lifts shall not exceed 2 feet loose and extreme care will be taken to prevent damage to or movement of the conduit by the compaction equipment.

601.4.3 Backfill: Backfill shall be sound earthen material free from broken concrete, broken pavement, wood or other deleterious material. Unless otherwise specified, this may be native material with no piece larger than 8 inches, select material or aggregate base course. Under pavement, parking lots, sidewalks, etc., pieces larger than 3 inches will not be used in the final 12 inches below the pavement subgrade.

Where water consolidation is used, backfill will be placed in lifts as required in the following table prior to settlement.

Trench Width	Backfill Lifts
18″ to 24″	Not to exceed 4′
25″ to 36″	Not to exceed 6′
Over 36″	Not to exceed 8′

The above backfill lift limitations are not applicable when water saturation is done by the jetting method.

Where mechanical compaction is used, backfill shall be placed in lifts the height of which shall not exceed that which can be effectively compacted depending on the type of material, type of equipment and methods used, and under no circumstances shall exceed 4 feet.

Backfill, around utilities that are exposed during trench excavation, shall be placed in accordance with the bedding methods.

601.4.4 Compaction Densities: Unless otherwise provided in the plans and/or special provisions, the trench backfill shall be thoroughly compacted to not less than the following densities when tested and determined by AASHTO T-99 and T-191 or ASTM D-2922 and D-3017. When AASHTO T-99, method A or B, and T-191 are used for density determination, MAG Detail 190 will be used for rock correction.

The density required will depend on the Type shown on the plans and/or called for in the special provisions. Density required for each Type is as follows:

TABLE 601-2

MINIMUM DENSITY REQUIRED

Backfill Type	Location	From Surface To 2′ Below Surface	From 2′ Below Surface To 1′ Above Top of Pipe	From 1′ Above Top of Pipe to Bottom of Trench
I	Under any existing or proposed pavement, curb, gutter, sidewalk, or such construction included in the contract, or when any part of the trench excavation is within 2′ of the above.	100% for granular 95% for non-granular	90%	90%
II	On any utility easement street, road or alley right-of-way outside limits of (1).	85%	85%	90%
III	Around any structures or exposed utilities	95%	in all cases	

Note: The type required will generally be shown on the plans and the plans will govern. Where no type is shown on the plans the type shall comply with the above.

A consideration in determining the backfill Types as shown on the plans, is based on the trench widths as shown in the Contract Documents. If these trench widths increase beyond those widths referred to above and fall within the 2-foot limit of paved surfaces and other improvements due to construction exigencies, the backfill designation for that portion within the 2-foot limit of such improvements shall be Type I even though Type II backfill is shown on the plans.

601.4.5 Compaction Methods: Water consolidation by jetting shall be accomplished with a 1½″ pipe of sufficient length to reach the bottom of the lift being settled with adequate hose attached and a water pressure of not less than 30 psi. All jetting shall be accomplished transversely across the trench at intervals of not more than 6 feet with the jetting locations on one side of the trench offset to the jetting locations on the other side of the trench. The entire lift shall be leveled and completely saturated working from the top to the bottom.

Jetting shall be used as the consolidation method for all conduit bedding. The Contractor shall be entirely responsible for establishing each lift depth so as to avoid floating the conduit being placed and shall make any repair or replacement at no cost to the Contracting Agency. However, for conduit larger than 24 inches I.D. the first lift shall not exceed the springline of the conduit.

Flooding is not acceptable as a water consolidation method unless authorized in the specification or by a written change order. It will consist of the inundation of the entire lift with water and then puddled with poles or bars to insure saturation of the entire lift.

Where jetting or flooding is utilized and the surrounding materal is such that it does not permit proper drainage, the Contractor shall provide, at his expense a sump and a pump at the downstream end to remove the accumulated water.

The use of water consolidation does not relieve the Contractor from the responsibility to make his own determination that such methods will not result in damage to existing improvements. The Contractor shall be responsible for any damage incurred.

Where water consolidation is not permitted or does not result in adequate compaction, the backfill material shall be compacted with hand and/or mechanical work methods using equipment such as rollers, pneumatic tamps, hydro-hammers or other approved devices which secure uniform and required density without injury to the pipe or related structures.

Where Type I backfill is required, water consolidation will not be permitted for non-granular material, except in the following situation. In a new development prior to paving and prior to opening the area to public traffic, water consolidation, will be permitted for non-granular material at the Contractor's discretion and responsibility.

601.4.6 Specifications for Granular Material: For purposes of this specification, granular material shall mean material for which the sum of the plasticity index and the percent of the material passing a No. 200 seive shall not exceed 23. The plasticity index shall be tested in accordance with AASHTO T-90.

601.4.7 Rights-Of-Way Belonging to Others: Backfill and compaction for irrigation lines of the Salt River Valley Water Users' Association and Roosevelt Irrigation Districts and for trenches in State of Arizona and Maricopa County rights-of-way outside the limits of the Contracting Agency shall be accomplished in accordance with their permit and/or specifications.

601.4.8 Test Holes: Boring logs shown on the plans do not constitute a part of the contract and are included for the Contractors's convenience only. It is not intended to imply that the character of the material is the same as that shown on the logs at any point other than that where the boring was made. The Conractor shall satisfy himself regarding the character and amount of rock, gravel, sand, silt, clay and water to be encountered in the work to be performed.

601.5 PAVEMENT REPLACEMENT AND SURFACE RESTORATION:

601.5.1 Grading: The Contractor shall do such grading in the area adjacent to backfilled trenches and structures as may be necessary to leave the area in a neat and satisfactory condition approved by the Engineer.

601.5.2 Restoring Surface: All streets, alleys, driveways, sidewalks, curbs, or other surfaces, in which the surface is broken into or damaged by the installation of the new work, shall be resurfaced in kind or as specified to the satisfaction of the Engineer in accordance with Section 336.

601.5.3 Cleanup: The job site shall be left in a neat and acceptable condition. Excess soil, concrete, etc., shall be removed from the premises.

601.5.4 Temporary Pavement: The Contractor shall install temporary asphalt pavement or the first course of permanent pavement replacement in accordance with Section 336 immediately following backfilling and compaction of trenches that have been cut through existing pavement. Except as otherwise provided in Section 336, this preliminary pavement shall be maintained in a safe and reasonably smooth condition until required backfill compaction is obtained and final pavement replacement is ordered by the Engineer. Temporary paving removed shall be hauled from the job site and disposed of by the Contractor at no additional cost to the Contracting Agency.

601.6 PAYMENT:

No pay item will be included in the proposal, nor direct payment made for trench excavation, backfilling, compaction, or placement of temporary pavement. The cost of these features of the work shall be included in the unit price bid per linear foot for furnishing and laying pipe.

SECTION 605
SUBDRAINAGE

605:1 DESCRIPTION:

The subdrainage system shall be constructed in accordance with the notes and details shown on the plans and the applicable provisions of these specifications except as modified in the special provisions.

605.2 CONCRETE:

All concrete placed in drainage structures, subdrain outlets, pipe collars, and similar features of the subdrainage system shall conform to the applicable provisions of Section 725.

605.3 SUBDRAINAGE PIPE:

Subdrainage pipe, both perforated and non-perforated, shall be either bell and spigot concrete, bell and spigot vitrified clay, corrugated metal pipe, or asbestos-cement pipe as shown on the plans or specified in the special provisions. However, if the particular kind of pipe is not shown on the plans nor specified in the special provisions, subdrainage pipe shall be concrete pipe of at least standard strength quality and shall conform to the requirements of Section 736. Vitrified clay pipe shall conform to the requirements of Section 743. Asbestos-cement pipe shall conform to the requirements of Section 737. Corrugated metal pipe shall conform to the requirements of Section 760.

605.3.1 Pipe Joints: Unless the pipe joints are of a self-aligning type, have the bottom half of the bell joint filled with mortar to securely hold the pipe in alignment and to bring the inner surface of abutting pipes flush and even. Where a tight joint for non-perforated pipe is required, the bell joint shall be completely filled with mortar.

Asbestos-cement pipe joints shall be made with couplings in accordance with the recommendations of the pipe manufacturer.

605.4 SUBDRAINAGE MANHOLES:

Subdrainage manholes, including inlets, outlets, flap gates, gate boxes, and drop steps, shall comply with the requirements of the plans and the special provisions.

605.5 FILTER MATERIALS

The filter materials shall be placed within the limits shown on the plans. The compositions of the filter materials shall each conform to one of the following grading requirements; the particular requirement to be used will be specified in the special provision.

The materials used shall conform to requirements for concrete aggregates in Section 701; however, the requirements for grading, and reactivity, as stated therein, shall not apply. The minimum bulk specific gravity shall be 2.50, by ASTM C-127.

TABLE 605			
Filter Material Grading – % Passing			
Screen or Sieve Size	TYPE		
	F1	F2	F3
¾"		100	100
⅜"	100	80 – 100	70 – 100
No. 4	90 – 100	60 – 85	45 – 75
No. 8	75 – 90	45 – 70	30 – 60
No. 16	55 – 80	30 – 55	20 – 45
No. 30	30 – 60	15 – 40	10 – 30
No. 50	10 – 40	5 – 20	0 – 15
No. 100	0 – 15	0 – 10	0 – 5
No. 200	0 – 5	0 – 5	

605.6 PLACEMENT:

605.6.1 General: The excavated subgrade shall be kept free of surface water. Mudholes, ruts, or soft spots due to the Contractor's operations shall be repaired at no additional cost to the Contracting Agency, as ordered by the Engineer.

Filter and drain material shall be placed around drainage pipe so as to provide even support throughout the entire length of the pipe and to permit the installed pipe to lie upon true alignment and grade. The minimum thickness of filter material surrounding the pipe shall be 6 inches.

Filter material shall be spread to such depth as to obtain the required thickness after compaction and shall be uniform and true to the line and grades indicated on the plans.

The surface under sloped bank lining or invert shall not show any variation or departure greater than ½ inch from the testing edge of a 10 foot straightedge. Ridges and humps shall be regraded, depressions filled and compacted, and tested for straightness until grading is accomplished within the tolerance specified. No relative density will be required.

Pipe damaged during placement or compaction shall be replaced by the Contractor at no additional cost to the Contracting Agency. The Contractor shall exercise due care to prevent water from surface drainage or other sources, mud, muck, or debris, from running into the filter material both during and after its placement, until the lining, backfill, or structure placed thereon is completed or set. The Contractor shall provide and operate drainage sumps and pumps, or equivalent means satisfactory to the Engineer, to prevent any such saturations of the filter materials.

605.6.2 Under Sloped Bank Lining: Those portions of filter materials which become subgrade for sloped bank lining shall be compacted by 4 passes of a small roller weighing not less than 600 pounds, and 20 pounds per inch of roller width, or by other means approved by the Engineer.

605.6.3 Under Invert: Those portions of filter materials which become subgrade for channel invert linings shall be compacted by 2 passes of a smooth-wheeled roller lapping 1 foot each pass, or by use of manually-operated hand tampers, or by other means as approved by the Engineer. The weight of the roller or the size of the tamper shall be as approved by the Engineer.

605.6.4 In Trenches and Along Heels of Walls or Sides of Structures: The filter materials shall be placed in 1 foot lifts and compacted by hand-held tamping or vibrating equipment to the satisfaction of the Engineer.

605.7 TESTS OF THE SUBDRAINAGE SYSTEM:

Two separate tests shall be made on each subdrain line by the Contractor to assure the proper functioning of the subdrainage system.

Each test shall be conducted in the presence of the Engineer and shall consist of the flushing of the subdrain line with sufficient water to develop a flow of 5 cubic feet per minute out of the end of the line being tested, as measured by approved measuring equipment furnished by the Contractor.

When a channel invert slab is required, the first test of each completed section of the subdrain system shall be performed immediately prior to the placement of reinforcing steel for the channel invert slab and the second test shall be performed after completion of the channel invert work. Manholes shall be cleared of all debris prior to beginning the second test.

Final acceptance of the subdrainage system will be made only if the discharge is of uniform flow and of adequate quantity. Any necessary clearing of drain lines to meet the above requirements shall be performed by the Contractor at no additional cost to the Contracting Agency.

All costs involved in the performance of the tests, including the furnishing of all labor, equipment, and material required therefore, shall be included in the prices bid for the items under which the subdrainage system is to be constructed.

605.8 PAYMENT:

Payment for the work included in this specification will be made on the basis of the lump sum or unit prices stipulated in the proposal, unless the payment for subdrainage work is included in the cost for other improvements. Such payment shall include full compensation for furnishing all labor, tools, and equipment and incidentals for doing the work involved.

SECTION 610

WATER LINE CONSTRUCTION

610.1 DESCRIPTION:

The construction of all water lines shall conform to applicable standard specifications and details, except as otherwise required on the plans or as modified in the special provisions.

610.2 GENERAL:

All pipe shall be delivered, handled and installed in accordance with the manufacturer's recommendations and/or applicable provisions of AWWA standards

for installation of the various types of water mains specified, insofar as such recommendations and provisions are not in variance with the standard specifications and details.

Where waterlines are to be constructed in new subdivisions or in conjunction with street repaving projects, the streets shall be pre-graded to within 6 inches of the new street subgrade prior to trenching or cut stakes shall be set for trenching.

610.3 MATERIALS:

All pipe for water lines shall be of the classes shown on the plans or as specified below.

(A) The 4 through 16 inch pipe shall be asbestos-cement, ductile iron or cast iron, except where a particular material is specified. All pipe shall be Class 150 unless otherwise specified.

(B) Pipe larger than 16 inches may be either ductile iron or reinforced concrete water pipe – steel cylinder type – pretensioned unless an additional option is provided in the special provisions.

Cast iron water pipe and fittings – Section 750. Ductile iron water pipe and fittings – Section 750. Asbestos-cement water pipe and fittings – Section 752. Reinforced water pipe – steel cylinder type and fittings – AWWA C303.

610.4 CONSTRUCTION METHODS:

All water mains in major streets shall have a minimum cover of 48 inches over the top of the pipe. Water mains in other locations shall have a minmum cover over the top of the pipe as follows:

(A) 36 inches for mains smaller than 12 inches.

(B) 48 inches for mains 12 inches and larger.

Cover for water mains will be measured from existing or proposed finished grade of pavement or from natural ground, whichever is deeper.

No water main shall be deflected, either vertically or horizontally, in excess of that recommended by the manufacturer of the pipe or coupling, without the appropriate use of bends or offsets.

If adjustments of the position of a length of pipe is required after it has been laid, it shall be removed and rejoined as for a new pipe.

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. At all times when pipe laying is not in progress, the open ends of the pipe line shall be closed by a water-tight plug or other means approved by the Engineer.

Except as otherwise required in this specification, the special provisions, or by the Engineer, trench excavation, backfilling and compaction shall be in accordance with the requirements of Section 601. Backfilling may be accomplished as soon as the pipe line has been installed to the satisfaction of the Engineer, subject to the requirements for testing, as contained below.

Hydrostatic testing shall be in accordance with this specification.

All corporation stops used for testing and chlorination shall be left in the pipe line with the stop closed and all connecting pipe removed.

Thrust blocks shall be installed in accordance with this specification.

Valve boxes and covers shall be according to standard details.

Asbestos-cement pipe shall be installed in accordance with AWWA C-603, except pipe and fittings shall be in accordance with Section 752.

Cast iron pipe shall be installed in accordance with AWWA C-600, except pipe and fittings shall be in accordance with Section 750.

Ductile iron pipe shall be installed in accordance with this specification and pipe and fittings shall be in accordance with Section 750.

610.5 POLYETHYLENE CORROSION PROTECTION:

610.5.1 General: Where called for in the plans and specifications or directed by the Engineer, pipe, valves and fittings shall be protected from corrosion by encasement in a polyethylene protective wrapping referred to hereafter as polywrap. Although not intended to be a completely air and water tight enclosure the polywrap shall provide a continuous barrier between the pipe and surrounding bedding and backfill.

610.5.2 Materials: The polywrap shall be of virgin polyethylene, not less than 8 mils in thickness, formed into tubes or sheets as may be required. Naturally pigmented material may be used where exposure to ultra violet light will be less than 48 hours. Otherwise the material shall be pigmented with 2 to 2½ percent of well dispersed carbon black with stabilizers.

The polywrap shall be secured as specified below with 2 inch wide pressure sensative plastic tape not less than 10 mils thick. Tape shall be Scotchrap No. 50. Polyken No. 900. Tapecoat CT, Johns-Manville No. V-10 Trantex, or approved equal.

The minimum tube size for each pipe diameter shall be as listed below.

TABLE 610

Nominal Pipe Diameter (Inches)	Polywrap Flat Tube Width (Inches)	
	Cast Iron Or Ductile Iron With Push-On Joints	Cast Iron Or Ductile Iron With Mechanical Joints
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

610.5.3 Installation: The polyethylene tubing shall be cut into lengths approximately 2 feet longer than the pipe sections. With the pipe suspended from the center the tube shall be slipped over the spigot end and bunched up between the point of support and the spigot end. After the pipe is installed into the bell of the adjacent pipe the pipe shall be lowered to the trench bottom and the supporting sling removed from the center of the pipe. The pipe shall then be

raised at the bell end enough to allow the tube to be slipped along the full length of the barrel with enough left at each end to overlap the adjoining pipe about 1 foot. A shallow bell hole must be made at each joint to facilitate installation of the polywrap.

Pull the bunched-up polywrap from the preceding length of pipe, slip it over the end of the new length of pipe, and secure in place with one circumferential turn of tape plus enough overlap to assure firm adhesion. Then slip the end of the polywrap from the new pipe section over the end of the first wrap until it overlaps the joint at the end of the preceding length of pipe. Tape it in place.

The loose wrapping on the barrel of the pipe shall be pulled snugly around the barrel of the pipe, and excess material folded over the top of the pipe and the folds held in place by means of short strips of adhesive tape, at about 3 foot intervals along the pipe.

Repair any rips, punctures or other damage to the tube with the adhesive tape or pieces of tube material secured with tape.

Bends and reducers in the line shall be covered with polyethylene in the same manner as pipe.

Valves, tees, crosses and outlets shall be wrapped with flat sheets of the same material. The sheets shall be passed under valves and brought up around the body to the stem. Edges shall be brought together, folded twice and secured with the adhesive tape.

610.5.4 Payment: Payment for this item shall be per the provisions of Articles 109.4 and 109.5 of the specifications unless this item is specifically called for on the plans or in the supplemental specifications or special provisions as a specific component and pay item for a given project.

610.6 VALVES:

Valves shall be installed in accordance with AWWA C-600 or AWWA C-603 modified as follows:

All tapping sleeves, gate valves, butterfly valves, air release and vacuum valves and corporation stops shall be in accordance with Section 630.

Just before installation in the trench, valves shall be fully opened and closed to check the action, and a record made of the number of turns required to fully open or close the valve. For valves 16 inches and larger, a member of the water utility shall be present to check the action and record the number of turns. The inside of all valves shall then be thoroughly cleaned and the valve installed. Valves 12 inches and smaller in size shall be supported by concrete blocks, in accordance with the standard details.

Valves 16 inches and larger in size along with their bypass valves, shall be supported on concrete slabs, and/or concrete piers, as indicated on the plans.

Concrete supports shall be provided under valves in vaults and manholes, and shall be constructed an inch low, then grouted with non-shrink grout. Adjustable pipe supports shall be as indicated on the plans. Buried valves shall be supported on concrete blocks as detailed on the plans.

Valve boxes shall be installed over all buried valves in accordance with standard details.

Standard couplings or matching joints shall be used when more than one length

Thrust blocks shall be installed in accordance with this specification.

Valve boxes and covers shall be according to standard details.

Asbestos-cement pipe shall be installed in accordance with AWWA C-603, except pipe and fittings shall be in accordance with Section 752.

Cast iron pipe shall be installed in accordance with AWWA C-600, except pipe and fittings shall be in accordance with Section 750.

Ductile iron pipe shall be installed in accordance with this specification and pipe and fittings shall be in accordance with Section 750.

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610.5.1 General: Where called for in the plans and specifications or directed by the Engineer, pipe, valves and fittings shall be protected from corrosion by encasement in a polyethylene protective wrapping referred to hereafter as polywrap. Although not intended to be a completely air and water tight enclosure the polywrap shall provide a continuous barrier between the pipe and surrounding bedding and backfill.

610.5.2 Materials: The polywrap shall be of virgin polyethylene, not less than 8 mils in thickness, formed into tubes or sheets as may be required. Naturally pigmented material may be used where exposure to ultra violet light will be less than 48 hours. Otherwise the material shall be pigmented with 2 to 2½ percent of well dispersed carbon black with stabilizers.

The polywrap shall be secured as specified below with 2 inch wide pressure sensative plastic tape not less than 10 mils thick. Tape shall be Scotchrap No. 50. Polyken No. 900. Tapecoat CT, Johns-Manville No. V-10 Trantex, or approved equal.

The minimum tube size for each pipe diameter shall be as listed below.

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8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

610.5.3 Installation: The polyethylene tubing shall be cut into lengths approximately 2 feet longer than the pipe sections. With the pipe suspended from the center the tube shall be slipped over the spigot end and bunched up between the point of support and the spigot end. After the pipe is installed into the bell of the adjacent pipe

the pipe shall be lowered to the trench bottom and the supporting sling removed from the center of the pipe. The pipe shall then be raised at the bell end enough to allow the tube to be slipped along the full length of the barrel with enough left at each end to overlap the adjoining pipe about 1 foot. A shallow bell hole must be made at each joint to facilitate installation of the polywrap.

Pull the bunched-up polywrap from the preceding length of pipe, slip it over the end of the new length of pipe, and secure in place with one circumferential turn of tape plus enough overlap to assure firm adhesion. Then slip the end of the polywrap from the new pipe section over the end of the first wrap until it overlaps the joint at the end of the preceding length of pipe. Tape it in place.

The loose wrapping on the barrel of the pipe shall be pulled snugly around the barrel of the pipe, and excess material folded over the top of the pipe and the folds held in place by means of short strips of adhesive tape, at about 3 foot intervals along the pipe.

Repair any rips, punctures or other damage to the tube with the adhesive tape or pieces of tube material secured with tape.

Bends and reducers in the line shall be covered with polyethylene in the same manner as pipe.

Valves, tees, crosses and outlets shall be wrapped with flat sheets of the same material. The sheets shall be passed under valves and brought up around the body to the stem. Edges shall be brought together, folded twice and secured with the adhesive tape.

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Just before installation in the trench, valves shall be fully opened and closed to check the action, and a record made of the number of turns required to fully open or close the valve. For valves 16 inches and larger, a member of the water utility shall be present to check the action and record the number of turns. The inside of all valves shall then be thoroughly cleaned and the valve installed.

Valves 12 inches and smaller in size shall be supported by concrete blocks, in accordance with the standard details.

Valves 16 inches and larger in size along with their bypass valves, shall be supported on concrete slabs, and/or concrete piers, as indicated on the plans.

Concrete supports shall be provided under valves in vaults and manholes, and shall be constructed an inch low, then grouted with non-shrink grout. Adjustable pipe supports shall be as indicated on the plans. Buried valves shall be supported on concrete blocks as detailed on the plans.

Valve boxes shall be installed over all buried valves in accordance with standard details.

Standard couplings or matching joints shall be used when more than one length of pipe is required, or when two or more pieces are joined, to form the valve box riser.

Install extension stems on all valves where the operating nut is 5 feet or more below grade.

610.7 MANHOLES AND VAULTS:

Construction shall consist of furnishing all materials and constructing manholes or vaults complete in place, as detailed, including foundation walls, cast iron steps, frames, covers, and any incidentals thereto, at location shown on the plans.

Manholes shall be constructed to conform with the requirements of Section 625 and standard details, except the inside diameter shall be 60 inches.

Vaults shall be constructed of reinforced concrete conforming to Section 725 and of concrete pipe conforming to ASTM C-76 Wall A or B. Vaults shall be kept moist for 7 days before backfilling.

610.8 FIRE HYDRANTS:

The Contractor shall furnish all labor, materials, and equipment necessary to install fire hydrants complete in place at locations shown on the plans in accordance with the standard details and special provisions. Fire hydrants furnished by the Contractor shall conform to the requirements of Section 756.

If paint is chipped, scuffed, or otherwise damaged during handling and installation, the Contractor shall touch up such spots as may be designated by the Engineer.

All hydrants must be flushed and left in good working condition with the control valve open.

610.9 CONNECTION TO EXISTING MAINS:

Existing pipe to which connections are to be made shall be exposed by the Contractor as directed by the Engineer, to permit field changes in line, grade or fittings, if necessary.

All connections to existing mains shall be constructed according to the plans.

Valves connecting new work to the existing system shall be kept closed at all times.

If it is necessary to obtain water from a utility system, clearance must be obtained from the Superintendent of Water Distribution. Valves shall not be operated until such clearance is obtained.

After disinfected samples have been taken and the new work passes the bacteriological tests, the new line shall then be turned over to the Contracting Agency with all branch lines and tie-in valves closed.

When shutdown of an existing water main is necessary in order to connect to the new lines, the Contractor shall make application and pay the required charges to the Contracting Agency. A conference between the Contractor's representative, Engineering Inspection, and Water Distribution personnel shall establish the time and procedures to insure that the shutdown will be for the shortest possible time. If necessary to minimize inconvenience to customers, shutdowns may be scheduled during other than normal working hours. The water supply to some customers, such as hospitals, cannot be shut off at any time. Provisions to furnish a continuous supply of water to such establishments will be required. After the procedures and time for a shutdown are agreed upon, it shall be the Contractor's responsibility to notify all customers in advance that the water will be turned off. When possible, customers shall be notified 24 hours in advance and in no case, except in emergency, shall notification be less than 30 minutes. Notification shall be in writing, giving the reason for the shutdown and the time and duration the water service will be shut off.

The Contracting Agency will close existing valves, but will not guarantee a bone-dry shutdown.

610.10 METER SERVICE CONNECTIONS:

All new meters must be installed by the Contracting Agency after the proper application as required by Code with fees paid at prevailing rates.

When plans call for connections from a new water main to an existing water meter, the work shall include new copper pipe or polyethylene pipe and fittings except as follows:

(A) Wrapped galvanized pipe shall be used to connect or extend existing galvanized service pipe. Type K soft copper pipe or tubing shall be used to connect or extend existing copper service pipe except when otherwise called for in the plans.

(B) When the existing main is not abandoned, and the existing meter is to be connected to the new line, the corporation stop at the old main shall be closed and the abandoned service line cut 6 inches from the old main.

(C) Taps and service connections to the new main shall not be made until after testing and disinfection is completed.

(D) Meter service piping may be installed by drilling in place of open cut construction when approved by the Engineer.

When called for on the plans, the meter and box shall be relocated by the Contractor as directed by the Engineer. Existing meters which are shown on the plans to be relocated shall be located and installed in accordance with standard details.

Water meter boxes which are broken during construction shall be replaced by the Contractor at no additional cost to the Contracting Agency. Existing meter boxes which are already broken prior to start of construction shall be replaced by the Contractor with boxes furnished by the Contracting Agency. Boxes may be picked up by the Contractor after written authorization is received from the Engineer. The written authorization shall include the street address of each broken meter box and the size of meter box required. All water meter boxes shall conform to the standard details.

610.11 FIRE LINE SERVICE CONNECTIONS:

Fire line service connections shall be installed in accordance with standard details.

The fire line from the control valves at the main to the detector check valve shall be constructed of cast iron or ductile iron pipe to Section 750.

610.12 COUPLINGS, JOINTS, GASKETS AND FLANGES:

(A) Couplings: The couplings used to join the pipe to flanged valve adapters shall be Dresser Style 38, Smith-Blair 411 or an approved equal.

(B) Joints: The joints and fitting shall conform to Sections 750 and 752.

(C) Bolts and Nuts:

(1) For pipe 12 inches and smaller: Bolts and nuts for use in field connections or for connecting fittings shall be carbon steel equivalent to ASTM A-307, Grade B, with cadmium plating in accordance with ASTM A-165, except that the minimum thickness of the plating shall be .00020 inches. Cadmium plated bolts shall have Class 2A

threads and the nuts used with them shall have Class 2B threads. All bolt diameters shall normally be ⅛ inch smaller than the bolt hole diameter. High strength, heat treated cast iron tee-head bolts with hexagon nuts, all in accordance with the strength requirements of AWWA C-111, may be used in lieu of the cadmium plated bolts and nuts for jointing mechanical joint cast iron or ductile iron pipe and fittings only.

(2) For pipe 16 inches and larger: All bolts and nuts on flanges for valves and flexible couplings shall be carbon steel equivalent to ASTM A-307, Grade B. Bolt diameters shall normally be ⅛ inch smaller than the bolt hole diameters.

These bolted joints shall be protected as follows: Following installation and before backfilling, all couplings, steel flanges, bolts, nuts, anchor bolts and rods, bolting of all flanged valves, and all exposed steel shall be protected from corrosion by either of the two methods outlined below at the Contractor's option.

(a) Below ground installations shall be coated with NO-OX-1D "A" with a film of not less than 1/32 inch thick and then coated with cement mortar not less than 1 inch thickness before backfilling. Cement mortar shall be composed of 1 part cement, ASTM C-150, Type II, low alkali, to 3 parts sand. Before application of the cement mortar coating the area to be protected shall be covered with a layer of 2 x 2 inch No. 14 gage welded wire fabric, firmly wired in place.

(b) Below ground installations shall be protected by the application of hot coal-tar enamel. The coal-tar enamel shall be in accordance with AWWA C-203 and shall be applied to the top part of the pipe or fittings by daubers for at least 2 coats for a total minimum thickness of 1/16 inch. The coal-tar for under side of the pipe flanges or fittings shall be applied by the pan or cocoon method as described below and in AWWA Manual M-11, Steel Pipe.

Pan Method: The coating pan is securely anchored in place on the underside of the pipe and straddling the connection to be coated. The pan shall be wide enough so that the entire connection will be coated.

Hot coal-tar enamel is poured into the pan, from one side only, until the pan is completely filled. The drain plug or valve, is then opened and the excess coal-tar drained out. The pan can then be removed. Details of the coating pan and corresponding dimensions are given in AWWA Manual M-11.

The upper portion of the connection, and all remaining exposed steel pipe, will then be coated by the use of a dauber. The coal-tar coating shall be applied in at least 2 coats for a minimum thickness of 1/16 inch. The daubers and method of application conform to AWWA C-203. No thinning will be allowed.

Cocoon Method: The cocoon is formed by placing glass fiber cloth or roofing paper, of the proper width, around the underside of the connection and adjacent exposed steel pipe. The edges of the cocoon shall be securely fastened to the pipe. Backfill is lightly placed to the spring line, and the top of the cocoon is opened and layed back on the filled area and hot coal-tar enamel poured, from one side only, until the cocoon is completely filled. The loose backfill prevents rupture of the cocoon. The upper portion of the connection and remaining exposed steel pipe shall be coated as above.

(D) Gaskets: Except as other wise provided, all gaskets for pipe lines shall be one piece full faced gaskets from one-ply cloth inserted SBR rubber material. Gaskets for flanges 20 inch and smaller shall be from 1/16 inch thick material. Gaskets for flanges 24 inches and larger shall be from ⅛ inch thick material. Gasket material shall be J-M 109 as manufactured by Johns-Manville Corporation or an approved

equal. Physical characteristics of the rubber compound shall meet ASTM D-2000, Class 4AA805A13.

(E) Flanges: Cast iron flanges shall conform to AWWA C-110 as to material, diameter, thickness, drilling, etc. Steel flanges shall be ring or hub type, and shall conform to AWWA C-207, Class D. All flanges shall be drilled and have flange diameters and bolt circles conforming to AWWA C-110, except bolt holes will be ⅛ inch larger than the bolts given for the various sizes. All bolts shall be as specified above and all flanges shall have a flat facing.

610.13 BLOCKING:

All pipe lines, valves and fittings 16 inches and smaller in diameter shall be blocked with concrete thrust blocks in accordance with standard details. Thrust block areas for pipe, valves and fittings larger than 16 inches in diameter shall be calculated for each size pipe, valve and fitting to be installed and shown on the plans.

Thrust block areas shall be calculated on the basis of Class 150 pipe tested at 188 psi bearing against undisturbed 3,000 psf soil.

If soil or pressure conditions other than those stated above are encountered, the thrust block areas shall be calculated and submitted for approval. The areas stipulated in the standard details are minimum and shall not be decreased.

610.14 TESTING:

All pipelines shall be tested for watertightness by subjecting each section to hydrostatic tests in accordance with applicable provisions of AWWA C-600, except as modified below, and shall consist of pressure test and leakage tests. The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pump, including measuring device, and all other equipment necessary for making the tests, except pressure gages, and shall pay the Contracting Agency for water used in the tests.

(A) Pressure Tests: All pipe lines shall be tested for watertightness by subjecting each section to a pressure test, measured at the lowest end of the section under test. The test pressure shall be at least 125 percent of class rating of pipe under test. The duration of each pressure test shall be at least 2 hours. Each section of a new line between sectionalizing valves or between the last sectionalizing valve and the end of the project shall be tested separately as required in AWWA C-600, and/or as modified in these specifications, except that any such section less than 500 feet in length may be tested with the adjacent section, if both sections of line have the same pipe class rating. No section greater than ½ mile in total pipe length shall be tested without special written permission of the Engineer.

The test may be made before or after backfilling. However, if mechanical compaction is to be used in the backfilling operations as spelled out in AWWA C-600, the test shall not be made until the backfilling is completed and compacted. All connections, blowoffs and hydrants and valves shall be tested with the main as far as is practicable.

The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as determined by the Superintendent of Water Distribution, with at least 24 hour notice required before tests are scheduled. While the test section is under test pressure, a visual inspection for leaks may be made along the pipe line, and all visible leaks repaired. The pressure test shall not begin until the pipe has been filled with water for at least 24 hours to allow for absorption.

(B) Leakage Tests: Leakage tests shall be made after pressure test has been satisfactorily completed and all backfilling and compaction is completed to top of trench. The Contractor shall furnish the necessary apparatus and assistance to conduct the test.

The duration of each leakage test shall be at least 2 hours. To pass the leakage test, the leakage from the pipe line shall not exceed the leakage allowed by the following formula:

$$L = \frac{ND\sqrt{P}}{4500}$$

in which

L = allowable leakage in gallon per hour.

N = number of joints in the pipe line being tested, this "N" being the standard length of pipe furnished divided into the length being tested, with no no allowance for joints at branches, blowoff, fittings, etc.

D = nominal diameter of pipe in inches.

P = average observed test pressure of the pipe being tested, equal to at least 100 percent of the class rating of pipe being tested, in psi gage, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gage.

Should the test on any section of the pipe line show leakage greater than specified above, the Contractor shall locate and repair the defective pipe, fittings, or joint until the leakage is within the specified allowance of 2 hour duration.

Leakage is defined as the quantity of water necessary to be supplied into the pipe line section under test to maintain the specified leakage test pressure after the pipe line has been filled with water and all air expelled. All repairs and retests, if required, shall be made at the Contractor's expense.

Connections to the existing pipelines or existing valves shall not be made until after that section of new construction has satisfactorily passed the hydrostatic tests.

610.15 DISINFECTING WATER LINES:

After pressure testing and before placing in service, all water lines shall be disinfected. Disinfection shall be accomplished in accordance with Section 611. All valves in the lines being disinfected shall be opened and closed several times during the 24 hour period of disinfection.

610.16 PAVEMENT AND SURFACING REPLACEMENT:

Pavement and surfacing replacement shall be in accordance with the requirements of Section 336.

610.17 CLEANUP:

When testing, chlorination, compaction, and cleanup do not follow pipe laying in an orderly manner, the Engineer reserves the right to close down trenching and pipe laying until these operations are adequately advanced.

610.18 MEASUREMENT AND PAYMENT:

(A) Pipe:

(1) Measurement of all pipe shall be of the linear feet of pipe installed, measured along the centerline of the pipe, through all valves and fittings, from the centerline of the fittings or centerline of valves on ends of pipe to the centerline of fittings, centerline of valves on ends of pipe or to the end of pipe, as the case may be, for all through runs of pipe. Measurement shall be to the nearest 0.1 foot.

Measurement of branch line pipe shall start at the centerline of valve at connection to the main. Branches of tees that are valved and capped will not be measured.

Measurement of meter service pipe shall be from the centerline of the new main to the connection at the meter, along the centerline of service pipe.

(2) Payment will be made at the unit price bid per linear foot of each type and size of pipe called for in the proposal. Such payment shall be compensation in full for furnishing and installing the pipe and fittings, specials, adapters, etc., complete in place, as called for on the plans and/or on the standard details, and shall include all costs of excavation, removal of obstructions, shoring and bracing, bedding, back-filling, compaction, maintenance of traffic, testing, disinfecting, connections to existing lines or works, and all work not specifically covered in other pay items.

A contingent item for cast iron fittings not shown on the plans shall be included in the proposal. Payment will be made at the unit price bid per pound on the theoretical weight of the fittings installed, which shall be compensation in full for furnishing and installing the fittings.

(B) Service Connection To Existing Water Meters:

(1) Measurement shall be of the number of unit connections made for water meter services, as called for in the proposal. Each proposal item unit shall consist of the connection to the water main and to the meter, as required in standard details.

(2) Payment will be made at the unit price bid for each unit water meter service connection and shall be compensation in full for labor materials (other than pipe) equipment, tapping, and all necessary incidentals. Payment for new service pipe required to make the connection will be made separately, as stipulated above.

(C) Relocation of Existing Meters and Boxes: Measurement shall be of the number of meters and boxes moved and reinstalled. Payment will be made at the unit price bid in the proposal for each meter and box relocated and installed.

(D) Permanent Pipe Supports and Encasement of Existing Pipes: Measurement shall be of each unit included in the proposal, and payment shall be compensation in full for supporting or encasing existing pipe, as required on the plans, including excavation, form work, reinforcing, concrete, handling and controlling flows in the existing pipe, removing and replacing existing pipe where necessary, supporting, backfilling and compaction, and pavement and/or surfacing replacement required in excess of pay width(s) allowed in Section 336.

(E) Concrete Thrust Blocks: Concrete thrust blocks and anchors for all pipe 16 inch and larger shall be measured by the cubic yard(s) of concrete placed, as required on the plans and/or as directed by the Engineer. Payment will be made at the unit price bid per cubic yard, and shall be compensation in full for excavation, formwork, placing and finishing concrete, reinforcing, backfilling and compaction, and pavement and/or surfacing replacement required in excess of pay width(s) allowed in

Section 336. All thrust blocks and anchors for 12 inch and smaller pipe shall be included in the linear foot cost of the pipe.

(F) Valves: Measurement of and payment for valves, tapping sleeves and valves, and valve boxes shall be for each item furnished and installed, as designated in Section 630.

(G) Fire Hydrants: Measurement shall be the number of fire hydrants installed. Payment will be at the unit price bid for the installation of each fire hydrant complete in place and in operating condition. The 6 inch cast iron pipe and fittings, required for making the connection from the main to the hydrant, shall be a separate pay item in the proposal as described above.

(H) Pavement and/or Surfacing Replacement: Payment for pavement and/or surfacing replacement will be made as stipulated in Section 336, except as otherwise established in this specification. The cost of pavement and/or surface replacement required for meter service installations shall be included in the price bid for meter service pipe.

SECTION 611

DISINFECTING WATER MAINS

611.1 CLEANING AND TREATING PIPE:

The interior of all pipe and fittings shall be kept as free as possible of all dirt and foreign material at all times, until the pipe is placed in the new line.

If in the opinion of the Engineer, the pipe contains dirt that will not be removed during the flushing operation, the interior of the pipe shall be cleaned and swabbed, as necessary, with a .005 to .010 percent chlorine solution.

611.2 LAYING PIPE:

If the Contractor or pipe-laying crew cannot install the pipe in the trench without getting earth into it, the Engineer may require that, before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size be placed over each end of the pipe and left there until the connection is to be made to the adjacent pipe.

At the close of each day's work, the end of the last laid section of pipe shall be plugged, capped, or otherwise tightly closed to prevent the entry of foreign material of any nature.

611.3 PREVENTING TRENCH WATER FROM ENTERING PIPE:

At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means approved by the Engineer. Joints of all pipe in the trench shall be completed before the work is stopped. If water is in the trench, the seal shall remain in place until the trench is pumped dry.

611.4 PACKING MATERIAL:

Only such packing materials as are included in the list of acceptable materials in AWWA C-600 for installation of cast iron water main, shall be used. The packing materials shall be handled in such a manner as to avoid contamination, and shall be dry when placed in the joints. All such materials shall be free of oil, tar, or greasy

substances, except that treated paper packing material, jute, cement, or sulphur compound caulking will not be permitted.

611.5 FLUSHING COMPLETED PIPELINES:

(A) Preliminary Flushing: All mains 12 inches and smaller shall be flushed, prior to chlorination, as thoroughly as possible with the water pressure and outlets available. Flushing shall be done after the pressure test has been made. It must be understood that flushing removes only the lighter solids and cannot be relied upon to remove heavy material allowed to get into the main during laying. It is difficult to flush mains over 12 inches in diameter, so in such instances the requirements above, must be rigidly adhered to.

Heavy duty, factory bushed, tapped couplings, with corporation stops shall be located at all high points in the lines to allow the air to be removed prior to testing the waterlines and at disinfection points as may be required. Field taps will not be permitted.

The couplings, at high points and disinfection points, shall be left exposed during backfilling until the testing is complete. Couplings and corporation stops shall be left on the mains upon completion of water mains.

(B) Valve Damage by Foreign Material: Unless proper care and thorough inspection are practiced during the laying of water mains, small stones, pieces of concrete, particles of metal, or other foreign material may gain access to mains newly laid or repaired. If it is believed that such foreign material(s) may be in the main, all hydrants on the line shall be thoroughly flushed and carefully inspected after flushing to see that the entire valve operating mechanism of each hydrant is in good condition.

611.6 CHLORINE RESIDUAL:

Before being placed in service, all new mains and repaired portions of, or extensions to existing mains shall be chlorinated so that a chlorine residual of not less than 10 ppm remains in the water after 24 hours standing in the pipe.

611.7 METHODS OF APPLYING CHLORINE:

Any of the following methods of application of chlorine (arranged in order of preference) may be used, subject to the approval of the Engineer:

Liquid chlorine gas-water mixture.

Direct chlorine feed.

Calcium or sodium hypochlorite and water mixture.

611.8 APPLICATION OF LIQUID CHLORINE:

A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device or, if approved by the Engineer, the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas or of the gas itself must provide means for preventing the backflow of water into the cylinder.

611.9 CHLORINE-BEARING COMPOUNDS IN WATER:

On approval of the Engineer, a mixture of water and a chlorine-bearing compound of known chlorine content may be substituted for liquid chlorine.

(A) Compounds to be Used: The chlorine-bearing compounds that may be used are: Calcium hypochlorite*, and sodium hypochlorite**.

(B) Preparation of Mixture: High-test calcium hypochlorite must be prepared as a water mixture for introduction into the water mains. The powder should first be made into a paste and then thinned to approximately a 1 percent chlorine solution (10,000 ppm). The preparation of a 1 percent chlorine solution requires the following proportions of powder to water:

Product	Amount of Compound	Quantity of Water (Gallons)
High-test calcium hypochlorite (65–70% Cl)	1 lb.	7.50
Liquid laundry bleach (5.25% Cl)	1–2 pts.	12.6

611.10 POINT OF APPLICATION:

The preferred point of application of the chlorinating agent is at the beginning of the pipeline extension or any valved section of it and through a corporation stop inserted in the top of the newly laid pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension.

611.11 RATE OF APPLICATION:

Water from the existing distribution system or other source of supply shall be controlled so the rate of flow shall not exceed 500 gpm, unless approved by the Superintendent of Water Distribution, through a suitable measuring device into the newly laid pipeline during the application of chlorine. The rate of chlorine solution flow shall be in such proportion to the rate of water entering the pipe that the chlorine dose applied to the water entering the newly laid pipe shall produce at least 10 ppm of residual chlorine after 24 hours standing in the pipe. This may be expected with an application of 50 ppm, although some conditions may require more.

On lines 12 inches in diameter or less, determination of the rate of flow of water into the line to be treated may be made by starting with the line full of water and measuring the rate of discharge at a hydrant located at the end of the pipe farthest away from the point of chlorine application.

For lines larger than 12 inches in diameter, the disinfection operation is generally started with the line empty.

Measurement of the flow of water into and out of all lines shall be made by means of a pitot gage, current type meter, or other approved device.

611.12 PREVENTING REVERSE FLOW:

Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valves shall be used to accomplish this.

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*Comparable to commercial products known as HTH, Perchloron, and Pittchlor.

**Known commercially as liquid laundry bleach.

611.13 RETENTION PERIOD:

Treated water shall be retained in the pipe long enough to destroy all nonspore-forming bacteria. This period should be at least 24 hours and should produce no less than 10 ppm residual chlorine at the extreme end of the line at the end of the retention period.

NOTE: If the circumstances are such that less than a 24 hour retention period must be used, the chlorine concentration shall be increased to 100 ppm. Under these conditions, special care should be taken to avoid attack on pipes, valves, hydrants and other appurtenances.

611.14 CHLORINATING VALVES AND HYDRANTS:

In the process of chlorinating newly laid pipe, all valves or other appurtenances shall be operated while the pipeline is filled with the chlorinating agent.

611.15 FINAL FLUSHING, SAMPLING AND TESTING:

Following chlorination, all treated water shall be thoroughly flushed from the newly laid pipeline at its extremities until the replacement water throughout its length shall, upon testing, be proved comparable in quality to the water served to the public from the existing water system. This satisfactory quality of water delivered by the new main shall continue for a period of at least 2 full days as demonstrated by laboratory examination of samples taken from a tap located and installed in such a way as to prevent outside contamination. Such samples for laboratory examination shall not be taken until flushing of the pipe shall have reduced the residual chlorine to 0.6 ppm or less throughout its length. Samples shall never be taken from an unsterilized hose or fire hydrant, because such samples will seldom meet bacteriological standards.

Water and Sewers Department laboratory technicians will perform sampling for tests of new water mains upon receipt, from the inspector, of a written request by the Contractor. The written request should be made to the Water and Sewers Department not later than 4:00 p.m. on the day prior to that on which samples are to be taken, so that the Department can properly schedule laboratory work.

Waterlines up to but less than 150 feet in length require one sampling riser installed near the end; lines 150 feet to 300 feet in length, two sampling risers, one near each end of the line; lines 300 to 3,000 feet in length, a minimum of three sampling risers.

Two samples shall be taken on separate days at each sampling location.

Results of all tests shall be sent by the laboratory to the Water and Sewers Department. Results of labortory analysis will be interpreted by the Water and Sewers Department, and reported to the Engineer. Under no circumstance shall the Contractor or Engineering Division personnel contact the laboratory. If there is need for test results before written reports are submitted, such information shall be obtained only from the Water and Sewers Department.

611.16 REPETITION OF CHLORINATION PROCEDURE:

Should the initial treatment fail to result in the conditions specified above, the original chlorination procedure shall be repeated until satisfactory results are obtained.

611.17 PAYMENT:

No separate pay item shall be contained in the proposal for disinfecting water mains. This operation shall be included in the price bid for the water mains, installed complete in place, as specified in the proposal.

SECTION 615

SEWER LINE CONSTRUCTION

615.1 DESCRIPTION:

The construction or extension of sewer lines shall conform to the applicable standard specifications and details, except as otherwise required on the plans or as modified in the special provisions.

615.2 TRENCHING:

Excavation of trenches shall be accomplished in accordance with Section 601.

The Engineer shall furnish the Contractor alignment and elevation stakes at agreed-upon intervals and offset together with cut sheets showing the difference in elevation from the top of the stakes to the flowline of the pipe.

The trench shall be dry when the fine grading of the bottom of the trench is accomplished. Before placement of pipe the fine grade shall be carefully checked by use of a string line, laser beam, or other means so that when in final position the pipe will be true to line and grade, ± 0.05 feet for 8 inch through 12 inch, ± 0.10 feet for 15 inch and larger.

615.3 LAYING PIPE:

Pipe shall be of the type, class, and size called for on the plans. Any vitrified clay pipe used for sanitary sewers up to and including a diameter of 30-inches shall be of extra strength, vitrified clay pipe conforming to Section 743. Pipe larger than 30 inches shall be of the type specified in the special provisions.

All pipe shall be protected during handling against impact shocks and free falls. No damaged or defective pipe shall be installed in the work. Pipe shall be kept clean at all times, and as the work progresses, the interior of the pipe shall be cleared of all dirt and superflous materials of every description.

Cracks in concrete pipe shall be subject to the provisions of Section 735.

The laying of the pipe shall be in finished trenches free from water or debris, and shall be commenced at the lowest point, with the spigot ends pointing in the direction of the flow. Each pipe shall be laid firmly and true to line and grade, in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flowline. Any adjustment to line and grade shall be made by scraping away or filling in under the body of the pipe, never by wedging or blocking under the pipe ends.

The alignment and grade of each length of pipe shall be checked after setting by measurement from the string line, laser beam target or other means approved by the Engineer.

At all times when work is not in progress, open ends of the pipe and fittings shall be securely closed to the satisfaction of the Engineer, so that no water, earth or other substance will enter the pipe or fittings.

615.4 FITTINGS:

All fittings shall conform to the requirements of the pipe specifications and shall be located as shown on the plans, or as directed by the Engineer, in accordance with the standard details.

615.5 JOINTING:

Prior to making pipe joints, all surfaces of the portions of the pipes to be joined shall be cleaned, dried, and prepared in accordance with the manufacturer's recommendations. The joints shall then be carefully centered and completed.

Trenches shall be kept water-free during the installation of joints and couplings.

The joint and coupling materials will be as specified in the appropriate pipe sections and shall be installed in accordance with the manufacturer's recommendations. Cement mortar joints will NOT be permitted in sanitary sewer construction.

615.6 SANITARY SEWER SERVICE TAPS:

When the construction of sanitary sewer service taps are called for in the special provisions, they shall be constructed in accordance with standard details for sewer taps.

The location of the service tap for each property shall be in the downstream ⅓ of the lot, or as requested by the property owner. Sewer service taps shall not be covered until they have been plugged and marked in accordance with standard details and their location has been recorded by the Engineer.

615.7 SANITARY SEWER CLEANOUTS:

The cleanouts shall be constructed at locations shown on the plans, in accordance with the standard details for cleanouts.

615.8 MANHOLES:

Manholes shall be constructed to conform with the requirements of Section 625 and standard details.

615.9 TESTING:

As the pipe laying progresses, and after partial backfilling, the interior of the sewer or pipeline shall be visually inspected for alignment and grade, by means of artificial or reflected light. Necessary corrections shall be made by the Contractor at no additional cost to the Contracting Agency.

Sewers and pipelines shall be subject to test for leakage after the lines have been partially backfilled, in accordance with the following:

(A) Approximately 20 percent of the length of lines will be tested as specified below. If tests made indicate that the work is being done and the lines are tight, the Engineer may waive tests on the other parts of the lines, or call for spot tests, to insure proper construction.

The Contracting Agency reserves the right to require testing of the entire installation. The cost of testing shall be borne by the Contractor, and sections showing excess leakage shall be repaired by the Contractor at no additional cost to the Contracting Agency.

(B) Testing shall be accomplished by plugging the downstream end and filling the pipe with water in suitable sections. Equipment for the test shall be furnished by the Contractor, and shall include a metal stand pipe, a suitable meter or method of measuring the quantity of water used. A period of at least one hour's time shall be allowed for absorption before making the test.

(C) The allowable water loss for sanitary sewers shall not exceed 0.5 gallons per hour per 100 feet of pipe per inch of diameter of pipe under a minimum test head of 4 feet above the top of the pipe at the upper end.

615.10 OPTIONAL TESTING PROCEDURE:

(A) General:

The following air test procedure shall be acceptable as an alternate method for testing of sanitary sewers except when specifically prohibited by the contract documents.

If air testing is elected by the Contractor, all pipe shall be tested for acceptance after backfill is completed and compacted. At the Contractor's option, for his own information, a presumptive test may be made prior to backfilling but this shall in no case be considered the acceptance test.

Prior to performing the acceptance leakage test, the pipe shall be thoroughly cleaned and saturated. This shall be performed by flushing a sewer cleaning device through the pipe. This may be an inflated sewer cleaning ball, or a poly-pig type of cleaner that will fit snugly into the pipe. The cleaner shall be placed in the last cleanout or manhole on the pipe to be cleaned and water shall be introduced behind it. The cleaner shall pass through the pipe with only the pressure of the water propelling it. All debris flushed out ahead of the cleaner shall be removed at the first manhole where its presence is noted. In the event the cleaner is stopped by cemented or wedged debris in a damaged pipe, the Contractor shall remove the obstruction.

The Contractor may test the entire length of pipe from manhole to manhole by placing an inflatable test plug at each end of the pipe. Optionally he may test in shorter increments by fastening the inflatable test plugs together and advancing the assembly through the pipe in increments not less than 2 feet shorter in length than the distance between the plugs. In the event that any increment fails to pass the test, the plug assembly may be advanced forward or backward in short increments to pinpoint the leak.

The pressure gauge used shall be supplied by the Contractor, shall have minimum divisions of 0.10 psi, and shall have an accuracy of 0.04 psi. Accuracy and calibration of the gauge shall be certified by a reliable testing firm at 6 month intervals or when requested by the Engineer. In addition, the Engineer may compare the Contractor's gauge with a Contracting Agency owned gauge at any time.

The acceptance test shall be made only in the presence of the Engineer or his duly authorized representative.

(B) Test Procedure:

(1) The Contractor shall plug all pipe outlets with suitable test plugs and securely brace each plug.

(2) Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.

(3) Check exposed pipe and plugs for abnormal leakage by coating with a soap solution. If any failures are observed, bleed off air and make necesary repairs.

(4) After an internal pressure of 4.0 psig is obtained, allow at least 2 minutes for internal air temperature to stabilize, adding only the amount of air required to maintain pressure.

(5) After the 2 minute period, disconnect the air supply.

(6) When the pressure decreases to 3.5 psig, start timing. Determine the time in seconds that is required for the pressure to fall from 3.5 psig to 2.5 psig. The test duration time must be equal to or greater than the minimum test time obtained as outlined below.

(C) Minimum Test Duration Times:

The following procedures for obtaining minimum test duration times from the following nomograph Table 615 are based on a maximum air loss of 0.003 cfm per square foot of internal area but not more than 2 cfm for the entire length under test.

(1) For test sections of one diameter, or for sections such as laterals with a few short taps.

If the length of the section under test is not greater than the length shown in Column L_A, read the minimum test duration time in seconds from Scale T_A.

If the length of section under test is greater than L_A, but within the limits of Scale L. extend a straight line from the diameter on Scale D to the length on Scale L and read the minimum test duration in seconds on Scale T_B.

(2) For test sections consisting of more than one size pipe, and for lengths not falling within the limits of Scale L.

For test section lengths falling within the limits of Scale L, extend a straight line from the diameter read on Scale D to the corresponding length on Scale L for each size of pipe included and read values for C and K directly from the corresponding scales.

For test section lengths not falling within the limits of Scale L, calculate C and K from the formulas at the bottom of the nomograph.

Add C's and add K's.

If the total of C's is 1.0 or greater, the sum of K's equals the minimum test duration in seconds.

If the total of C's is less than 1.0, divide the sum of K's by the sum of C's. The quotient is the minimum test duration in seconds.

615.11 BACKFILLING:

Backfilling and compaction shall be done in accordance with Section 601.

615.12 PAVEMENT AND SURFACING REPLACEMENT:

Pavement and surfacing replacement shall be done in accordance with Section 336.

615.13 CLEANUP:

The Engineer has the right to close down forward trenching and pipe laying where testing, backfill, compaction and cleanup does not follow in an orderly manner.

615.14 MEASUREMENT AND PAYMENT:

(A) Sewer Pipe and Fitings: (Vitrified clay, cast iron and other approved types of pipe.)

(1) Measurement will be made horizontally thru manholes and fittings and from centerline to centerline of structures, for the various types and sizes of pipe called for on the plans and in the proposal.

(2) Payment for the various sizes and types of pipe will be made at the unit price bid per linear foot, and shall be compensation in full for furnishing and installing the pipe and fittings complete in place, as specified, including excavation, removal of obstructions, backfilling, water settling, compaction, sheeting and bracing, testing, and all incidental work not specifically covered in other pay items.

(B) Sanitary Sewer Service Taps:

(1) Measurement will be the number of taps installed.

(2) Payment will be made at the unit price bid and shall be compensation in full for furnishing and installing pipe and fittings complete in place, as specified and called for on the plans and standard details, including all costs of excavation, removal of obstructions, shoring and bracing, backfilling, compaction, pavement replacement, maintenance of traffic, and all work incidental thereto.

(C) Sanitary Sewer Cleanouts:

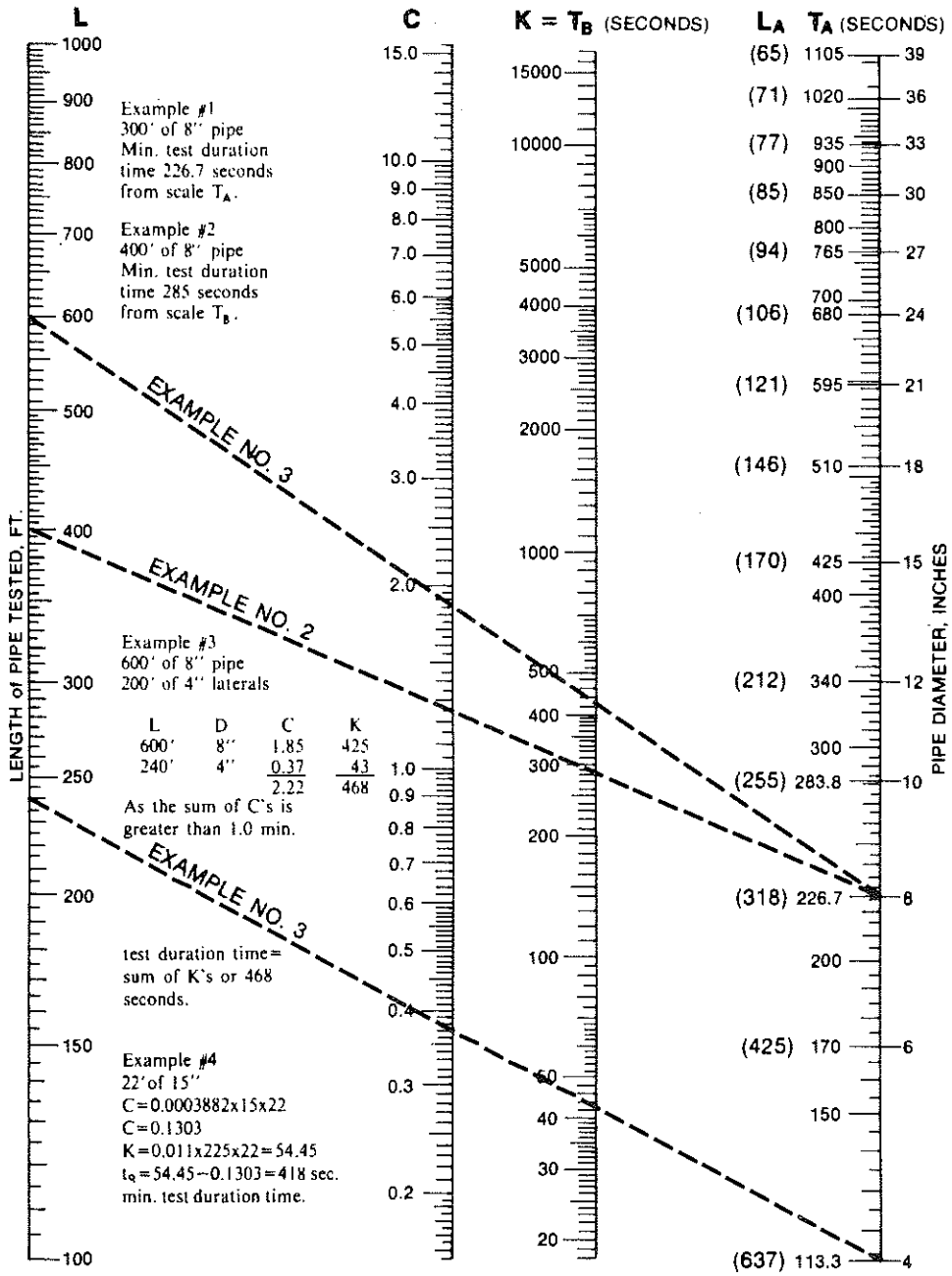
(1) Measurement will be the number of cleanouts installed.

(2) Payment will be made at the unit price bid and shall be compensation in full for furnishing and installing pipe, fittings, and frame and cover as called for on the plans and in accordance with the standard details.

SECTION 615

TABLE 615

AIR TEST



NOMOGRAPH FOR THE SOLUTION OF K = .011d²L.
C = .0003882dL, t_q = K ÷ C

SECTION 618

STORM DRAIN CONSTRUCTION WITH CONCRETE PIPE

618.1 DESCRIPTION:

This section covers concrete pipeline construction used for the conveyance of irrigation water and storm drainage in streets, easements, and alley right of ways, under low hydrostatic heads.

Installation of pipe in laterals of Salt River Valley Water Users' Association or other irrigation districts shall conform to the specifications and permit of the respective irrigation district.

Installation of pipe in State Highways shall conform to the specifications and permit of the Arizona Department of Transportation.

618.2 MATERIALS:

The concrete pipe, specials, joints, gaskets, and testing shall be according to Sections 620 or 735 and 736, except as specified below or as modified by special provisions.

(A) Specials: Pipe specials such as closure pieces, wyes, tees, bends, and manhole shafts shall be provided as indicated on the plans, and such specials shall be made equal in strength, diameter, and other physical characteristics to the standard straight pipe lengths by the use of extra concrete, extra reinforcing, or steel items. Drawings of specials shall be submitted to the Engineer for approval before their fabrication.

(B) Rubber Gasket Joints: When rubber gasket pipe is used, the joint shall be sealed with a continuous ring gasket made of a special composition rubber of such size and cross section as to fill completely the recess provided for it. The gasket shall be the sole element depended upon to make the joint watertight, and shall have smooth surfaces, free from pits, blisters, porosity, and other imperfections. The rubber compound shall contain not less than 60% by volume of first grade synthetic rubber. The remainder of the compound shall consist of pulverized fillers free from rubber substitutes, reclaimed rubber and deleterious substances. The compound shall meet the following physical requirements when tested in accordance with appropriate ASTM Specifications:

(1) Tensile Strength of the compound shall be at least 2,100 psi ASTM D-412.

(2) Elongation at Rupture shall be at least 400%, ASTM D-412.

(3) Shore Durometer Hardness, Type A. Value *40–60, ASTM D-2240.

(4) Cold Flow: The percentage shall not exceed 20. The determination shall be made in accordance with Method B ASTM D-395, with the following exception. The disc shall be ½" thick and the diameter shall be that of the rubber gasket. The gaskets shall not be exposed to direct sunlight for a time greater than needed to accomplish normal installation.

(5) Specific Gravity shall be consistent within +0.05 and shall be between 0.95 and 1.45, ASTM D-297.

(C) Cement Mortar Joints for R.C.P will be in accordance with subsection 736.4.1.

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618.3 CONSTRUCTION METHODS:

Excavation, bedding, backfilling, and compaction or consolidation of backfill and bedding of trenches shall be accomplished in accordance with Section 601, except as specified below, or as modified by special provisions.

The Contractor shall over-excavate the trench and fill with select material in accordance with standard details.

Where the cover over the top of the pipe is less than 10 feet, the maximum trench width is unrestricted. The pay width, however, for pavement replacement shall remain in accordance with Section 336. For pipe, with 10 feet or more cover, the maximum trench width shall be as required by Section 601.

The laying of the pipe shall be in finished trenches free from water or debris, and shall be commenced at the lowest point, with the spigot ends pointing in the direction of the flow. Each pipe shall be laid firmly and true to line and grade, in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden off-sets of the flowline. Any adjustment to line and grade shall be made by scraping away or filling in under the body of the pipe, never by wedging or blocking under the pipe ends.

Variation from prescribed alignment and grade shall not exceed 0.10 foot and the rate of departure from or return to established grade or alignment shall be no more than 1 inch in 10 feet of pipeline unless otherwise approved by the Engineer. For closures and deflecton angles greater than 10 degrees, joints shall be made by use of a concrete collar, per standard details.

Pipe shall be of the type, class and size shown on the plans or in the special provisions.

All pipe, for permit construction, shall be reinforced concrete pipe, ASTM C-76, Class III. The minimum cover from the top of the pipe to the finished grade shall be 2 feet and the maximum cover shall be 12 feet.

All pipes installed under railroad tracks shall be reinforced concrete pipe, ASTM C-76, Class V and the minimum cover over all pipes shall be as specified in the railroad permit and/or special provisions. Bedding shall be in accordance with standard details.

The allowable water loss for irrigation lines shall not exceed 2 gallons per hour per 100 feet of pipe per inch of diameter of pipe, under a minimum test head of 1 foot above the top of the pipe at the upper end when tested in accordance with the procedures of Section 615.

618.4 JACKING PIPE:

At locations where jacking is required, the storm drain line shall be installed by jacking to the lengths indicated on the plans, in accordance with the following. The methods and equipment used in jacking reinforced concrete pipe conduit shall be optional with the Contractor, provided that the proposed method is first approved in writing by the Engineer. Such approval, however, shall in no way relieve the Contractor of the responsibility for damages of any nature which might occur as a result of the methods used.

Only workmen experienced in the operation of jacking concrete conduit shall be used.

The driving ends of the conduit shall be properly protected and the conduit shall be driven true to alignment and grade. The deviation from true line and grade at any

single point within the jacked portion shall be limited to 0.5 feet horizontal deviation from line and ±0.2 feet vertical deviation from grade.

Any section of conduit which may show signs of failure shall be removed and replaced with a new section of precast conduit or with a cast-in-place section, which in the opinion of the Engineer is adequate to carry the loads imposed upon it. In this respect it shall be understood that where pipe is specified on the drawings to be jacked into place the jacked pipe shall be reinforced concrete of the strength specified in these specifications and the design of such pipe is based upon superimposed loads and not upon loads which may be placed upon the pipe as a result of jacking operation. Any increase in pipe strength required in order to withstand jacking loads shall be the responsibility of the Contractor. The reinforcing shall be circular and of either single or double cage design.

Spacer blocks shall be placed in the inside circular space which will allow sufficient width for point mortaring when jacking is completed and to equalize pressures during jacking. Three grout holes per 8-foot section of pipe shall be made during manufacturing.

Double rubber gaskets and band type joints shall be provided for 36 inch diameter and larger pipe.

One hole shall be made on the top midway between the ends. Two additional holes, each approximately 1.5 feet from each end and approximately midway between the springline and top on opposite sides shall be made.

Where the nature of the soil, or the structure under which the conduit is being jacked is such that, there is increased danger of a cave-in or damage to said structure, the method of jacking the conduit shall be as specified below.

The leading section of conduit shall be equipped with a jacking head securely anchored thereto to prevent any wobble or alignment variation during jacking operations. The length and details of the jacking head shall be subject to the written approval of the Engineer. Excavation shall be carried out entirely within the jacking head and no excavation in advance thereof will be permitted. Every effort shall be made to avoid any loss of earth outside of the jacking head. Excavated material shall be removed from the conduit as excavation progresses, and no accumulation of such material within the conduit will be permitted. Upon completion of the jacking operations, all voids around the outside face of the conduit shall be filled by grouting through each of the previously constructed grout holes to the satisfaction of the Engineer. The grout shall be a mixture of one part cement to three parts sand and a mixture by volume.

Grouting equipment and material shall be on the job before jacking operations are started in order that grouting around the jacked conduit may be started immediately after the jacking operation. After grouting, the holes in the conduit shall be repaired to the satisfaction of the Engineer.

618.5 MEASUREMENT:

(A) Main Line Pipe: Shall be the number of linear feet of pipe laid as measured along the pipe axis.

Unless hereinafter modified, measurement shall extend through manholes when no change in pipe size occurs. When a change in pipe size occurs within a manhole, unless hereinafter modified, measurement for each size will be taken to the centerline of the manhole.

(B) Connecting Pipe: Shall be the number of linear feet of pipe installed, as measured along the pipe axis from a main line pipe, or a manhole, or a catch basin to a catch basin, or a plugged end, and shall include the portions of the connecting pipe embedded in the above structures.

(C) Jacked Pipe: Shall be made at the ground surface and shall be the number of linear feet of ground surface undisturbed by the cut and cover construction on either side of the jacked section.

618.6 PAYMENT:

(A) Main Line Pipe: Will be paid at the unit price bid per linear foot, to the nearest foot, for each size and type of pipe and shall be compensation in full for furnishing and installing the reinforced concrete pipe as specified and as shown on the plans including removal of obstructions, excavation, bedding, backfilling, compacting, testing, joint materials, joining, collars, and field closures.

(B) Connecting Pipe: Will be paid at the unit price bid per linear foot, to the nearest foot for each size of pipe and shall be compensation in full for furnishing and installing complete in place as shown on the plans and as specified, the connecting pipe and specials including spur connections, removal of obstructions, excavation, bedding, backfilling, compacting, joint materials, joining, collars, field closures, and testing.

(C) Jacked Pipe: Will be paid the same as for main line pipe.

SECTION 620

CAST-IN-PLACE CONCRETE PIPE

620.1 GENERAL:

This specification covers cast-in-place non-reinforced concrete pipe intended for use as storm sewers or irrigation lines. The abbreviated title is CIPP. CIPP is conduit made of portland cement concrete cast monolithically in a properly prepared trench, using equipment specifically designed for this purpose. The type of equipment to be used by the Contractor must be approved by the Engineer and the Contractor may be required to furnish evidence of the successful use of this equipment on prior work. CIPP will be placed only:

(A) By experienced operators. The Engineer will be the sole judge as to experience level.

(B) In the presence of the Engineer.

(C) In ground capable of standing unsupported from the bottom of the trench to the top of the pipe without sloughing.

(D) In fill when it can be demonstrated to the satisfaction of the Engineer that the fill will adequately support the pipe.

620.2 MATERIALS:

620.2.1 Cement shall be ASTM C-150, Type II, low alkali as per Section 725.

620.2.2 Sand aggregate used for concrete and mortar shall conform to Section 701. Maximum size of the aggregate shall not be greater than 1/3 of the minimum wall thickness up to and including a wall thickness of 4-1/2-inches (114 MM). The maximum aggregate size is 1-1/2-inches (38 MM).

620.2.3 Water used for concrete and for curing the pipe shall be as per Section 725.

620.2.4 Concrete shall be Class A in accordance with Section 725. Slump shall be the minimum required for satisfactory placement of the concrete by the equipment used by the Contractor. The slump shall not exceed 3-inches (75 MM).

620.2.5 Bonding mortar shall consist of two (2) or more parts of cement to three (3) parts of sand by volume.

620.3 CONSTRUCTION METHODS:

620.3.1 Excavation: The trench will be neatly excavated with vertical sides and semi-circular bottom. The trench shall be shaped to form the bottom outside of the pipe on the alignment and to the grades specified in the plans. Departure from and return to established grade shall not exceed 1-inch per 10 linear feet (25 MM per 3 M) with a maximum allowable departure of 1-1/2-inches (40 MM). Departure from and return to specified alignment shall not exceed 2-inches per 10 linear feet (50 MM per 3 M) with a maximum allowable alignment departure of 4-inches. The bottom of the trench, hereinafter known as the trench form, will be shaped to provide full, firm, and uniform support by undisturbed earth or compacted fill for at least the bottom 210 degrees of the pipe. Density of the fill shall be at least five percent (5%) greater than the natural inplace soil, but in no case less than 85 percent (85%) when tested in accordance with AASHTO T-99, Method A and T-191 or ASTM D-2922 and D-3017.

When it is necessary to install the pipe in rocky areas, the rock will be removed and replaced with suitable fill material compacted to proper density. The rock will be over-excavated to leave a 6-inch (150 MM) minimum compacted soil cushion between the rock and the pipe. For construction accuracy, areas left void by rock removal will be completely filled with compacted material, then trenched for the pipe as though natural ground. If the rock below the pipe subgrade is fractured or fragmented or if it consists of large cobblestones or boulders, the replacement fill material will be carefully selected to insure that it is of such gradation that it will not be removed downward by fluctuation of the water table. In no case will expansive soils be used for fill. A similar procedure of over-excavation, backfill, compaction, and retrenching will be used where sloughing sand or where soft or spongy soil conditions are encountered. When expansive clays are encountered, they will be thoroughly moistened by ponding, to completely expand the soil, and the moisture maintained until the concrete is placed.

Where the pipe is to be constructed through fill material, such fill shall have stability in the zone of the trench form equal to firm undisturbed earth, in the area adjacent to the fill.

Upon direction of the Engineer, the Contractor shall substitute RCP or an acceptable alternate at locations where the conditions are unsuitable for CIPP. All cost for this substitution shall be borne by the Contractor.

620.3.2 Placement: At the time of concrete placement, all soil in the trench will be adequately moistened so that water is not drawn from the freshly placed concrete. However, the trench form will be completely free of water, mud, and debris. All forming devices, including the slipforms and hopper of the placement device, shall be thoroughly moistened.

Concrete shall not be placed when temperature of the concrete exceeds 90 degrees Fahrenheit (32 Celsius) or is less than 50 degrees Fahrenheit (10 Celsius). The soil adjacent to the trench shall be at a temperature above freezing.

The pipe shall be constructed in one placement, the entire cross-section being placed monolithically. Inside forms shall be sufficiently rigid to withstand consolidation of the fresh concrete. Placement shall be such as to produce a thoroughly consolidated homogeneous concrete mixture conforming to the test requirements of this specification. Effective consolidation means shall be applied to the fresh concrete over the entire circumference and from within the pipe shell. Consolidation means shall be capable of effectively placing and consolidating fresh concrete at production speeds. Methods of consolidating shall be capable of building up sufficient pressure to effectively bond the concrete to the surrounding earth and to keep loose sand, mud, and water out of the pipe shell.

(A) Construction Joints:

When work is stopped at the end of a placement or for any period that would permit initial set to take place, a construction joint shall be formed. The ends of the pipe that are to be in butt contact shall be left in rough condition with a slope of approximately 45 degrees. Before resuming, if the pipe diameter is 60-inches (1.5M) or less, an excavation shall be made along the sides and bottom of the joint to permit casting of a concrete collar around the outside of the joint. This collar shall have a minimum thickness of 1-1/4 times the wall thickness of the pipe and shall lap the entire joint by at least two (2) times the wall thickness. Immediately before resuming concrete placement the surfaces to be bonded shall be cleaned of all laitance, coatings, foreign materials, and loose or defective concrete,

thoroughly wetted and coated with a layer of bonding mortar (Section 620.2.5) approximately 1/4-inch (6MM) thick. In lieu of the bonding mortar, neat cement paste may be thoroughly scrubbed onto the wet surface of the previously placed concrete.

For a joint that may be used for connections to another pipe or structure, a joint shall be made by squaring off the end of the pipe. An excavation shall be made along the sides and bottom of the cast-in-place pipe, for any diameter, to permit casting of a concrete collar as described above.

The outside top of all joints shall be capped for the entire width of the pipe that is exposed, that is, between the earth walls of the excavated trench. This cap shall have a minimum thickness equal to the wall thickness of the pipe and shall lap the joint, both upstream and downstream from the joint by at least twice the wall thickness of the pipe. A cap as described is required regardless of pipe size.

(B) Pipe Dimensions and Tolerances:

(1) The internal diameter of the pipe at any point shall not be less than 95 percent of the nominal diameter, and the average of any four (4) measurements of the internal diameter made at 45 degree intervals shall not be less than the nominal diameter.

(2) For pipe less than 15-inches (381 MM) inside diameter, the minimum wall thickness shall be 2 inches (50 MM).

For pipe with an inside diameter of 15-inches (381 MM) to 24-inches (610 MM) the minimum wall thickness shall be 2-1/2-inches (63 MM). For pipe exceeding 24-inches (610 MM) inside diameter, the minimum wall thickness shall be 1/12 of the inside diameter, plus 1-inch (25 MM).

(3) Offsets at form laps and horizontal edges shall not exceed 1/2-inch (13 MM) for pipe having inside diameter not greater than 42-inches (approximately 1 M); 3/4-inch (19 MM) for pipe having inside diameter greater than 42-inches, but not greater than 72-inches (approximately 2 M); and 1-inch (25 MM) for pipe having inside diameter greater than 72 inches (1.8 M).

620.3.3 Curing and Backfilling: The Contractor shall be responsible for proper curing of the concrete and backfilling the trench to an even grade. Final backfill and compaction shall not be started until concrete has developed a compressive strength of at least 2,000 psi (13.8 MPa). Curing shall be performed in such a manner as to prevent the premature drying of the concrete. The Contractor shall use one of the four methods described below.

(A) A 3-inch (75 MM) layer of moist loose soil or sand shall be carefully placed over the top of the pipe immediately after the pipe is cast. The backfill shall be material free of clods and rocks having a diameter greater than 2-inches (50 MM) and any other deleterious foreign materials. The backfill shall be carefully placed over the top of the pipe to prevent damage to the wet concrete. The thickness of the backfill shall be increased by 9-inches (228 MM) after initial set of the concrete has occurred. The backfill shall be kept moist at all times until the pipe has been covered to a depth of 12-inches (305 MM) or more.

(B) The exposed top portion of the pipe may be covered with wet burlap or other material of high moisture retentive properties immediately after the pipe is cast. The covering material shall be kept continuously moist until the placement of final backfill as described above. Moisture retentive material may be removed or left in place at the option of the Contractor.

(C) A pigmented membrane-curing compound conforming to ASTM C-309 may be applied to the exposed surface immediately after the pipe is cast. The compound shall be applied at the rate of not less than one (1) gallon for each 150 square feet (1 litre for each 3.7 square M) of exposed concrete. The pipe shall then be covered with a minimum of 3-inches (75 MM) of moist loose soil when the curing compound is sufficiently hard to resist damage from the fill. Final backfill shall be placed when the pipe attains suitable strength.

(D) Polyethylene film complying with ASTM C-171, nominal thickness 0.0015-inches (0.038 MM), may be placed on the exposed top surface of the pipe immediately after the pipe is cast. The film shall be anchored in place with loose soil to assure continuous, adequate curing. The trench shall be completely backfilled as soon as the pipe attains suitable strength.

A humid atmosphere within the pipe, as evidenced by condensation on the interior surface, shall be maintained for at least seven (7) days following placement, except for a maximum period of 48-hours allowed for removing forms and making repairs. To prevent air drafts which may dry the pipe and to maintain a humid atmosphere inside the pipe, all openings into the pipeline shall be kept closed or covered, except when and where work is actually in progress on the inside of the pipe. If necessary to promote high humidity, the pipeline will be partially filled with ponded water during the curing period.

620.3.4 Repair: Care shall be taken when removing the forms that the pipe is not damaged. Immediately after the removal of the forms, the inside of the pipe shall be inspected and all required repairs made before final backfilling begins. All spalls, cracks or indentations not satisfying Section 620.3.2(A) shall be filled with mortar per Section 620.2.5. Cracks may be repaired with epoxy materials.

Longitudinal cracks exceeding 0.01 inches (0.25 MM) in width and 12-inches (305 MM) in length shall be cause for rejection of the pipe. The pipe section or reach in question shall either be removed and replaced or shall be repaired in a manner approved by the Engineer.

620.3.5 Finish: Except for the form offsets the interior surface of the pipe shall be equivalent to or better than a wood float finish. All extraneous concrete shall be removed from the interior surface.

620.4 METHODS OF TESTS:

Wall thickness shall be checked at the top, sides and bottom, every 100 feet (30 M). Where thickness is not determined by probes through the fresh concrete, small holes shall be drilled a day or so after placement. The holes shall be properly and permanently closed and sealed, flush with the inside surface of the pipe, after measurements are made.

Test cylinders shall be prepared and tested as per Section 725. If the cylinder tests indicate that the concrete does not meet the specified strength requirements, cores shall be taken from the same section of concrete represented by the faulty test cylinder under the supervision of the Engineer. The concrete should be at least 14 days old before the core specimens are taken. The diameter of the core specimens for the determination of compressive strength should be at least three (3) times the maximum nominal size of the coarse aggregate used and must be at least twice the maximum nominal size of coarse aggregate.

The length of the specimen, when capped, should be twice the core diameter. A core having a maximum height of less than 95 percent of its diameter before capping or a height less than its diameter after capping shall not be tested.

If cores are taken the Contractor shall patch all core holes in such a manner that the patch will be permanent, will not leak, and will have a smooth interior finish flush with the interior surface of the pipe.

Procedures and payment for coring shall be in accordance with applicable portions of Section 725.

The Engineer will evaluate the test results and his decision as to required corrective action will be final.

620.5 MEASUREMENT:

Measurement of cast-in-place concrete pipe will be the number of linear feet of pipe measured horizontally along the pipe axis from end to end of pipe. At changes in diameter, the measurement shall be to center of manhole or transition.

620.6 PAYMENT:

Payment will be made at the contract unit price bid per linear foot to the nearest foot for each size of pipe and shall be compensation in full for furnishing and installing the cast-in-place concrete pipe as specified, including removal of obstructions, excavation, backfilling, compacting, testing, and all incidental costs not specifically covered in other items in the proposal.

SECTION 621

CORRUGATED METAL PIPE AND ARCHES

621.1 DESCRIPTION:

These specifications cover plain galvanized, bituminous coated, and bituminous coated and paved galvanized corrugated metal pipe for use in storm sewers. The pipe shall be of the types, constructed as specified, and shall be manufactured in accordance with the requirements of the stated specifications. Except as otherwise required, corrugated metal pipe shall conform to AASHTO M-36 and M-190.

621.2 MATERIALS:

The types of pipe and fabrication shall be in accordance with Section 760.

621.3 INSTALLATION:

Excavation, bedding and backfill shall be in accordance with Section 601, except as modified by standard details.

No pipe shall be laid except in the presence of an inspector. Each pipe shall be carefully inspected immediately before it is laid and defective pipe will be rejected. Pipe lines shall be laid to the grades and alignment indicated on the drawings. Variation from prescribed grade and alignment shall not exceed 0.10 foot, and the rate of departure from, or return to established grade or alignment shall be no more than 1 inch in 10 feet, unless otherwise approved by the Engineer. Proper facilities shall be provided for lowering sections of pipe into trenches. All pipes, elliptical or round, as well as pipe arches requiring bituminous coating and/or pavement shall be equipped with lifting lugs as required and shall have connecting bands designed to provide positive connection without damaging the coating on the pipe or pipe arch.

All field repairs to the bituminous coating or paving shall be made with asbestos reinforced bituminous mastic: Flintkote C-13-C4, Inertol Hotmastic (black), Pioneer Kooler Seal, or an approved equal.

Corrugated metal pipe and/or pipe arches shall be laid with separate section joined together in such a manner that the joint space shall not exceed ½ inch, with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the side. Elliptical pipe shall be installed so that the major or minor axis, whichever the case may be, and which should be indicated by suitable markings on the top of each end of the pipe sections, coincides with the survey alignment of the trench excavation. Any metal in the joints which is not thoroughly protected shall be coated with bituminous mastic. During the installation, the pipe shall be handled with care so as not to damage the bituminous coating. Coupling band bolts and damaged areas of the coupling bands and pipe shall be given a coating of bituminous mastic as specified above prior to placing the backfill. Pipe on which the bituminous coating or paving has been damaged to such extent that satisfactory field repairs cannot be made, as determined by the Enginer, shall be removed and replaced at no additional cost to the Contracting Agency.

621.3.1 Joints: Before the connecting band is placed around the pipe, the ends of the pipe that will be beneath the band, shall be coated with bituminous mastic or, if of suitable design, fitted with circular rubber gaskets to provide a watertight joint. The band shall be tightened evenly, keeping equal tension on the bolts. If mastic is used, tension shall be maintained over an interval of time until the flow of mastic terminates. The joint shall remain uncovered over a period designated by the Engineer, and before covering the joint the nuts shall be tested for tightness. If the nut has a tendency to loosen its grip on the bolt, it shall be tightened again and remain uncovered until a tight, permanent joint can be obtained. Prior to backfilling around the joint, the bolts, lugs, and nuts shall be given a coating of bituminous mastic. The annular space between abutting pipe sections shall be filled with bituminous mastic after jointing.

621.3.2 Pipe Elongation: Except as otherwise specified, the standard details shall control as to conditions under which pipe must be elongated. Pipe shall be elongated 5 ± ½ percent of the nominal diameter to take advantage of the buildup of side support as it settles back toward a full round shape under the backfill load. The method or technique for obtaining and releasing the elongation shall be optional to the Contractor. Under no circumstances shall the vertical diameter of the pipe at any point along the pipe section, after backfill and compaction is completed, be less than the nominal diameter of the pipe, or more than 5 percent greater than the nominal diameter of the pipe as shown on the plans or specified elsewhere in this specification. Any damage done as a result of strutting shall be repaired as directed by the Engineer at no additional cost to the Contracting Agency. Strutting of pipe shall be approved by the Engineer.

621.3.3 Cutting: The Contractor will be prohibited from using conventional welding torches in cutting full lined CMP due to fire hazard. Pipe will either be sawcut or cut with special cutting tools which will not expose the pipe to the fire hazard of a normal acetylene torch. Whenever possible, connections shall be shop fabricated to prevent any exposure to fire hazard.

621.3.4 Repair of Damage to Coatings: Corrugated metal pipe shall be carefully handled at all times to prevent damage to the asphalt or spelter coating or asphalt paving. Each length of pipe shall be carefully inspected immediately prior to placing in the trench to ascertain that no damage has been done to the exterior coating that will

be concealed when the pipe is placed. Any damage to the spelter coating shall be repaired to the satisfaction of the Engineer in accordance with Section 771. Any damage to the asphalt coating or asphalt paving shall be repaired to the satisfaction of the Engineer with bituminous mastic as specified above.

621.4 TEST SPECIMENS:

All tests on the bituminous coating shall be made on samples secured from pipe delivered to or about to be delivered to the Contractor, or from the coating and lining facility of the pipe fabricator at the time the pipe is being coated.

Compliance with these specifications as set forth, shall be the responsibility of the Contractor. Three certified copies of test results indicating compliance shall be furnished for each lot or shipment prior to delivery of the material to the Contractor.

621.5 MEASUREMENT:

Measurement of corrugated metal pipe will be the number of linear feet of pipe, measured horizontally, from end to end of pipe through manholes and specials. At changes in diameter the measurement will be to center of manhole or special.

621.6 PAYMENT:

Payment will be made at the contract unit price bid per linear foot, to the nearest foot, for each size and type of pipe and shall be compensation in full for furnishing and installing the corrugated metal pipe as specified, including removal of obstructions, excavation, backfilling, compacting, testing, and all incidental costs not specifically covered in other items in the proposal.

SECTION 625

MANHOLE CONSTRUCTION AND DROP SEWER CONNECTIONS

625.1 DESCRIPTION:

625.1.1 Sewer Manholes: Construction shall consist of furnishing all materials and constructing manholes complete in place, as detailed, including foundation walls, cast iron steps, manhole frames, covers, and any incidentals thereto, at locations shown on the plans.

625.1.2 Drop Sewer Connections: Construction shall consist of furnishing all materials and constructing drop sewer connections complete in place as detailed, including foundation materials, pipe, and any incidentals thereto, at locations shown on the plans.

625.2 MATERIALS:

Unless otherwise shown on the plans or specified in the special provisions, materials to be used shall conform with the following:

Bricks for manholes Section 775.

Cement mortar for manholes Class D, Section 776.

Concrete for manholes Class A, for drop sewer connection Class C, Section 725.

Pipe used in manholes or drop sewer connections Section 743.

Manhole frame, cover and steps Section 787 and cast in accordance with standard details.

Plastic manhole steps, which conform to O.S.H.A. and A.S.T.M. C-487 requirements, and steel manhole steps, which are completely encapsulated in corrosion resistant rubber and conform to O.S.H.A. and A.S.T.M. C-478 requirements, may be substituted for cast-iron manhole steps. The manufacturer shall furnish the Engineer a certification indicating conformance.

625.3 CONSTRUCTION METHODS:

625.3.1 Manholes: Manholes shall be constructed of brick, of precast concrete sections, or of cast in place concrete with cast iron manhole steps, frames and covers, in accordance with the standard details. The invert channels shall be smooth and semi-circular in shape, conforming to the inside of the adjacent sewer sections. Changes in direction of flow shall be made with a smooth curve, having a radius as large as the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly.

Invert channels may be formed of concrete or brick masonry having a smooth plastered surface, may be half tile laid in concrete or brick, or may be constructed by laying full section of sewer pipe through the manhole and breaking out the top half after the surrounding concrete or brick masonry has hardened. The floor of the manhole outside the channels shall be smoothed and shall slope towards the channels.

The excavation shall be made cylindrical to a diameter sufficient in size to permit sheeting if necessary and leave room that the bricks may be laid in a workmanlike manner and the outside plaster coat properly applied or the precast concrete sections or forms may be properly assembled.

A circular concrete foundation of Class A concrete, as shown on the details shall be poured below the bottom of the sewer pipe.

Brickwork shall not be laid upon a concrete foundation less than 24 hours after such foundation has been poured. No brick work shall be laid in water, nor, except as prescribed for curing, shall water be allowed to stand or run on any brickwork until the mortar has thoroughly set. Where new work is joined to existing unfinished work, the contact surfaces of the latter shall be thoroughly cleaned and moistened.

Bricks shall be thoroughly moistened prior to placing, and shall be laid in full cement mortar beds. Every course may be a header course, but at least every fourth course shall be a header course. The horizontal cross section of the manhole shall be circular unless otherwise called for on the plans or standard details. An oval or egg-shaped section will not be permitted. A double row-lock course of brick in the manhole wall shall be arched over the top half of the circumference of all inlet and outlet pipes. The brick manholes shall be plastered outside with ½ inch of cement mortar as shown on the standard details. Inside of brick wall shall be neatly pointed. The plaster coat shall be cured with a liquid membrane-forming compound conforming with Section 726 immediately after plaster has been placed and finished.

Frame and Cover. All machined surfaces on the frame and cover shall be such that the cover will lie flat in any position in the frame and have a uniform bearing through its entire circumference. Any frame and cover which creates any noise when passed over by automobiles shall be replaced. Frames shall be set firmly in a bed of mortar true to line and grade, all as shown on the plans and as called for in these specifications.

Backfilling shall be done in accordance with the requirements for trench backfilling as stated in Section 601.

625.3.2 Drop Sewer Connections: Drop sewer connections shall be constructed in conformance with standard details, as the case may be.

Backfilling shall be done in accordance with the requirements for trench backfilling, as stated in Section 601.

625.4 MEASUREMENT:

Measurement will be per manhole installed, complete in place, regardless of depth.

Measurement will be per drop sewer connection installed.

625.5 PAYMENT:

Payment will be made at the unit price bid each manhole, and shall be compensation in full for furnishing and installing manhole, complete, with formed invert, concrete foundation, ladder rungs, cast iron frame and cover, excavation and backfill, paving cut replacement in excess of the applicable pay widths authorized in Section 336, and any incidentals thereto, in conformance with the plans and specifications.

Payment will be made at the unit price bid each, and shall be compensation in full for furnishing and installing vitrified clay pipe sanitary sewer drop connections, concrete encasement, excavation, backfilling, water settling, compaction, sheeting and bracing, removal of obstructions, paving cut replacement, in excess of the applicable pay widths authorized in Section 336, testing, and all work incidental thereto in conformance with the plans and specifications.

SECTION 630

TAPPING SLEEVES, VALVES AND VALVE BOXES ON WATER LINES

630.1 DESCRIPTION:

The installation of all valves shall conform to this specification and standard details, except as otherwise required on the plans or as modified in the special provisions.

630.2 GENERAL:

For valves 12 inches and smaller, the Contractor shall furnish the manufacturer's standard data and catalogues for the following items being furnished:

(A) Gate valves, tapping sleeves and valves, curb stop valves and butterfly valves.

(B) Castings.

For valves larger than 12 inches, the Contractor shall furnish shop drawings and technical data required for evaluating and approval of each type of valve, tapping sleeve and valve and butterfly valve. This information shall include complete details, dimensions, weights, diameter of stems, alloy for all valve parts, and any information that may be required to assemble, install, operate and maintain the valve.

When it is doubtful that a manufacturer's product conforms to specifications, the Contracting Agency reserves the right to require submittal of more complete information before approving the above items.

The name of the manufacturer, the month and year of manufacture, the size of the valve, model number, and rated working pressure, shall be cast on the body of each valve.

The Contracting Agency may test 10 percent of each type and size of valve furnished. Failure of any of the valves tested to meet these specifications, shall be deemed sufficient cause to reject the entire lot delivered.

The internal working parts of valves of the same make, type, and size, shall be interchangeable.

630.3 GATE VALVES:

(A) All valves shall conform to the latest revisions of A.W.W.A., C-500 or C-509, supplemented as follows:

Valves shall be of the double disc iron body, bronze mounted type or iron body resilient seated solid wedge gate valve with a cast iron wedge, designed to work equally well with pressure on either side of the gate, shall be non-rising stem type and shall be left hand opening, counter clockwise.

All interior ferrous surfaces exposed to fluid flow shall be factory coated with a two part thermosetting epoxy coating, to a minimum thickness of 4 mils.

Valves on water mains shall be hub-end or have Ring-Tite or Fluid-Tite bells for Class 150 asbestos cement pipe, or mechanical joints conforming to AWWA C-111, or Titon joints for cast iron pipe.

Valves attached to side outlets shall be flanged and unless otherwise noted have 2 inch square operating nuts.

By-pass valves shall be flanged.

Valves in blow-off lines shall be flanged.

Valves in fire hydrant lines shall have hub-ends or mechanical joint ends.

Valves in air release and vacuum relief lines shall be flanged or screwed as shown on the plans.

Valves shall be constructed so that the bonnet and stem may be removed while the valve is closed and under the specified working pressure on either or both sides, without undue leakage past either disc. Valves, 12 inches and smaller, shall be equipped with O-ring packing.

Valves, 2 inches and smaller, shall be Jones, Ford, Hayes, Mueller or an approved equal, and shall be threaded, all bronze, standard, double-disc, non-rising stem valves with wheel handles.

(B) Gate Valves, 16-inch and larger: Valves 16-inches and larger shall be double-disc gate valves, in accordance with A.W.W.A. C-500 except as hereinafter modified. When called for on the plans, there shall be by-passes for valves 16-inches and larger.

Valves shall have bevel gears with 2 inch square operating nuts. The gears and stuffing box shall be enclosed in a watertight cast iron case, for operation in a buried location. Bolts, nuts, studs, etc., used with the gear case, shall conform to the requirements for Bonnet Bolting in AWWA C-500. The case shall be filled with grease at the factory.

Valves shall be for operation in a horizontal position. The valve ends shall be flanged.

Valves shall be equipped with bronze tracks, rollers and scrapers, for operation in a horizontal position.

By-pass valves shall be furnished with each valve, mounted in position A as indicated in AWWA C-500. By-pass valve sizes shall be as follows:

TABLE 630-1

Gate Valve Diameter in Inches	By-Pass Valve Diameter in Inches
16 to 20	3
24 to 30	4
36 to 42	6
48	8

630.4 TAPPING SLEEVES AND VALVES:

(A) Tapping Valves: Tapping valves shall be identical in construction with the above specifications for gate valves. Tapping sleeves are considered an integral part of a tapping sleeve and valve assembly, with openings the same as the valve. Tapping valves shall have ends and seat rings of sufficient size to permit the use of full size cutters of either the Mueller or Smith type tapping machines. Tapping sleeve valves shall be flanged on one end to fit the tapping sleeve and the other end shall be hub-end or mechanical joint.

The tapping valve shall have the discs and seat ring so constructed that the inside diameter of the rings shall be at least 3/16 inch larger than the nominal size of the valve. The seat rings shall be bronze and shall have a minimum seating surface area equal to that of a standard gate valve, and the discs shall be proportionately larger to match.

Except for making meter service connections, the actual wet taps shall be made by the Contracting Agency using their tapping machine, after the Contractor has installed the tapping sleeve and valve. The Contractor must make the excavation of sufficient size to allow the field crews room to perform the necessary work. The Contractor shall pay the Contracting Agency the established fees for these services.

The Contractor shall pay the established shutdown charge to the Contracting Agency every time it is necessary to shut off valves and take a section of a water main out of service. No valve in the existing system shall be operated by the Contractor.

The above charges, as well as charges for tap connections to steel cylinder and reinforced concrete pipe, are subject to change, as established by the Contracting Agency.

(B) Tapping Sleeves: Tapping sleeves shall be of extra heavy construction to provide resistance to line pressures. They shall be built in two halves for assembly around the main to be tapped.

The branch outlet shall have a flanged face for bolting to the tapping valve.

The walls of the castings shall be extra heavy and reinforced for extra strength.

The inside diameter of the outlet branch shall be sufficiently larger than the nominal size to provide clearance for the full size cutters of the tapping machine.

Tapping sleeves may be of either the type in which water is allowed to circulate between the sleeve and the outside surface of the pipe, or of the type in which water is

confined to the area immediately surrounding the tap opening. Sleeves shall be used only on the type and size of pipe for which they are designed and dimensioned.

(1) For sleeves of the first type, gaskets of lead or of other suitable material shall be provided to form watertight joints along the entire length of the sleeve. The circumferential joints at the ends of the run of these sleeves shall be sealed by lead caulked joints or mechanical joints. These joints shall conform to the requirements set forth in AWWA C-111 as to dimensions, clearances, materials, etc., except that gaskets and glands for mechanical joints shall be in two pieces.

The longitudinal gaskets shall be totally confined or compressed between ridges and/or grooves extending continuously for the full length of both halves of the sleeve casting. Bolts shall be located close to the outside of the gaskets and closely spaced so as to exert sufficient pressure to form a watertight joint and to amply take care of any design stresses. For sleeves with lead gasketed longitudinal joints and lead caulked end joints the minimum bolting shall be as follows, or have bolts having an equivalent cross sectional area.

TABLE 630-2

Line Size Inches	Branch Size Inches	Min. No. Bolts Lead Gaskets	Minimum Size Bolts
3,4	3,4	6	¾"
6 thru 16	3,4,6	10	¾"
8 thru 12	8,10,12	12	¾"
14,16	8,10,12	12	⅞"
14,16	14,16	16	⅞"
18,20,24	3,4,6,8	10	1"
18,20,24	10,12,14,16	14	1"
18,20,24	18,20,24	18	1"

(2) Tapping sleeves in which the water is confined to the immediate area of the tap opening shall be Kennedy Square Seal, Rich-Corey improved, or approved equal.

The outlet half of each sleeve shall be fitted with a continuous gasket of approximately circular cross section permanently cemented into a groove surrounding the outlet opening. The back half of each sleeve shall be fitted with elastomeric pads, a metal shoe, or other device for developing adequate pressure on the before mentioned gasket to prevent leakage at any pressure within the design capacity of the pipe.

630.5 BUTTERFLY VALVES:

(A) 16 INCHES AND LARGER:

(1) General: This specification generally describes valves as manufactured by B-I-F Industries, Inc., Henry Pratt Company, Allis Chalmers Manufacturing Co., and Leopold Company, or approved equal.

Where material or equipment is designated on the plans or in this specification by a trade or manufacturer's name, it is so designated primarily to establish standards of quality, finish, appearance and performance.

All specific requirements of this specification must be adhered to, and all necessary modifications shall be made in the article specified by the trade name, type or model of manufacturer's equipment to make it conform to all specific requirements of this specification.

(2) Flanged Valves: Valves shall be cast iron body, 90 degree closing with rubber seats, in accordance with AWWA C-504, Class 150-B, as modified herein.

Butterfly valves shall be installed with the valve shaft in a horizontal position and the operating shaft vertical.

All valves on pipeline shall be left-hand opening, counter-clockwise.

Valves shall be flanged one end with the other end of the spool type to take a dresser type coupling, or may be flanged both ends and provided with a flange to spigot adaptor. The valve manufacturer shall check the plans for the location of the flange in the event the valve is to be flanged one end with the other end of the spool type.

Discs shall rotate 90 degrees between the fully opened and fully closed position and shall be of materials as specified in AWWA C-504, except that fabricated steel or cast steel discs will not be accepted. The valve disc shall be either of the type where the shaft passes through the disc or of the offset type with stub shafts. The discs not offset must have a one-piece shaft extending completely through the valve disc. Valve shafts and disc shaft fasteners shall be of Type 304 stainless steel, or approved equal.

Valve seats shall be of natural or synthetic rubber, and may be either on the disc or in the body.

(a) Seats which are in the body shall be either bonded or mechanically retained in final position. Clamping devices, if used, shall be made of Ni-Resist cast iron or 18-8, Type 304, stainless steel or an approved equal. Seats which are on the disc edge shall be retained by Type 304 clamp ring and screws, and must close against 18-8, Type 304 stainless steel seat rings and screws positioned in the valve body.

(b) Cast iron discs shall have a seating surface (edge) of 18-8, Type 304 stainless steel held in position with type 304 stainless steel fasteners, if used.

Manual operators for the pipeline valves shall have AWWA 2 inch square operating nuts and shall require at least 2 turns per inch diameter to rotate the disc 90 degrees. Operators shall be of the totally enclosed, self-locking gear or screw type with adjustable stops, factory set, to limit disc travel. Operators for valves within the tank site shall have hand wheel operators. Operator cases shall be expressly designed for installation and operation in a buried or submerged location and shall be fully gasketed, sealed, and factory grease packed. Operators shall be sized to accept a minimum of 300 ft./lbs. input torque on stops at ends of travel without damage to valve of operators. The operator torque rating shall be calculated in accordance with AWWA C-504, Appendix "A." The velocity shall be taken as 16 fps.

Valves shall be installed in accordance with the details shown on the plans.

All interior and exterior steel or cast-iron surfaces of all buried valves and operator assemblies, except finished or bearing surfaces, shall be shop coated with 2 coats of asphaltic varnish conforming to Federal Specification TT-V-51c.

(3) Couplings: The couplings used to join the butterfly valves with the special pipe adaptors shall be Dresser Couplings Style 38, victaulic coupling styles 41 and 44, or approved equal.

Bolts for couplings shall be cast iron or high strength steel and develop the physical strength requirements of ASTM A-307, Grade B. Cast iron bolts and nuts shall be made of material having at least 50,000 psi tensile strength.

(B) 3 INCHES THROUGH 12 INCHES:

This specification generally describes valves and operator assemblies designed for underground service, as manufactured by Dresser Industries, B-I-F Industries Incorporated, Henry Pratt Company, Allis Chalmers Manufacturing Company, or approved equal.

Where material or equipment is designated on the plans or in this specification by a trade or manufacturer's name, it is so designated primarily to establish standards of quality, finish, appearance and performance.

All specific requirements of this specification must be adhered to, and all necessary modifications shall be made in the article specified by the trade name, type or model of manufacturer's equipment to make it conform to all specific requirements of this specification.

The valves shall be in accordance with AWWA C-504, Class 150-B, except as modified herein:

(1) Valve ends may be the thin type or wafer type to be installed between flanges drilled in conformance with ASA B 16.1-125 or may be flanged both ends or the valves may have bell ends with rubber gaskets, for cast iron pipe or asbestos cement pipe conforming to the kind of pipe being used.

(2) Valves shall be designed for buried service with the valve shaft in a horizontal position and the operating shaft vertical.

(3) Valves shall be left-hand-opening, counter-clockwise unless shown otherwise on the plans.

(4) Discs shall be Ni-Resist, ASTM A-436, Type 1, or cast iron, ASTM A-48, Class 40, in accordance with the following variations:

(a) Cast iron disc may be used providing the rubber seat ring is contained on the disc with the rubber ring closing against a Type 304 stainless steel ring or a bronze ring contained in the body of the valve.

(b) Ni-Resist disc may be used where rubber seat is contained in the valve body.

(c) Valves with rubber seats in the valve body may have cast iron discs with a Type 304 stainless steel or bronze edge seating surface retained on the edge of the disc.

Shafts and disc shaft fasteners shall be constructed of Type 304, stainless steel, unless the shaft is completely sealed from the line fluid. Valve shafts completely sealed from the line fluid may be of high strength steel with all other metal parts in contact with the line fluid to be Type 304 stainless steel.

Valves with rubber seat mounted in the body shall have the rubber either bonded or mechanically retained in its final position. Rubber seats which are on the disc edge shall be retained by a clamping ring and screws. Clamping ring and screws shall be made of 18-8 stainless steel, Type 304, or bronze conforming to ASTM B-61 or ASTM B-143.

of pipe is required, or when two or more pieces are joined, to form the valve box riser.

Install extension stems on all valves where the operating nut is 5 feet or more below grade.

Manual operators shall have AWWA 2 inch square operating nuts and shall require at least 2 turns per inch diameter to rotate the disc 90 degrees. Operators must accept a minimum of 300 ft. lbs. input torque on stops at ends of travel without damage to valve or operator. The operator torque rating shall equal, or exceed, the valves shown in Table I of AWWA C-504 for valve class specified above.

All interior and exterior steel or cast iron surfaces of all buried valves and operator assemblies, except finished or bearing surfaces, shall be shop coated with 2 coats of asphaltic varnish conforming to Federal Specification TT-V-51c.

630.6 AIR RELEASE AND VACUUM VALVES:

Valve assemblies shall be furnished and installed where shown and as detailed on the drawings.

(A) Air release on water mains shall be controlled by the use of an air release valve assembly, of size and type as shown on the plans. Air release valves shall be of the flanged or screwed type as shown and shall be similar and equal to Apco, Crispin or Simplex.

(B) Vacuum and Air Relief when called for on the plans shall be controlled by a vacuum relief valve on the air release valve noted above and the valves shall be of the same manufacture or may be a combination air and vacuum valve assembly similar and equal to Apco, Crispin or Simplex.

630.7 CONSTRUCTION METHODS:

All valves, their supports, manholes, vaults and valve boxes shall be installed in accordance with Section 610.

Valves 16 inches and larger, before being shipped from the factory, shall have the flanged ends completely covered with plywood. Plywood shall be left on the valves unit just before installation in the line.

630.8 MEASUREMENT:

Measurement will be by the unit each of the various kinds and sizes of valves, manholes, vaults, or tapping sleeves and valves, including valve boxes and covers.

630.9 PAYMENT:

Payment will be made at the unit price bid each and shall be compensation in full for the complete installation in place including all labor, materials, equipment, and all incidentals necessary to complete the installation. The compensation will also include the cost of necessary pavement replacement in excess of the pay widths allowed in Section 336 for pavement replacement over pipe trenches.

SECTION 631

WATER TAPS AND METER SERVICE CONNECTIONS

631.1 DESCRIPTION:

This specification covers work by Contractors installing water services in new subdivisions by Permit and in projects under Contract. All the materials used shall comply with applicable standard specifications and the work performed in accordance with these specifications and standard details. The service connections shall be complete and all materials shall be furnished by the Contractor except for the water meter.

All water service connections shall be constructed of Type K copper tubing or ultra high molecular weight polyethylene pipe of nominal iron pipe outside diameter.

All new subdivision water lines shall be staked for line and grade at 100 foot intervals by the Developer's Engineer prior to construction. All meter locations shall be staked by setting two stakes for line and marking one of the stakes for grade.

631.2 MATERIALS:

Copper pipe, tubing and fittings shall conform with Section 754. Polyethylene pipe shall conform with Section 755.

All fittings, pipe and tubing for polyethylene and copper pipe shall be as noted on standard details.

631.3 INSTALLATIONS:

631.3.1 General: Installation of copper tubing for meter service connections shall be in accordance with Section 754.

Meter service connection with copper tubing shall be in accordance with standard details.

The water service connection shall include the tap on the main, the corporation stop, the saddle if applicable, service pipe, appurtenant fittings, the curb stop, meter box and meter box cover, in accordance with standard details. Water meter boxes shall be installed in accordance with standard details to line and grade set by the Developer's Engineer. Upon acceptance, the Developer shall be responsible for damage to water meter boxes and covers until such time as the meters are installed by the Contracting Agency.

After the installation and acceptance of the water main and meter service pipe connections the water meter will be installed by the Contracting Agency upon proper application and payment of prevailing fees.

631.3.2 Standards: Except as otherwise specified all work shall be done in accordance with Sections 601 and 610.

631.3.3 Excavation and Backfill: The backfilling and compaction may be done as soon as the service line is installed, except backfilling and compaction shall not be completed around the corporation stop at the main water line until after inspection and recording of all tap locations. Trench bottom must be smooth and free of sharp objects. The minimum width of trench for water service pipe shall be 3 inches. The minimum depth of service pipe shall be 30 inches below the finished paving grade.

631.3.4 **Polyethylene Pipe:** Polyethylene pipe shall not be kinked, gouged or damaged during installation and backfilling operations. The pipe shall be placed in the trench allowing at least 12 inches per 100 feet for thermal contraction and expansion. Polyethylene pipe has a high thermal expansion and should never be confined under tension. The pipe should not be stored in the sun or left in the trench under abnormal high temperature. The pipe shall be carefully snaked in the trench bottom and covered up with uniform slack throughout its length. In trenches less than 8 inches in width, the expansion shall be obtained by making the tap on the opposite side of the main from the water meter and providing a loop of slack service pipe back over the top of the water main. Before installing, inspect pipe to detect any damage that may be caused by shipping, storage or handling. Damage spots can be cut out and pipe recoupled with Ford C-66-33, C-66-44, or approved equal brass compression fitting to form a continuous length. Damaged pipe shall not be used. Polyethylene pipe shall be cut only with a tubing cutter with rollers properly designated for the size of pipe being cut. When polyethylene pipe is used, the meter box setting must be placed parallel to the back of the sidewalk in accordance with standard details. Polyethylene pipe shall be installed with large sweeping bends with radius of not less than 18 inches. Polyethylene pipe has a cold flow characteristic and must not be installed under a stressed condition. Compression fittings only may be used with the plastic being held securely between metal to metal. Stainless steel or brass inserts shall be placed in the proper position in each compression fitting with care taken to assure that the insert remains in place when the fitting is tightened. All meter service lines shall extend at right angles from the main to the curb lines.

631.3.5 Service Taps: One inch and ¾ inch service taps to new meter mains may be made with a saddle, tapped coupling or direct tap in accordance with the following provsions:

The Developer may use heavy tapped couplings for meter service connections on all sizes of pipe including the 3 inch in cul-de-sac streets. Bronze corporation stops must be installed in the tapped couplings prior to pressure testing or disinfection of the water main. Normally in subdivisions no saddles are required for 6 inch pipe and larger. At the Contractor's option, saddles may be used on all 6 inch pipe and larger. All service connections on major and collector streets shall be made with saddles or heavy duty tapped couplings regardless of the water main size or service pipe size. All taps on pipe smaller than 6 inches must be made by either a saddle or heavy tapped coupling with bronze insert. Direct taps must be made by the use of a corporation stop with tapered AWWA machine thread. All wet taps must be made by the Mueller Type B-100 tapping machine or approved equal. A sharp tapping bit must be used in order to obtain clean sharp threads. In general, each tapping tool should be resharpened or discarded after making 6 taps. All copper service pipe which is attached to metallic water mains shall be insulated at the corporation stop with a dielectric insulator. The minimum distance between taps, saddles, and tapped coupling shall be 3 feet.

631.4 TESTING:

Before the service taps are made, the water mains shall be pressure and leakage tested and disinfected in accordance with Sections 610 and 611. After service taps are made and service lines installed, corporation stops shall be left open. The service pipe shall be tested by being subjected to normal main line pressure. Both ends of the service pipe shall be left exposed until after inspection and recording of all tap locations.

631.5 CLEANUP AND COMPLETION:

Upon completion and acceptance of all phases of the water main and meter service lines the Developer shall release the new subdivision water system to the Contracting Agency for final operation and maintenance with all interior valves and corporation stops in open position and with all meter curb stops and valves at the connections to existing mains closed.

631.6 INSPECTION:

The Developer's Engineer shall make an as-built plan and make a record of the locations of all water service connections prior to the connections being covered up. This as-built plan shall give the stationing of each service tap. The stationing to be continuous for each street, and shall begin at the street intersection or property line at the end of the block.

631.7 SERVICE OVER 2 INCHES:

All service taps larger than 2 inches shall be made by the Agency after an application and payment of prevailing fees, unless otherwise required by the Agency.

631.8 SERVICE ON EXISTING MAINS:

Where all or part of a new subdivision is served by existing water mains, only authorized personnel of the Contracting Agency shall install the service connections upon proper application and payment of prevailing fees.

SECTION 700

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MATERIALS

SECTION 701

ROCK, GRAVEL, AND SAND

701.1 GENERAL:

The following specifications set forth the requirements for crushed rock, gravel, sand, and quarry stone. Samplings and sieve analysis shall be performed in accordance with ASTM D-75 and ASTM C-136. Sand equivalents shall be determined in accordance with AASHTO T-176. The liquid limit and plasticity index shall be determined in accordance with AASHTO T-89 and T-90.

701.2 CRUSHED ROCK AND GRAVEL:

Rock and gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

701.2.1 Crushed Rock: Crushed rock shall consist of the product obtained by crushing rock, stone, or gravel so that at least 50 percent by weight of aggregate retained on the No. 4 sieve for ¾ inch or larger maximum sizes, and 50 percent retained on the No. 8 sieve for maximum sizes less than ¾ inch shall consist of particles which have at least one rough, angular surface produced by crushing. All material that will pass a grizzly with bars spaced 15 inches apart, clear opening, shall be crushed when producing from the Contracting Agency's source.

The gradation of crushed rock shall comply with ASTM D-448.

701.2.2 Gravel: Material designated herein as gravel shall be composed entirely of particles that are either fully or partially rounded and water-worn. Crushed rock obtained by crushing rock which exceeds ASTM D-448 maximum gradation sizes may be combined provided it is uniformly distributed throughout and blended with the gravel. The quality and gradation requirements shall be as stated in this specification.

701.3 SAND:

Sand shall be fine granular material produced by the crushing of rock or gravel or naturally produced by disintegration of rock and shall be sufficiently free of organic material, mica, loam, clay, and other deleterious substances to be thoroughly suitable for the purpose for which it is intended.

701.3.1 Sand for Asphalt Concrete Pavement: Sand for asphalt concrete pavement shall comply with AASHTO M-29 except that grading requirements shall be deleted and have a minimum sand equivalent of not less than 50 and shall be non-plastic when tested in accordance with AASHTO T-89 and T-90.

701.3.2 Sand for Portland Cement Concrete, Mortar and Plaster: It shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances.

The average value of sand equivalent determined on 3 successive samples shall not be less than 70. No individual sample shall have a sand equivalent less than 65.

The size and grading of sand to be used in cement concrete, mortar, and plaster shall be such as to conform with the requirements specified as follows:

Concrete:	ASTM C-33
Mortar:	ASTM C-144
Plaster:	ASTM C-35

701.3.3 Coarse Aggregate for Portland Cement Concrete: Coarse aggregate shall conform to ASTM C-33 gradings size No. 467, 57, 67, and 7.

701.3.4 Aggregate for Masonry Grout: The size and grading of the fine or coarse aggregate to be used in masonry grout shall conform with ASTM C-404.

701.4 QUARRY STONE:

701.4.1 General: Quarry stone shall be angular, sound, durable, hard, resistant to abrasion; free from laminations, weak cleavages, and undesirable weathering, leaching, exfoliation tendencies, and slaking; and of such character that it will not disintegrate from the action of air, water, or the conditions to be met in handling and placing. Stone shall be clean and free from deleterious impurities, including alkali, earth, clay, refuse, and adherent coatings. Suitable tests and/or service records will be used to determine the acceptability of the stone. Tests to which the material may be subjected include petrographic analysis, X-ray diffraction, specific gravity, absorption, abrasion, rock drop, soundness, wetting and drying, and such other tests as may be considered necessary to demonstrate to the Engineer that the materials are acceptable for use in the work. In connection therewith, the Contractor shall notify the Engineer in writing at least 60 days prior to use of the intended sources of quarry stone.

701.4.2 Test Requirements: Quarry stone shall meet the following requirements except as may be otherwise provided on the plans and in the special provisions:

(A) Apparent specific gravity: 2.65 minimum.

(B) Breakdown:

Rock drop breakdown:	5 percent maximum.
Abrasion breakdown at 1000 revolutions:	40 percent maximum.
Breakdown after 10 cycles of wetting and drying:	5 percent maximum.
Solubility in water, breakdown, or softening:	None.

701.4.3 Test Methods: Unless otherwise specified in the special provisions or indicated on the plans, test methods for quarry stone shall be as follows:

(A) Apparant specific gravity per ASTM C-127.

(B) Abrasion characteristics to be determined by either Rock Drop Test or Los Angeles Rattler, ASTM C-131, as required on the plans or the special provisions.

(1) Standard Rock Drop Test. Tests shall be made on groups of 5 accurately weighed sizes of rocks: No. 1, ranging from 75 to 100 lbs.; No. 2, 100 to 125 lbs.; No. 3, 125 to 150 lbs.; No. 4, 150 to 175 lbs.; No. 5, 175 to 225 lbs.

Each rock of the 5 sizes shall be dropped 3 times on the group of the other 4, in an enclosure, from successive heights of 10, 15, and 18 feet. The enclosure shall have a flexible medium weight galvanized iron floor or equivalent, set on a solid foundation. Order of dropping shall be Nos. 3, 2, 4, 1, 5. All rock passing a 3 inch square mesh screen after test shall be weighed and recorded as a percentage of the total initial weight of the 5 rocks.

(2) Los Angeles abrasion machine, per ASTM C-131, Grading B.

(C) Wetting and drying. The stone shall be crushed, screened, and 1000 or 1500 grams of the ¾ inch to ⅜ inch fraction taken for the test.

The crushed and graded stone shall be submerged in water for 18 hours at room temperature, after which the sample shall be drained and oven-dried at 140°F. When dry, the sample shall be cooled to room temperature. This would complete one cycle.

The percent loss shall be determined by screening the tested sample on a No. 4 sieve and shall be computed as follows:

$$\frac{100 \times \text{Weight of Material Passing No. 4 Sieve}}{\text{Total Weight of Sample}} = \% \text{ Loss}$$

(D) Accelerated water breakdown and solublity test. Air-dry samples of representative stone weighing approximately 1 lb. each shall be immersed for 8 hours at 140°F., in distilled water, local tap water, or 3.5 percent sodium chloride solution.

SECTION 702

BASE MATERIALS

702.1 GENERAL:

Materials for use as aggregate base shall be classified in the order of preference as follows:

(A) Crushed Aggregate.

(B) Processed Natural Material.

(C) Processed Steel Slag.

(D) Decomposed Granite.

When base material without further qualification is specified, the Contractor shall supply crushed aggregate. When a particular classification of base material is specified, the Contractor may substitute any higher classification of base material for the specified classification.

Except where materials are being obtained from a previously approved source, the Contractor shall give the Engineer 10 days advance notice, in writing, of the source of the base material he intends to use in order to allow sufficient time to perform the necessary tests.

702.2 CRUSHED AGGREGATE:

Crushed aggregate shall consist of crushed rock or crushed gravel or a combination thereof as defined in Section 701.

702.2.1 Soundness: The percentage of wear of crushed aggregate to be used as base will be determined as in Section 701, except that Grading B of ASTM C-131 shall be used. The percentage of wear of the material shall not exceed 40 after 500 revolutions.

702.2.2 Grading: The aggregate shall be well graded when tested in accordance with ASTM C-136 and C-117. The percentage composition by weight shall be within the following limits.

TABLE 702

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve		
	Select Material		Aggregate Base
	Type A	Type B	
3″	100		
1½″		100	
1⅛″			100
No. 4	30-75	30-70	38-65
No. 8	20-60	20-60	25-60
No. 30	10-40	10-40	10-40
No. 200	0-12	0-12	*3-12
P.I. MAX.	5	5	*5

*Except as required in Section 312.5 for inverted section and does not apply to Processed Steel Slag.

702.3 PROCESSED NATURAL MATERIAL:

702.3.1 General: Processed natural material shall consist of hard, durable fragments of stone or gravel and a filler of sand or other finely divided mineral matter. It shall be free from an excess of soft or disintegrated pieces, alkali, adobe, vegetable matter, loam, or other deleterious substances.

702.3.2 Physical Requirements: When sampled and tested in accordance with standard test methods, the aggregate shall meet the following requirements:

(A) Percentage of Wear: When tested in accordance with ASTM C-131, the percentage of wear shall not exceed 40 percent after 500 revolutions.

(B) Plasticity Index: When tested in accordance with AASHTO T-90, the plasticity index shall no be more than 5.

(C) Liquid Limit: When tested in accordance with AASHTO T-89, the liquid limit shall not be more than 25 percent.

702.3.3 Crushed Material: Crushed material is not required, but may be incorporated in the finished product.

702.3.4 Grading: The aggregate shall conform to the sieve analysis in this specfication except that the least dimension of the maximum particle size shall not exceed ⅔ of the compacted thickness of the specified lift being placed.

SECTION 702

702.4 DECOMPOSED GRANITE:

Decomposed granite shall be any granitoid igneous rock which has been weathered in place and which has as principal constituents granular fragments of quartz and feldspar. It may also contain fragments of granitic rock not yet broken down into the component minerals. This material shall remain stable when saturated with water. Particles larger than 3 inches, which will not be broken in the process of rolling and tamping during construction, shall not be used.

Decomposed granite shall conform to the following requirements:

(A) When tested in accordance with this specification, not more than 20 percent shall pass the No. 200 mesh sieve.

(B) The P.I. of material passing the No. 200 sieve prior to testing shall not be less than 3 nor greater than 10.

702.4.1 Preparation of Test Specimens: A quantity of sufficient size to have a dry weight of 15 pounds shall be selected and dried to constant weight at a temperature between 215°F. and 230°F. Fifteen pounds of this material shall then be subjected to 500 revolutions in a Los Angeles abrasion machine, as described in Section 701, except that nothing shall be placed in the drum other than the material to be tested.

The material that has been subjected to the breakdown shall be tested in accordance with ASTM C-117 to determine the percentage of material finer than a No. 200 mesh sieve by washing.

SECTION 703

RIPRAP

703.1 STONE:

Stone for plain and grouted riprap shall be sound and durable, free from seams and coatings, and of such characteristics that it will not disintegrate when subjected to the action of water. Loss by abrasion shall not exceed the limits specified in Section 701.

Stone shall be of shapes which will form a stable protection structure of the required depth. Rounded boulders or cobbles shall not be used on slopes steeper than 2 to 1 unless grouted. Angular shapes may be used on any slope. Flat or needle shapes will not be acceptable unless the thickness of the piece is more than ⅓ the length.

Waste concrete may be used, if the pieces are sound free from coatings and meet the size requirements specified for a stone.

703.2 SIZE OF STONE:

Riprap stone shall be as large as can be conveniently placed in a layer of the required depth. The stones, excepting small stones and spalls used to chink interstices shall weigh not less than 10 pounds and at least 50 percent of the stone shall weigh not less than 100 pounds.

703.3 CONCRETE:

The portland cement, aggregates and mixing shall be as specified in Section 725 and as herein specified. The aggregate may be pitrun material, at least 80 percent of which shall pass a 1½ inch square mesh screen. Separating aggregates by primary sizes will not be required. Los Angeles rattler tests and soundness tests will not be required.

The mixed concrete shall contain 376 pounds of portland cement per cubic yard.

The amount of water shall be such as to produce a mixture with a slump of 3 to 5 inches, when tested in accordance with ASTM C-143.

703.4 SACKS:

Sacks shall be made of burlap not lighter than 10 ounce and shall be approximately 19½ inches by 36 inches measured inside the seams when the sack is laid flat. Sound reclaimed sacks may be used. The capacity of each sack shall be 1.25 cubic feet. Each sack shall contain 1 cubic foot of concrete loosely placed so as to leave room for folding the open end, the fold just enough to retain the concrete at the time the filled sacks are placed. Immediately after filling, the sacks shall be placed and lightly trampled to cause them to conform with the ground surface and with adjacent sacks in place.

SECTION 705

PORTLAND CEMENT TREATED BASE

705.1 GENERAL:

The cement treated base shall consist of furnishing all materials in accordance with these specifications. The estimated cement requirement is 3½ percent by weight of the dry aggregate. The cement shall be Type II, low alkali.

705.2 AGGREGATE FOR CEMENT TREATED BASE:

The aggregate for cement treated base shall conform to the requirements of Section 701 except the plasticity of the material passing the No. 40 sieve shall not exceed 5 and the grading shall be as follows:

TABLE 705

Sieve Size	Percentage By Weight Passing Screen
1½"	100
No. 4	40-70
No. 40	30 Max.
No. 200	0-15

705.3 PORTLAND CEMENT AND WATER:

Portland cement and water shall conform to the requirements of Section 725.

705.4 COMPRESSIVE STRENGTH OF CEMENT TREATED BASE:

The minimum compressive strength at 7 days shall not be less than 500 psi when tested in accordance with ASTM D-1633.

705.5 BITUMINOUS MATERIAL FOR CURING SEAL:

Bituminous material for curing seal shall conform to the requirements of Section 712 or 713 for the type specified.

SECTION 710

ASPHALT CONCRETE

710.1 GENERAL:

Asphalt concrete shall consist of a mixture of paving asphalt and mineral aggregate which, with or without the addition of mineral filler and blending sand as may be required, shall be mixed at a central mixing plant in the proportions hereinafter specified to provide a homogeneous and workable mixture.

Asphalt concrete is designated as Type A 1½ Base Course; Type B-1 Single or Base Course; Type C-¾ Single Course; Type D-½ Single or Surface Course; and Type E-⅜ Surface Course of Dense Graded Mixes; Type F 1½ Base Course and Type G-⅜ Surface Course of Open Graded Mixes.

710.2 MATERIAL:

710.2.1 Asphalt: The asphalt to be mixed with mineral aggregate shall be paving grade asphalt conforming to Section 711, and shall be AR-20 to AR-80 or AC-10 to AC-40 as directed by the Engineer, unless otherwise specified in the special provisions.

710.2.2 Aggregate: Coarse and fine aggregates shall conform to the applicable requirements of Section 701 except as modified herein.

Coarse aggregate is material retained on the No. 4 sieve and fine aggregate is material passing the No. 4 sieve.

Blending sand shall be clean, hard and sound material, either naturally occurring sand or crushed fines which will readily accept asphalt coating. The exact grading requirements shall be such that, when it is mixed with the mineral aggregate, the combined product shall meet the requirements of the designated mix as specified elsewhere in this specification.

710.2.3 Mineral Filler and Anti-Stripping Agent:

(A) Mineral filler shall conform to the requirements of AASHTO M-17. The mineral filler shall be dry hydrated lime conforming to the requirements of ASTM C-207 Type N, or portland cement conforming to Section 725 or other approved mineral filler shall be added to the aggregate in accordance with the requirements contained herein. The amount of mineral filler to be used shall be determined by the Engineer. The method of adding the mineral filler shall be such that the aggregate is uniformly coated and the mineral filler is uniformly distributed without loss or waste within the material prior to adding the asphalt to the mixture.

(B) When aggregate is subject to stripping, as determined by one of the two procedures below, dry hydrated lime conforming to the requirements of ASTM C-207 Type N, portland cement conforming to Section 725 or other approved antistrip agent shall be added. Hydrated lime and portland cement shall be added in accordance with Section 710.2.3. Other approved no strip agents shall be added in accordance with the manufacturer's recommendations and approved by the Engineer.

(1) Prepare a test sample of the paving mixture. Spread it out in a loose thin layer and allow to air-season for 24 hours before testing. A suitable size sample (approximately ½ contents of a one quart container) shall be tested by placing it in a glass jar with a tight screw cap. The sample shall be completely covered with distilled water at room temperature. The jar and contents shall be allowed to stand for a period of 24 hours.

Then the sample shall be vigorously shaken for a period of 15 minutes. The sample of mixture shall be examined for stripping.

(2) ASTM D-1075 with a minimum dry strength of 250 psi and a minimum wet strength of 150 psi.

710.2.4 Combined Aggregates: The combined aggregates sampled after all processing, except the adding or asphalt and mineral filler, shall conform to the following quality requirements.

The ratio of the percentage of aggregate by weight passing the No. 30 sieve, to that passing No. 8 sieve, shall not exceed 65 percent in all dense graded asphalt concrete mixes.

At least 75 percent by weight of the aggregate retained on the No. 8 sieve shall consist of particles which have at least one rough, angular surface produced by crushing.

710.2.5 Job-Mix Formula: Unless otherwise authorized by the Engineer no work shall be started on the project, nor any mixture accepted therefore, until the contractor or his supplier has submitted samples of the materials intended for use and the Engineer has established a satisfactory job-mix formula based upon tests of the materials furnished. The formula shall indicate the definite percentage for each sieve fraction of aggregate, and for bituminous cement; also the intended temperature of completed mixture at the time it is discharged from the mixer. The material furnished shall conform to the approved job-mix formula within the tolerances specified herein.

Job-Mix Tolerances

Aggregate passing sieve No. 4 and larger	± 7 percent
Aggregate passing sieves No. 8 and 30	± 7 percent
Aggregate passing sieve No. 200	± 2 percent
Temperature of mixing and placing	± 25 degrees F.

The tolerances used in conjunction with the job-mix formula shall be such that the resulting gradation shall be within the specification limits. The amount of liquid asphalt, by weight, to be added to the different graduations of the mineral aggregate shall be as specified and determined by the Engineer. The amount specified by the Engineer shall be within the following range of the percentages of the total mixed material:

Mix Description	Percentage of Asphalt Range
A—1½"	4.0 to 5.0
B—1, C—¾	5.0 to 6.0
D—½, E—⅜	5.5 to 6.5
F—1½	4.5 to 6.0
G—⅜	6.0 to 7.0

The allowable tolerance in percentage of asphalt content from that percentage specified by the Engineer, when sampled and tested in accordance with AASHTO T-164 and T-168 as modified by Contracting Agency shall be plus or minus 0.4 percent.

After the job-mix formula has been approved and the mixing plant selected, the contractor and/or his supplier shall not change either of the above or utilize additional mixing plants without prior approval of the Engineer.

710.3 COMPOSITION AND GRADING:

The grading of the combined aggregates shall be such as to conform to the requirements indicated in the following tabulations in which the percentages shown are based on the weight of dry aggregate only.

TABLE 710

MINERAL AGGREGATE – PERCENTAGE BY WEIGHT PASSING

SIEVE SIZE	TYPE DENSE GRADED MIXES					TYPE OPEN GRADED MIXES	
	BASE COURSE	SINGLE COURSE OR BASE COURSE	SINGLE COURSE	SINGLE OR SURFACE COURSE	SURFACE COURSE	BASE COURSE	SURFACE COURSE
	A-1½	B-1	C-¾	D-½	E-¾	F-1½	G-¾
1½"	100	100				100	
1"	80-100	100	100	100			
¾"	70-95	80-100	90-100	97-100		50-90	
½"	—	65-85	75-100	85-100			
⅜"	50-65	55-75	65-90	70-90	100		100
No. 4	35-50	40-60	45-70	50-75	65-85	0-20	25-70
No. 8	25-40	25-45	30-55	35-65	45-70		0-10
No. 30	10-25	10-30	15-35	20-40	20-40		
No. 100	—				5-15		
No. 200	2-8	2-8	2-8	2-8	3-8	0-5	0-4

710.4 STORING, DRYING AND SCREENING AGGREGATES:

710.4.1 Stockpiling (Cold Feed Separation): Aggregate for Dense Graded Mixes shall be separated and stockpiled into 2 or more sizes of aggregate. If the mineral aggregate is separated into 2 sizes, one stockpile or bunker shall contain material of which a minimum of 80 percent will pass a No. 4 sieve and the other stockpile or bunker shall contain material of which a minimum of 80 percent will be retained on the No. 4 sieve. If the mineral aggregate is separated into more than 2 sizes, at least 2 of the stockpiles or bunkers shall comply with the above and the sizes and tolerances shall be as approved by the Engineer.

The grading of the cold feed stockpiles, or bunkers, for the duration of any one project shall not deviate from the grading as determined at the beginning of the project by more than the following tolerances:

Stockpile Tolerances

Aggregate passing ¾", ⅜", No. 4, No. 8 & No. 30 ..... ± 10 Percent

Aggregate passing No. 200 ..... ± 4 Percent

Any material added to the stockpiles, or bunkers, during the progress of the project shall comply with the above requirement; however, the resulting gradation shall be within the specification limits.

In placing materials in storage or in moving them from storage to the drier, any method which may cause the segregation, degradation or contamination, or the combining of materials of different gradings which will result in any stockpile or bunker failing to meet the requirements shall be discontinued and the material shall be reprocessed or wasted.

710.4.2 Drying and Heating: The mixing plant shall be provided with accurate mechanical means for feeding the aggregates from the stockpiles or bunkers into the drier at such a rate that a uniform production and temperature of dried aggregates will be obtained.

The feeders may be of the apron belt, reciprocating plate, vibrating type or tip gate, and shall have accurate and separate adjustments. These adjustments shall be capable of being locked in any position and the feeders shall be capable of delivering the required aggregate in the proper proportions.

Drying shall continue until the moisture content is not greater than 0.75 percent. In special cases when the aggregate is unusually porous, a moisture content in excess of 0.75 percent may be permitted at the discretion of the Engineer. In no event shall the aggregate be heated beyond the lowest temperature necessary for proper drying, mixing, spreading and compacting.

The drier shall be provided with a heat indicating device in order that the temperature of the aggregate leaving the drier may be determined. The heat indicating device shall be accurate to the nearest 10°F., and shall be installed in such a manner that a fluctuation of 10°F. in the aggregate temperature will be shown by the heat indicating device within one minute.

The drier shall be equipped with an approved type of dust collector system capable of removing objectionable or excess dust from the aggregate and either wasting the material so collected or returning all or any portion of it uniformly to the mixer, as the Engineer may direct. Dust collector shall comply

with the Maricopa County Bureau of Air Pollution Control Rules and Regulations as adopted by the County Board of Supervisors and applicable State laws or local ordinances.

710.5 BIN SEPARATION:

After being dried and in advance of mixing with asphalt, the mineral aggregate shall be separated into 3 or more sizes and stored in separate bins.

All mineral aggregate for mixes A—1½, B—1, and C—¾, Dense Graded, shall be separated into 3 or more bins as follows:

(A) Bin No. 1

Not less than 80 percent of the material in Bin No. 1 shall pass a No. 8 sieve.

(B) Bin No. 2

The sum of the percent of the material retained on a ⅜ inch sieve and the percent of the material passing a No. 8 sieve shall not exceed 25 percent.

(C) Bin No. 3

Not more than 20 percent of the material in Bin No. 3 shall pass a ⅜ inch sieve.

Mineral aggregate for mixes D—½ and E—⅜, Dense Graded, shall be separated into 2 or more separate bins as follows:

(A) Not less than 80 percent of the material in Bin No. 1 shall pass a No. 8 sieve.

(B) Not more than 20 percent of the material in Bin No. 2 shall pass a No. 8 sieve.

Mineral aggregate for mixes F—1½ and G—⅜, Open Graded shall be separated into 2 or more separate bins as follows:

(A) Bin No. 1

Not less than 85 percent of the material in Bin No. 1 shall pass a No. 8 sieve.

(B) Bin No. 2

Not more than 15 percent of the material in Bin No. 2 shall pass a No. 8 sieve.

Failure to comply with the requirements shall be corrected by drawing the bin and rescreening the material. If there is evidence of fine material hanging on the sides of the fine bin, the fine bin shall be equipped with a vibrating unit which will effectively vibrate the side walls of the bin and prevent any hang-up of segregated sizes while the plant is operating. A positive signal system shall be provide to indicate the low level of material in each bin. Each bin shall be provided with an overflow chute to prevent spilling into adjacent bins and to waste excess material from the bin. The inter-mingling of material between bins by the removal of patch-plates, or by other openings between bins, will not be permitted. The composite analysis of the bins as proportioned, shall comply with the grading limits required for the size mineral aggregate designated.

710.6 GENERAL MIXING:

The mineral aggregate and asphalt shall be mixed at a central mixing plant of the batch type mixes, continuous type mixes, or drum type mixer, as the contractor may elect.

The right is reserved to order the use of any drying, proportioning and mixing equipment discontinued which, in the opinion of the Engineer ,fails to produce a satisfactory mixture.

Filler material, if required, shall be added separately and in a thoroughly dry condition. Heating of filler material will not be required.

The amount of filler material to be used will be specified by the Engineer and shall be accurately proportioned by weight or by volumetric methods.

The amount of asphalt to be added to the mineral aggregate shall be as specified in this specification.

The temperature of the mineral aggregate shall not be higher than necessary for spreading and finishing at the time of adding the paving asphalt, and in no case shall the temperature for the Dense Graded Mixes exceed 325 degrees F., nor shall it exceed 250 degrees F. for Open Graded Mixes.

Asphalt shall be added to the mineral aggregate at a temperature conforming to the range of temperature specified in Section 711.

Thermometric equipment shall be provided to indicate the temperature of the asphalt near the charging valve at the mixer.

All scales shall be certified as to accuracy and sealed at least annually by the Sealer of Weights and Measures, and rechecked as ordered by the Engineer. Each scale installation shall be provided with certified weights as follows:

The contractor shall provide not less than 20 certified weights, each weighing 50 pounds, to be used by the Engineer in checking scales used on the project. Each weight shall be numbered and show the corresponding certified weight. The scales and weights shall remain the property of the Contractor and no payment will be made for their use.

The asphalt concrete manufacturer shall make whatever alternations are necessary to his equipment to enable the Sealer of Weights and Measures to conveniently check, calibrate and seal the aggregate and asphalt scales used in production of asphalt concrete.

Scales shall be so located that the mixer operator and the plant inspector have an unobstructed close-up-view of the indicating or registering devices. They shall indicate the true net weight without the application of any factor. The dial for dial type scales shall not be less than 12 inches in diameter and the figures thereon shall be clearly legible.

710.7 BATCH MIXING:

710.7.1 General Requirements: The mixer shall be of the twin-shaft pug mill type and shall be operated at the speed recommended by the manufacturer. It shall be equipped with paddles of sufficient size and number to deliver a thorough and uniform mixture. Should the paddles or other parts of the pug mill become worn to such extent as to adversely affect the quality of the mixing or allow leakage from the discharge gate, they shall be promptly replaced.

The amount of material that may be mixed per batch shall not exceed the rated capacity of the plant, or that which will permit complete mixing of all the materials.

Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected either by a reduction in the volume of materials or by other adjustments.

All boxes, hoppers, buckets or similar receptacles used for weighing mineral aggregate, filler material, and asphalt, as well as all scales used in batching materials shall be insulated against the vibration or movement of the rest of the plant, so that the error in weighing, with the entire plant operating, will not exceed 2 percent for any setting nor 1½ percent for any batch.

Dial heads or readout devices shall be mounted separate from batch plant or tower supports. This will nullify most vibrations from readout.

710.7.2 Aggregate: The aggregate scales shall be either multiple beam or springless dial type having a capacity exceeding 1½ times the total amount of materials to be weighed in one operation. Each scale graduation shall be approximately 1/1000 of the total capacity of the scale.

710.7.3 Asphalt: For mixers with a manufacturer's rated capacity of 4,000 pounds or less, the asphalt shall be measured by weight in a heated insulated bucket suspended from a springless dial scale system having a capacity of not more than 500 pounds with one-pound gradations. For mixers with a manufacturer's rated capacity of more than 4,000 pounds, the scale system shall have a capacity of not more than 1,000 pounds with one-pound gradations.

Asphalt shall be introduced into the mixer by means of a distributing pan fixed to the side of the mixer, by gravity distribution along the center of the mixer parallel to the mixer shafts, or by pressure spraying. The pan shall be equipped with movable vanes in order that the flow of asphalt may be directed across

the width of the pan as desired. The vanes shall be equipped with a means of quick adjustment and a positive lock to prevent shifting.

710.7.4 Filler Material: Filler material shall be introduced into the mixer through the weight box, or introduced into the center of the mixer.

710.7.5 Mixing: The entire batch shall be continuously mixed until all the materials are thoroughly blended into on homogeous mass. The maximum mixing time for any one batch shall be as hereinafter specified for that particular type mix. The time of mixing a batch shall begin on the charging stroke of the weigh hopper dumping mechanism and shall end when discharge from the mixer has started. The mixer shall be equipped with a time lock mechanism which locks the mixer discharge gate for the mixing period and activates an indicator light, or bell, which shall be used in signaling the end of the mixing time. The time lock and indicator light or lights, shall be actuated by the charging stroke of the weigh hopper charging mechanism. There shall also be provided an interlock and indicator light to provide for the dry mixing time for the introduction of filler which shall be a minimum of 4 seconds and not more than 15 seconds as required by the Engineer. The device shall be accurate to within 2 seconds. The time of mixing shall be not less than 30 or more than 45 seconds, or as otherwise directed by the Engineer. If for any reason the mix cannot be discharged when the mixing cycle is completed, power to the mill shall be cut off or the mix shall be wasted. The mixing shall begin with the introduction of the asphalt into the mixer, and shall end when the mixer gate is opened. When asphalt is introduced by spraying, the spraying time shall not exceed 15 seconds. In any event, mixing shall continue until uniform coating of the aggregate is obtained.

The mixer platform shall be of ample size to provide safe and convenient access to the mixer and other equipment. Mixer and weigh-box housing shall be provided with hinged gates of ample size to permit ready sampling of the discharge of aggregates from each of the plant bins.

Means shall also be provided for convenient and accurate sampling of the mixture.

710.8 CONTINUOUS MIXING:

710.8.1 General Requirements: In addition to the general requirements above specified, continuous mixing of the materials shall conform to the following:

(A) No asphalt concrete shall be produced until the plant has been calibrated to the satisfaction of the Engineer. When there is a change in the weight per cubic foot of the aggregate, the Engineer may require that the plant be recalibrated.

(B) The maximum rate of production at which the plant will be permitted to operate shall not exceed the manufacturer's recommendations.

710.8.2 Storage Bins: Storage bins shall be equipped with overflow chutes for each compartment. If there is evidence of fine material hanging on the sides of the fine bin, the fine bin shall be equipped with a vibrating unit which will effectively vibrate the side walls of the bin and prevent any hang-up of segregated sizes while the plant is operating. A positive signal system shall be provided to indicate the low level of material in each bin and as the level of material in any one bin approaches the strike off capacity of the feed gate, the device will automatically close down the feed of all materials to the mixer instantly. Unless this automatic signal system is in good working condition, the plant will not be permitted to operate. Openings in the partitions between the bins will not be permitted.

710.8.3 Feeder: The correct proportions of each aggregate size and filler material introduced into the mixer shall be drawn from the storage bins by an approved type of continuous feeder, which shall supply the correct amount of aggregate and filler material in proportion to the asphalt, and be so arranged that the proportion of each size can be separately adjusted. The continuous feeder for the aggregate may be mechanically or electrically actuated.

Aggregate feeders that are mechanically driven shall be directly connected with the drive on the asphalt pump.

Aggregate feeders that are electrically driven shall be actuated from the same circuit that serves the motor driving the asphalt pump. Current for operation of plants equipped with electrically driven feeders shall be actuated from the same circuit that serves the motor driving the asphalt pump. Current for operation of plants equipped with electrically actuated aggregate feeders shall not vary in frequency in excess of one cycle nor in voltage in excess of 10 percent. The drive shaft on the feeder shall be equipped with a revolution counter reading to one one-hundreth of a revolution.

710.8.4 Asphalt Pump: The asphalt pump shall be a positive displacement type pump. The use of a pressure relief valve will not be permitted. The plant shall be equipped with an indicating meter between the pump and spray, and the meter shall be in good working condition and accurately record the gallons of material pumped. All pipe, bins, fittings, and meter shall be steam jacketed or otherwise properly insulated.

The asphalt storage system shall be equipped with a device for automatic plant cut-off when the intake of the positive displacement pump is not working under positive pressure.

A suitable by-pass shall be installed between the pump and the spray bar to divert the flow of asphalt into an auxiliary container of not less than 25 gallon capacity in order that the Engineer may check the rate of delivery of the pump.

710.8.5 Discharge Hopper: The material from the mixer shall be discharged into a hopper in order that segregation of the mixture will be at a minimum. The hopper shall be approved by the Engineer.

710.8.6 Facilities for Sampling: Continuous mixing plants shall be equipped with 3 or more sampling hoppers. These shall be so placed that the discharge from each aggregate feeder may be diverted into each hopper while the feeders are in full operation. The weight of the hoppers shall be determined by means of a springless dial or a beam type scale.

The area around the hoppers shall be kept free of all aggregate and debris and the contractor shall furnish all labor required in handling the hoppers and weighing the materials and in disposing of all excess materials.

Means shall be provided for convenient and accurate sampling of the mixture as it leaves the mixer.

If the results obtained indicate that uniform proportioning of the aggregate from the bins or uniform and correct amounts of asphalt are not being delivered, the Engineer shall order that operations cease until proper corrections have been made.

710.9 DRUM MIXES:

710.9.1 General Requirements: The drum mix plant shall be capable of producing a thorough and uniform mixture. The production of the drum mix plant shall be governed by the rate required to obtain a thorough and uniform mixture.

No asphaltic concrete shall be accepted until the plant has been calibrated to the satisfaction of the Engineer. When tests indicate material produced is not in conformance with the approved job-mix design, no asphalt concrete will be allowed to be used on the job until the plant has been recalibrated to the satisfaction of the Engineer.

710.9.2 Aggregate Delivery System: An automatic plant shut-off shall be provided to operate when any aggregate bin becomes empty. Provisions shall be provided for conveniently sampling the full flow of materials from the total cold feed. Total cold feed shall be weighed continuously. The weighing system shall have an accuracy of 0.5 percent when tested for accuracy. The plant shall provide weight control of the cold aggregate feed by use of a belt scale, or other appropriate device, which will automatically regulate the feed gate and permit instant correction of variations in load. The cold feed flow shall be automatically coupled with the asphalt flow to maintain the required proportions of each material. Provisions shall be made for introducing the moisture content of the cold feed aggregates into the belt weighing signal and correcting wet aggregate weight to dry aggregate weight. Screens or other suitable devices which will reject oversize particles or lumps of aggregate that have been cemented together shall be installed in the feeder mechanism between the bins and the dryer drum.

Dry weight of the aggregate flow shall be displayed digitally in appropriate units of weight and time and totalized.

710.9.3 Additive Delivery Systems: Satisfactory means of metering shall be provided to introduce the proper amount of additives into the mix. Delivery systems shall prove accurate to plus or minus one percent when tested for accuracy. The additive flow shall be displayed digitally in appropriate units of (weight) and time shall be totalized.

710.9.4 Thermometric Equipment: A recording thermometer of adequate range shall be located to indicate the temperature of the bituminous material in storage. The plant shall also be equipped with approved recording thermometers, pyrometers, or other approved recording thermometric instruments at the discharge chute of the drum mixer.

710.9.5 Asphalt Delivery System: The drum mixer plant shall be equipped with a positive displacement type asphalt pump and an indicating meter between the pump and spray to monitor the proper amount of asphalt being introduced into the mix when displaced digitally in appropriate units of volume or weight. The asphalt delivery shall be interlocked with the aggregate weight and accurate to plus or minus one percent when tested for accuracy.

The asphalt delivery system shall be equipped with a device for automatic plant cut-off when the intake of the positive displacement pump is not working under positive pressure.

A suitable by-pass shall be installed between the pump and the spray bar to divert the flow of asphalt in order that the Engineer may check the rate of delivery of the pump.

710.9.6 Temporary Storage of Bituminous Mixture: Use of surge bins or storage bins for temporary storage of hot bituminous mixtures will be permitted as follows:

The bituminous mixture may be stored in insulated and heated storage bins for a period of time not to exceed 12 hours, provided an inert gas atmosphere is maintained in the bin during the storage period.

If the Engineer determines that there is an excessive amount of heat loss, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bin will be discontinued.

710.10 GENERAL REQUIREMENTS:

A temperature indicating device reading to 500 degrees F. and accurate to 5 degrees F. shall be fixed in the asphalt line or storage tank at a suitable location.

The temperature of the mixture discharged into the hauling vehicles shall not vary more than 30 degrees F. for successive batches. The discharge end of the asphalt binder circulating pipe shall be maintained below the surface of the asphalt binder in the storage tank to prevent discharging hot bituminous binder into open air. The contractor shall provide a suitable sampling outlet in the asphalt feed lines connecting the plant storage tanks to the asphalt weighing system or spray bar. The sampling device shall consist of a ½ inch or ¾ inch valve constructed in such a manner that a one gallon sample may be withdrawn slowly at any time during plant operations. The valve shall be maintained in good condition and if it fails to function properly, it shall be replaced. The sampling device shall be placed in a location that is readily accessible and in an area free of dangerous obstructions. A drainage receptacle shall be provided for flushing the devices prior to sampling.

The beds of trucks used to haul asphalt concrete mixtures shall be coated with a light film of distillate or light oil before loading. If, in the opinion of the plant inspector, there is an excessive amount of oil on the beds, the truck driver shall be required to raise the bed of the truck and drain off the excessive amount of oil.

Mixtures shall be delivered to the site of the work without segregation of the ingredients and within the temperature range specified in Section 321.

SECTION 711

PAVING ASPHALT

711.1 GENERAL:

The asphalt shall be produced from crude asphalt petroleum or a mixture of refined liquid asphalt and refined solid asphalt. It shall be free from admixture with any residues obtained by the artificial distillation of coal, coal tar, or paraffin oil and shall be homogeneous and free from water.

Asphalt shall not be heated during the process of its manufacture, storage, or during construction so as to cause injury as evidence by the formation of carbonized particles.

711.2 TESTING REQUIREMENTS:

Paving asphalt shall be classified by viscosity and shall conform to the requirements set forth in the following table:

TABLE 711-1A

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TABLE 1 Requirements for Asphalt Cement, Viscosity Graded at 140°F (60°C)

NOTE—Grading based on original asphalt.

Test	Viscosity Grade				
	AC-2.5	AC-5	AC-10	AC-20	AC-40
Viscosity, 140°F (60°C) P	250 ± 50	500 ± 100	1000 ± 200	2000 ± 400	4000 ± 800
Viscosity, 275°F (135°C), min. cSt	80	110	150	210	300
Penetration, 77°F (25°C), 100 g. 5 s. min.	200	120	70	40	20
Flash point, Cleveland open cup, min. °F (°C)	325 (163)	350 (177)	425 (219)	450 (232)	450 (232)
Solubility in trichloroethylene, min. %	99.0	99.0	99.0	99.0	99.0
Tests on residue from thin-film oven test: Viscosity, 140°F (60°C), Max. P	1250	2500	5000	10 000	20 000
Ductility, 77°F (25°C, 5 cm/min. min. cm	100*	100	50	20	10

*If ductility is less than 100, material will be accepted if ductility at 60°F (15.5°C) is 100 minimum at a pull rate of 5 cm min.

TABLE 711-1

ASTM D-3381

TABLE 3 Requirements for Asphalt Cement Viscosity Graded at 140° F. (60° C).

NOTE—Grading based on residue from rolling thin-film oven test.

Tests on Residue from Rolling Thin-Film Oven Test*	Viscosity Grade				
	AR-10	AR-20	AR-40	AR-80	AR-160
Viscosity, 140 Degrees F. (60 Degrees C), P	1000 ± 250	2000 ± 500	4000 ± 1000	8000 ± 2000	16000 ± 4000
Viscosity, 275 Degrees F. (135 Degrees C), min. cSt	140	200	275	400	550
Penetration, 77 Degrees F. (25 Degrees C), 100g, 55 min.	65	40	25	20	20
% of original penetration, 77 Degrees F. (25 Degrees C), min.	...	40	45	50	52
Ductility, 77 Degrees F. (25 Degrees C), 5 cm/min. min, cm	100*	100*	75	75	75
Tests on original asphalt: Flash Point, Cleveland Open Cup, min. Degree F. (Degree C)	400 (205)	425 (219)	440 (227)	450 (232)	460 (238)
Solubility in trichloroethylene, min. %	99.0	99.0	99.0	99.0	99.0

*Thin-film oven test may be used but the rolling thin-film oven test shall be the referee method.
*If ductility is less than 100, material will be accepted if ductility at 60°F. (15.5°C) is 100 minimum at a rate of 5 cm/min.

711.3 TEST REPORT AND CERTIFICATION:

At the time of delivery of each shipment of asphalt, the supplier supplying the material shall deliver to the purchaser 3 certified copies of the test report which shall indicate the name of the supplier, type and grade of asphalt delivered, date and point of delivery, quantity delivered, delivery ticket number, purchase order number, and results of the above specified tests. The test report shall be signed by an authorized representative of the supplier certifying that the product delivered conforms to the specifications for the type and grade indicated.

Until the certified test reports and samples of the material have been checked by the Engineer to determine their conformity with the prescribed requirements the material to which such report relates and any work in which it may have been incorporated as an integral component will be only tentatively accepted by the Contracting Agency. Final acceptance will be dependent upon the determination of the Engineer that the material involved fulfills the requirements prescribed therefor. The certified test reports and the testing required in connection with the reports shall be at no addiional cost to the Contracting Agency.

711.4 TEMPERATURES:

Unless otherwise specified in these specfications or in the special provisions, the various grades of paving asphalt shall be applied at a temperature range as indicated in Table 711-2, the exact temperature to be determined by the Engineer.

At no time, after loading into a tank car or truck for transportation from the refinery to the purchaser, shall the temperature of the paving asphalt be raised above 400 degrees F.

TABLE 711-2

Application Temperature of Paving Asphalts

Grade of Material	Pug Mill Mixing Asphalt Temperature Degree F. Min.	Pug Mill Mixing Asphalt Temperature Degree F. Max.	Distributor Application Temperature Degree F. Min.	Distributor Application Temperature Degree F. Max.
AR-160	300	350	375	450
AR-80 & AC-40	275	325	325	375
AR-40 & AC-20	275	325	300	350
AR-20 & AC-10	275	325	285	350
AR-10 & AC-5	225	275	260	325

Paving asphalt shall be heated in such a manner that steam or hot oils will not be introduced directly into the paving asphalt during heating.

711.5 DISTRIBUTING EQUIPMENT:

Distributing Equipment shall meet the requirements of Section 712.

711.6 CONVERSION OF QUANTITIES:

When pay quantities of paving asphalt are determined from volumetric measurements, the volumetric measurement at any temperature shall be reduced to the volume the material would occupy at 60 degrees F. in accordance with ASTM D-1250. In converting volume to weight, the computations shall be based on the following data:

TABLE 711-3		
Grade of Material	Gals. Per Ton at 60 Degrees F.	Lbs. Per Gal. at 60 Degrees F.
AR-160	235	8.51
AR-80 & AC-40	235	8.51
AR-40 & AC-20	235	8.51
AR-20 & AC-10	237	8.44
AR-10 & AC-5	239	8.36

SECTION 712

LIQUID ASPHALT

712.1 GENERAL:

Liquid asphalt shall consist essentially of either natural crude or refined asphalt petroleum, or a residual product thereof, and shall conform to the following classifications:

(A) Medium curing products designated by the letters MC, shall consist of a paving asphalt conforming to the provisions in Section 711, fluxed or blended with a kerosene type solvent.

(B) Rapid curing products designated by the letters RC, shall consist of a paving asphalt conforming to the provisions in Section 711 fluxed or blended with a naptha solvent.

The asphalt shall not be heated during the process of its manufacture or during construction so as to cause injury as evidence by the formation of carbonized particles.

712.2 TEST REQUIREMENTS:

Liquid asphalts shall consist of materials specified in the above classifications and shall conform to the requirements set forth in the following tables:

NOTE: Table 712-1 pertaining to slow curing (SC) asphalt product is deleted.

TABLE 712-2

AASHTO M-82 TABLE 1

	MC-30		MC-70		MC-250		MC-800		MC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60°C (140°F) centistokes	30	60	70	140	250	500	800	1600	3000	6000
Flash point (Tab. open-cup), degrees C° (F)	38 (100)	...	38 (100)	...	66 (150)	...	66 (150)	...	66 (150)	...
Water percent	...	0.2	...	0.2	...	0.2	...	0.2	...	0.2
Distillation test: Distillate percentage by volume of total distillate to 360°C (680°F)										
to 225°C (437°F)	...	25	0	20	0	10	...	...	...	...
to 260°C (500°F)	40	70	20	60	15	55	0	35	0	15
to 315°C (600°F)	75	93	65	90	60	87	45	80	15	75
Residue from distillation to 360°C (680°F) Volume percentage of sample by difference	50	...	55	...	67	...	75	...	80	...
Tests on residue from distillation: Absolute viscosity at 60°C (140°F) poises	300	1200	300	1200	300	1200	300	1200	300	1200
Ductility, 5 cm/cm, cm.	100	...	100	...	100	...	100	...	100	...
Solubility in Trichloroethylene, percent	99.0	...	99.0	...	99.0	...	99.0	...	99.0	...

TABLE 712-2

MEDIUM CURING PRODUCTS

SPECIFICATION DESIGNATION	ASTM TEST METHOD	AASHTO TEST METHOD	GRADE			
			MC 70	MC 250	MC 800	MC 3000
Flash Point, Tag. Open Cup, °F., Min.	D-1310	T-79	100	150	150	150
Viscosity, Kinematic, 140°F., Centistokes	D-2170	T-201	70-140	250-500	800-1600	3000-6000
Distillation						
Distillage, % of total distillate to 680°F.						
To 437°F.			0-20	0-10		
To 500°F.	D-402	T-78	20-60	15-55	0-35	0-15
To 600°F.			65-90	60-87	45-80	15-75
Residue from Distillation to 680°F. Vol. % by difference, Min.			55	67	75	80
Tests on Residue from Distillation						
Penetration at 77°F.	D-5	T-49	120-250	120-250	120-250	120-250
Ductility, 77°F., Cm. Min.(1)	D-113	T-51	100	100	100	100
Solubility in CCL_4, % Min.(2)	D-2042	T-44	99.5	99.5	99.5	99.5
Water, % Max.	D-95	T-55	0.2	0.2	0.2	0.2
Spot Test Heptane-Xylene Equivalent, % Max.(3)		T-102	35	35	35	35

(1) If penetration of residue is more than 200 and its ductility at 77°F. is less than 100 the material will be acceptable if the ductility at 60°F. is greater than 100.

(2) Test Method AASHTO T-44, except that ethylene dichloride, dichloroethylene or trichloroethylene, being less toxic solvents, may be used for routine testing; however, in case of dispute, carbon tetrachloride shall be used.

(3) Test Method AASHTO T-102, except that the test at 24 hours and the test on the glass plate shall be eliminated from the method.

TABLE 712-3
AASHTO M-81 TABLE 1

	RC-70		RC-250		RC-800		RC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 60°C (140°F) centistokes	70	140	250	500	800	1600	3000	6000
Flash point (Tag, open-cup), degrees C (F)	...	...	27 (80)	...	27 (80)	...	27 (80)	...
Water, percent	...	0.2	...	0.2	...	0.2	...	0.2
Distillation test: Distillate, percentage by volume of total distillate to 360°C (680°F)								
to 190°C (374°F)	10	...	...	...	...	...	...	...
to 225°C (437°F)	50	...	35	...	15	...	...	...
to 260°C (500°F)	70	...	60	...	45	...	25	...
to 315°C (600°F)	85	...	80	...	75	...	70	...
Residue from distillation to 360°C (680°F) volume percentage of sample by difference	55	...	65	...	75	...	80	...
Tests on residue from distillation: Absolute viscosity at 60°C (140°F) poises	600	2400	600	2400	600	2400	600	2400
Ductility, 5 cm./min. at 25°C (77°F) cm	100	...	100	...	100	...	100	...
Solubility in Trichloroethylene, percent	99.0	...	99.0	...	99.0	...	99.0	...

712.3 TEST REPORTS AND CERTIFICATIONS:

Test reports and certifications will be furnished in accordance with Section 711.

712.4 APPLICATION:

Application of asphalt will not be permitted when in the opinion of the Engineer, the surface to be treated is appreciably damp, or when weather conditions are unsuitable.

Unless authorized by the Engineer, no liquid asphalt shall be spread when the air temperature is lower than 50 degrees F. At 50 degrees F. the atmospheric temperature must be rising.

Unless otherwise specified in these specifications or in the special provisions, the various grades of liquid asphalt shall be applied at temperatures within the limits specified in the table of application temperatures below, the exact temperature to be determined by the Engineer. When liquid asphalt is to be mixed with aggregate, the temperature of the aggregate, at the time of adding the liquid asphalt, shall not exceed that shown in the column of pug mill mixing temperatures.

At no time after loading into a tank car or truck for transportation to the site of the work, unless authorized by the Engineer, shall the temperature of the liquid asphalt be raised above that given in the last column of the following table:

TABLE 712-4

Application Temperatures of Liquid Asphalts

All Types of Liquid Asphalt	Pug Mill Mixing Temp for MC Liquid Asphalts, Degrees F.		Distributor Application Temperature Degree F.	
	Min.	Max.	Min.	Max.
70	90	155	105	175
250	125	200	140	225
800	160	225	175	255
3000	200	260	215	290

Liquid asphalt shall be heated by a retort or steam coils in such a manner that steam or hot oils will not be introduced directly into the liquid asphalt during heating.

The contractor shall be responsible to see that liquid asphalt is prevented from spraying upon adjacent pavements, curbs and gutters, that portion of the traveled way being used by traffic, structures, planter islands, railings and barriers, markers, trees and shrubbery, adjacent property and improvements, and other highway improvements or facilities not mentioned herein.

712.5 DISTRIBUTING EQUIPMENT:

Distributor trucks shall be of the pressure type with insulated tanks. The use of gravity distributors will not be permitted.

Spray bars shall have a minimum length of 9 feet and shall be of the full circulating type. The spray bar shall be adjustable to permit varying height above the surface to be treated.

The distance center to center of the nozzles shall not exceed 6 inches. The valves shall be operated by levers so that one or all valves may be quickly opened or closed in one operation. The valves which control the flow from nozzles shall be of a positive acting design so as to provide a uniform unbroken spread of bituminous material on the surface. The distributor shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied and with a tachometer of the auxiliary wheel type reading speed in feet per minute. The spreading equipment shall be so designed and articulated that uniform application of a bitiuminous material, in controlled amounts, may be made ranging from 0.05 to 2.0 gallon per square yard of surface and with a range of pressure from 25 to 75 psi. If a spray bar extension is used to cover a greater width, it shall be of the full circulating type. The distributor shall be equipped with a hose and nozzle attachment to be used for spotting skipped areas and areas inaccessible to the distributor. The distributor shall also be equipped with pressure gauges and an accurate thermometer for determination of the temperature of bituminous material. Distributor and booster tanks shall be so maintained at all times as to prevent dripping of bituminous material from any part of the equipment.

The Engineer reserves the right to order the discontinuance of use of equipment, which, in his opinion, fails to produce a satisfactory distribution of asphalt in accordance with the specification.

712.6 CONVERSION OF QUANTITIES:

When pay quantities of paving asphalt are determined from volumetric measurements, the volumetric measurement at any temperature shall be reduced to the volume the material would occupy at 60 degrees F. in accordance with ASTM D-1250. In converting volume to weight, the computations shall be based on the following data:

TABLE 712-5

Grade of Material	Gals. Per Ton at 60 Degrees F.	Lbs. Per Gal. at 60 Degrees F.
70	253	7.90
250	249	8.03
800	245	8.16
3000	241	8.30

All types MC and RC of the same grade shall be considered to have equal weights per volume.

SECTION 713

EMULSIFIED ASPHALTS

713.1 GENERAL:

Emulsified asphalts shall be composed of a paving asphalt base uniformly emulsifiied with water and an emulsifying or stablizing agent. It shall be homogeneous throughout and if stored, shall show no separation of ingredients within 30 days after delivery. Emulsified asphalt shall be classified as rapid setting, medium setting or slow setting type in either anionic or catonic emulsions.

TABLE 713-1
(Specification Designation)

AASHTO M-140 – TABLE I

REQUIREMENTS FOR EMULSIFIED ASPHALT

Type	Rapid-Setting				Medium-Setting						Slow-Setting			
Grade	RS-1		RS-2		MS-1		MS-2		MS-2h		SS-1		SS-1h	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Tests on emulsions, Viscosity, Saybolt Furol at 77°F (25°C)s	20	100			20	100	100		100		20	100	20	100
Viscosity, Saybolt Furol at 122°F (50°C)s			75	400										
Settlement, 5 days, percent		5		5		5		5		5		5		5
Demulsibility, 35 ml. 0.02 N $CaCl_2$, percent	60		60											
Coating ability and water resistance: ... Coating, dry and aggregate					good		good		good					
Coating, after spraying					fair		fair		fair					
Coating, wet aggregate					fair		fair		fair					
Coating, after spraying					fair		fair		fair					
Cement mixing test, percent												2.0		2.0
Sieve test, percent		0.10		0.10		0.10		0.10		0.10		0.10		0.10
Residue by distillation, percent	55		63		55		65		65		57		57	
Tests on Residue from Distillation Test: Penetration 77°F (25°C), 100g, 5 s	100	200	100	200	100	200	100	200	40	90	100	200	40	90
Ductility, 77°F (25°C), cm/min, cm ..	40		40		40		40		40		40		40	
Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5		97.5		97.5	

TABLE–713-1 (Cont'd)
(Specification Designation)
AASHTO M-208 – TABLE 1
REQUIREMENTS FOR CATIONIC EMULSIFIED ASPHALT

Type	Rapid-Setting				Medium-Setting				Slow-Setting			
Grade	CRS-1		CRS-2		CMS-2		CMS-2h		CSS-1		CSS-1h	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Tests on emulsions: Visc., Saybolt Furol at 77°F. sec									20	100	20	100
Visc., Saybolt Furol at 122 F, sec	20	100	100	400	50	450	50	450				
Settlement, 5 days, %		5		5		5		5		5		5
Demulsibiilty, 35 ml 0.8% sodium dioctyl sulfosucinate, %	40		40									
Coating ability and water resistance: Coating, Dry aggregate					Good		Good					
Coating, after spraying					Fair		Fair					
Coating, wet aggregate					Fair		Fair					
Coating, after spraying					Fair		Fair					
Particle charge test	Positive		Positive		Positive		Positive		Positive*		Positive*	
Sieve Test, %		0.10		0.10		0.10		0.10		0.10		0.10
Cement mixing test, %										2.0		2.0
Distillation: Oil distillate, by volume of emulsion, %		3		3		12		12				
Residue, %	60		65		65		65		57		57	
Tests on residue from distillation test: Penetration, 25°C (77°F), 100 g, 5 sec.	100	250	100	250	100	250	40	90	100	250	40	90
Ductility, 25°C (77°F), 5 cm per min., cm	40		40		40		40		40		40	
Solubiilty in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5		97.5	

*If the Particle Charge Test result is inconclusive for CSS-1 and CSS-1h, material having a maixmum pH value of 6.7 will be acceptable.

713.3 TESTS REPORT AND CERTIFICATION:

Test reports and certifications shall be made in accordiance with Section 711.

713.4 TEMPERATURES:

Unless otherwise specified, the various grades of emulsified asphalt shall be applied at temperatures within the limits specified below, the exact temperature to be determined by the Engineer. Emulsified asphalt shall be reheated if necessary, but at no time after loading into a tank car or truck for transportation to the work site shall the temperature of the emulsion be raised above the maximum temperature shown in the Table below. During all reheating operations, the emulsified asphalt shall be agitated to prevent localized overheating. Emulsified asphalt shall not be permitted to cool to a temperature of less than 40 degrees F.

TABLE 713-2

Application Temperature of Emulsified Asphalt

Grade of Emulsified Asphalt	Minimum Degrees F.	Maximum Degrees F.
RS-1, MS-1 SS-1, SS1h, CSS-1, CSS-1h	70 Degrees	140 Degrees
RS-2, MS-2, MS-2h, CRS-1 CRS-1h, CRS-2, CRS-2h CMS-2, CMS-2h	125 Degrees	185 Degrees

Emulsified asphalt shall be heated in such a manner that steam or hot oils will not be introduced directly into the emulsified asphalt during heating.

713.5 DISTRIBUTING EQUIPMENT:

Distributing equipment shall be as specified in Section 712 except that hand spray by means of hose or bar through a gear pump or air tank shall be acceptable for light application to 0.10 gal. per square yard for resurface work corners or tacking of vertical edges. Care shall be exercised to provide uniform coverage.

713.6 CONVERSION OF QUANTITIES:

When pay quantities of emulsified asphalt are determined from volumetric measurements, the volumetric measurement at any temperature shall be reduced to the volume the material would occupy at 60 Degrees F. in accordance with ASTM D-1250. In converting volume to weight, the computations shall be based on the following data:

TABLE 713-3

Grade of Material	Gals. Per Ton at 60 Degrees F.	Lbs. Per Gal. at 60 Degrees F.
All grades	240	8.33

SECTION 714

AIR REFINED ASPHALT

714.1 GENERAL:

Air refined asphalt shall be a liquid petroleum asphalt that has been modified by air blowing to comply with the specifications below. It shall be free from admixture with any residues obtained by the distillation of coal, coal tar, or paraffin oil and shall be homogeneous and free from water.

714.2 TESTING REQUIREMENTS:

Air refined asphalt shall be classified by temperature grades and conform to the requirements set forth in the following table:

TABLE 714-1

SPECIFICATION DESIGNATION	ASTM TEST METHOD	AASHTO TEST METHOD	GRADES	
Softening Point (Ring & Ball), °F.	D-36	T-53	160°-180°F.	180°-200°F.
Penetration of Original Sample:				
At 32°F. 200g. 60 Sec.	D-5	T-49	15+	10+
At 77°F. 100g. 5 Sec.			25-40	15-30
At 115°F. 50g. 5 Sec.			90−	60−
Ductility at 77°F. Cms. Min.	D-113	T-51	3+	2+
Flash Point (Cleveland Open Cup) °F. Min.	D-92	T-48	425+	425+
Solubility in Carbon Tetrachloride, % Min.	D-2042	T-44	99.0+	99.0+
Loss on Heating, 325°F., 5 Hours, % Max.	D-6	T-47	1.0−	0.5−
Penetration after loss on Heating % of Original, Min.	D-5	T-49	75	75
General Requirements	The asphalt shall be prepared by the refining of petroleum. It shall be uniform in character and shall not foam when heated to 350°F.			

SECTION 714

714.3 TEST REPORT AND CERTIFICATION:

Test reports and certifications shall be made in accordance with Section 711.

714.4 DELIVERY AND PUMPING:

The asphalt shall be delivered to the project in insulated pressure distributor vehicles. Tanks for distributors shall have a minimum capacity of 2000 gal. and be equipped with removable manhole covers, a 2 inch minimum size overflow pipe, and suitable strainers at the outlets to the pumps. A metal bar approximately ⅛ inch × ½ inch calibrated to accurately indicate the contents of the tank in 10 gallon increments shall be provided.
Distributors shall be equipped with heating systems consisting of torch-generating type burners and heat flues having sufficient radiation to insure the rapid circulation of hot gases from the burners. Pressure tanks for the burners shall be equipped with pressure gauges and shall be of such capacity to insure efficient operation of the heating system. Heating devices shall be capable of maintaining a uniform temperature of the asphalt of not less than 350°F. during the period of pumping. A thermometer with a range of 300°F. to 450°F. shall be so mounted in the tank as to accurately indicate the temperature of the asphalt. Tanks shall be so equipped and operated that the asphalt will be circulated or agitated throughout the entire heating process.

The distributor truck shall be equipped with a rotary positive pressure-type pump, capable of pumping the asphalt at a pressure between 20 and 60 psi through 2 full circulating delivery lines at the same time, so arranged that either line can be used separately. A pressure gauge shall be provided to show the pressure at which the asphalt is being applied. A by-pass regulator shall be provided and the pump shall be reversible or a suck-back arrangement shall be provided. The minimum inside diameter of the return lines and connections shall be 1½ inches. All lines and nozzles shall be furnished by the Contractor unless otherwise specified.

The distributor truck shall be equipped with a water tank having a minimum capacity of 100 gallons and a pump with hose and nozzle capable of spraying water on the working area at a pressure of 20 psi.

714.5 CONVERSION OF QUANTITIES:

When pay quantities of air refined asphalt are determined from volumetric measurements, the volumetric measurement at any temperature shall be reduced to the volume the material would occupy at 60°F. in accordance with ASTM D-1250. In converting volume to weight, the computations shall be based on the following data:

TABLE 714-2

Grade of Material	Gals. Per Ton at 60°F.	Lbs. Per Gal. at 60°F.
All grades	234	8.56

SECTION 715

SLURRY SEAL

715.1 GENERAL:

Slurry seal shall consist of a mixture of asphalt emulsion, mineral aggregate, mineral fillers, and water properly proportioned and mixed.

715.2 MINERAL AGGREGATES:

Mineral aggregate shall consist of sound and durable sand and/or crushed stone and approved mineral filler where required. Sand and crushed stone shall conform to applicable requirements of Section 701. Mineral fillers shall conform to requirements of ASTM D-242 and shall be considered as part of the blended aggregate, and shall be used when required, in the minimum amounts. Mineral fillers shall only be used if needed to improve the workability or stripping characteristics of the aggregate-emulsion mixture. Ninety percent of aggregates retained on the No. 50 sieve shall have at least one fractured face produced by crushing. Material passing the No. 50 sieve shall contain at least 10 percent natural uncrushed sand. The material shall be non-plastic when tested in accordance with ASTM D-424. The sand equivalent shall be not less than 50. The abrasion loss per ASTM C-131 shall not exceed 35 percent. The grading of the aggregate shall conform to the following:

TABLE 715

Sieve Size	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing
3/8"	100	100	100
No. 4	100	85-100	70-90
No. 8	90-100	65-90	45-70
No. 16	65-90	45-70	28-50
No. 30	40-60	30-50	19-34
No. 50	25-42	18-30	12-25
No. 100	15-30	10-21	7-18
No. 200	10-20	5-15	5-15
Emulsified Asphalt content as a % of Dry Wt. of Aggregate (approx)	18	16	14
Pounds of Aggregate per sq. yd. (approx)	8-10	12-18	18-25

Mineral fillers such as hydrated lime, portland cement, limestone dust, fly ash, shall be considered as part of the blended aggregate and shall be used, when required, in the minimum amounts. They shall meet the gradation requirements of ASTM D-242. Mineral fillers shall only be used if needed to improve the workability or stripping characteristics of the aggregate-emulsion mixture.

All material samples shall be furnished by the Contactor at no additional cost to the Contracting Agency. All materials and material sources shall be approved prior to use of materials in the work and samples shall be submitted for approval not less than 7 days before commencing construction. Additional samples of materials shall be furnished during construction, upon request.

715.3 BITUMINOUS MATERIALS:

The emulsified asphalt shall make a homogeneous mix with good suspension of the aggregate particles and shall conform to the requirements of Section 713 for Types SS-1h and CSS-1h, or other approved cationic emulsion as ordered by the Engineer.

The tack coat shall consist of 1 part of emulsified asphalt conforming to the type specified for the slurry seal, and 3 parts water.

715.4 WATER:

Water from any domestic source will be satisfactory provided that it is found to be compatible with the slurry ingredients intended for use.

715.5 TEST CERTIFICATES AND REPORTS:

Test certificates and reports for the bituminous material shall be furnished in accordance with Section 711.

715.6 CONVERSION OF QUANTITIES:

Volumetric conversions shall be accomplished in accordance with Section 713.

SECTION 716

PRECOATED CHIPS

716.1 GENERAL:

Precoated chip seals shall consist of one or more applications of bituminous or asphalt-rubber material, followed by an application of precoated stone chips, smoothed and compacted, on existing roadway in accordance with this specification.

716.2 MATERIALS:

716.2.1 Bituminous Materials: The bituminous binder for precoating shall be asphalt cement, of any standard paving grade as specified in Section 711.

716.2.2 Stone Chips: The cover material for the paving asphalt binder shall be stone chips having a percentage of wear not to exceed 40 at 500 revolutions when tested in accordance with AASHTO T-96.

Sodium sulphate soundness test shall be in accordance with AASHTO T-104 and shall not show a loss in excess of 12 percent. A minimum of 75 percent of the material, by weight, retained on the No. 8 sieve, shall have at least one fractured face produced by crushing.

Grading of the stone chips when tested in accordance with AASHTO T-11 and T-27 shall comply with the following. When sealing low-volume traffic streets only, the grading shall be ¼ inch nominal size as follows:

TABLE 716-1

Sieve Size	Percent Passing
⅜"	100
¼"	80-100
No. 8	0-5
No. 200	0-2

When sealing high traffic-volume streets only, the grading shall be ⅜ inch nominal size as follows:

TABLE 716-2	
Sieve Size	**Percent Passing**
½"	100
⅜"	70-100
¼"	0-10
No. 8	0-5
No. 200	0-2

SECTION 717

ASPHALT-RUBBER

717.1 GENERAL:

Hot asphalt-rubber seal shall consist of a mixture of hot paving grade asphalt and ground tire rubber combined with heat into a visco-elastic composition. After application it shall be immediately covered with cover aggregate.

717.2 MATERIALS:

717.2.1 The asphalt shall be as per Section 711.

717.2.2 The granulated rubber shall meet the following requirements:

The specific gravity of the material shall be 1.15 ± .02 and shall be free from fabric, wire, or other contaminating materials except that up to 4 percent of calcium carbonate may be included to prevent the particles from sticking together.

717.2.3 The cover aggregate shall conform to the requirements of Section 716. The grading of cover aggregate shall comply with Table 716-1 for light traffic use and Table 716-2 for heavy traffic use. Cover aggregate shall be hot precoated chips in accordance with Section 331.

Except where materials are being obtained from a previously approved source, the Contractor shall furnish samples for testing in accordance with Section 725.

717.2.4 The kerosene shall have an initial boiling point of not less than 350°F.

SECTION 718

PRESERVATIVE SEAL

718.1 GENERAL:

The asphalt concrete preservative seal shall be composed of a petroleum resin-oil base uniformly emulsified with water.

718.2 TESTING REQUIREMENTS:

The asphalt concrete preservative seal emulsion shall conform to the following physical and chemical requirements:

TABLE 718

Specification Designation	ASTM Test Method	Requirements
Viscosity, Saybolt-Furol, at 77°F., Sec.	D-244	15-40
Residue, % Min. (1)	D-244	60-65
Miscibility Test (2)	D-244	No coagulation
Sieve Test, % Max. (3)	D-244	0.10
Particle Charge Test	D-244	Positive
Tests on Residue from ASTM D-244: Viscosity, cs., 140°F.	D-445	100-200
Asphaltenes, % Max.	D-2006	0.75
Maltenes Dist. Ratio (4) $\frac{PC + A_1}{S + A_2}$	D-2006	0.3-0.5

(1) ASTM D-244 modified evaporation test for percent of residue is made by heating a 50 gram sample to 300°F. until foaming ceases, then cool immediately and calculate results.

(2) Test procedure identical with ASTM D-244 except that .02 normal calcium chloride solution shall be used in place of distilled water.

(3) Test procedure identical with ASTM D-244 except that distilled water shall be used in place of 2 percent sodium oleate solution.

(4) In the maltenes distribution ratio test by ASTM D-2006.

PC = Polar Compounds A_1 = First Acidaffins

A_2 = Second Acidaffins S = Saturates

SECTION 725

PORTLAND CEMENT CONCRETE

725.1 GENERAL:

Portland cement concrete shall be composed of Portland cement or Portland Pozzolan cement, Pozzolonic Materials, fine and coarse aggregates, water, and, if provided for or allowed, certain admixtures.

All of the materials used for concrete shall be in accordance with these specifications and requirements for the particular material as provided herein.

Weighing and metering devices used for the purpose of proportioning materials shall fulfill requirements as to accuracy and tolerance prescribed by the Weights and Measures Division of the State of Arizona and shall be sealed and certified in accordance with the procedures established by this agency. This certification shall not be over 12 months old and shall be renewed whenever required by the Engineer. When portable plants are set up at a new or temporary location, the scales and scale assembly shall be inspected and certificate issued regardless of the date when the scales were last tested. The Engineer may require the Contractor to run a quick scale check at any time with certified weights furnished by the Contractor and order the scale recertified if necessary.

725.1.1 Classes of Concrete:

TABLE 725

Classes and Master Limits of Concrete

Class of Concrete	Min. Cement Content Lbs. Per Cu. Yd.	Min. Strength At 28 Days Compressive (1)
AA	600	4,000 psi
A	520	3,000 psi
B	470	2,500 psi
C	420	2,000 psi

(1) As tested in accordance with ASTM C-39. Maximum slump 5 inches when tested in accordance with ASTM C-143.

Class AA concrete shall be used as specified.

Class A concrete shall be used for concrete structures, either reinforced or non-reinforced, and for concrete pavements.

Class B concrete may be used for curbs, gutters and sidewalks.

Class C concrete may be used for thrust blocks, encasements, fill or over-excavation, etc.

725.2 PORTLAND CEMENT:

Cement to be used or furnished under this specification shall be Portland cement, conforming with the requirements of ASTM C-150, Type II, low alkali, or Portland

Pozzolan Cement, conforming with the requirements of ASTM C-595, Type IP (MS), low alkali, except when another type including high early strength is specified in the special provisions or shown on the plans. Type V cement (ASTM C-150) shall be specified in the special provisions for use in concrete which will be exposed to contact with soils or waters containing water soluble sulfates (as S04) in concentration greater than 0.20% by weight of soil or 1500 PPM in solutions. Pozzolonic materials shall not be used as a directly added ingredient in concrete in combination with Portland Pozzolan Cement.

Cement shall be sampled and tested as prescribed in applicable ASTM specifications. The Contractor shall obtain and deliver to the Engineer a certification of compliance signed by the cement manufacturer, identifying the cement and stating that the cement delivered to the batching site complies with those specifications. When requested by the Engineer, the Contractor shall furnish him with 3 copies of said certification. The cost of furnishing tested cement shall be considered as included in the contract bid price and no additional allowance will be made therefore.

When suitable facilities, as recommended by the Concrete Plant Manufacturer's Bureau, and approved by the Engineer, are available for handling and weighing bulk cement, such facilities shall be used. Otherwise the cement shall be delivered in original unopened sacks that have been filled at the mill and bear the name or brand of the manufacturer. The type of cement, and the weight of cement contained in each sack shall be plainly marked thereon.

Cement shall be stored in such manner as to permit ready access for the purpose of inspection and identification, and so as to be suitably protected against damage by contamination or moisture. Should any lot of bulk cement be delivered to the site show evidence of contamination, the Engineer may require that such lot be removed from the site.

A cement shall not be mixed with any other brand or type unless written permission has first been obtained from the Engineer.

All cement used in the manufacture of concrete for any individual structure shall be of the same brand unless otherwise approved by the Engineer.

725.2.1 Pozzolonic Materials: Pozzolonic materials to be used in concrete or furnished under this specification shall conform to the requirements of ASTM C-618 for Class N or Class F.

A maximum of 15 percent by weight of the minimum Portland cement requirement listed in Table 725 may be replaced with Pozzolan at a ratio of not less than 1.2 pounds of Pozzolan per pound of Portland cement replaced.

Pozzolans shall be sampled and tested as prescribed in ASTM C-618 and ASTM C-311. The Contractor shall obtain and deliver to the Engineer a certification of compliance signed by the Pozzolan supplier identifying the Pozzolan and stating the Pozzolan delivered to the batching site complies with applicable specifications. The cost of furnishing tested Pozzolan shall be considered as included in the contract bid price and no additional allowance will be made therefore.

Pozzolan material shall be handled and stored in the same manner as Portland cement. When facilities for handling bulk Pozzolan are not available, the Pozzolan shall be delivered in original unopened sacks bearing the name and brand of the supplier, the type and source of the Pozzolan, and the weight contained in each sack plainly marked thereon.

A Pozzolan shall not be mixed with any other brand or type unless written permission has first been obtained from the Engineer. All Pozzolan used in the manufacture of concrete for any individual structure shall be of the same type, and from the same source unless otherwise approved by the Engineer.

725.3 AGGREGATES:

Aggregates shall be crushed rock or gravel or a combination thereof and sand conforming to the requirements prescribed in Section 701. Prior to the delivery of the aggregates, the Contractor will be required to furnish samples for testing, and shall notify the Engineer as to when and where they will be available. Thereafter, additional required samples shall be furnished at the expense of the Contractor, but the cost of testing and making the grading analysis will be borne by the Contracting Agency. Samples shall be taken by the Engineer or in the presence of the Engineer.

No method which may cause the segregation, degradation or the combining of materials of different grading shall be used.

725.4 AGGREGATE GRADING:

Aggregates for each batch of concrete to be prepared shall be combined from materials separately stored in the various sizes and gradations as prescribed in Section 701. The relative proportions of each aggregate used will be as required to meet the provisions of this specification and will be the responsibility of the Contractor.

Except where the amount of concrete for any one job is 10 cubic yards or less, various sizes of both coarse and fine aggregate shall be proportioned by weight unless permission to do otherwise has first been obtained from the Engineer. Aggregates that are proportioned by volume shall be measured in containers of known capacity. Regardless of the method employed, either by weight or volume, each individually stored size of aggregate shall be proportioned separately, but not necessarily weighed individually.

The maximum size of the aggregate shall not be larger than one-fifth of the narrowest dimension between forms of the members for which the concrete is to be used, or larger than ¾ of the minimum clear spacing between reinforcing bars.

725.5 WATER:

The amount of water shall be varied in accordance with the percentage of free moisture in the material and the requirements of the workability of the aggregate.

The equipment for measuring and supplying the water in the mixer shall be so constructed and arranged that the amount of water to be added to the mixture can be measured, in gallons or by weight, positively and that the predetermined quantity of water required can be discharged rapidly in one operation into the mixing drum without dribbling. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than 1 percent from the required quantity. Adequate means for determining and checking the accuracy of the equipment shall be provided and made available to the Engineer at all times.

The water used for mixing with concrete shall be potable and free from oil, vegetable matter and other deleterious substances, and shall conform to the following requirements:

Water for prestressed concrete shall not contain chlorides calculated as sodium chloride in excess of 1,000 parts per million nor sulphates calculated as sodium sulphate in excess of 1,000 parts per million nor any sulphates calculated as sulphate in excess of 1,000 parts per million. Water shall not contain an amount of impurities that will cause a change in the time of setting of Portland cement of more than 25 percent nor a reduction in the compressive strength of Portland cement mortar of more than 5 percent compared to results obtained with distilled water.

725.6 ADMIXTURES:

Admixtures of any type, except as otherwise specified, shall not be used unless written authorization has been obtained from the Engineer.

If an air-entraining agent is authorized, the amount used will be limited to the extent that the amount of entrained air by volume shall not be more than 6 percent. Air-entraining agents complying with AASHTO M-154 or ASTM C-260 will be permitted as long as strength requirements are met. Any admixture shall be measured accurately by mechanical means into each batch by equipment and in a method approved by the Engineer. Any admixtures used shall be included in the bid price for that item.

725.7 PROPORTIONING:

All proportioning equipment shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association. The proportioning shall consist of combining the specified sizes of aggregates, each stored in a separate bin with cement, Pozzolanic Materials, and water as herein provided. Weigh hoppers shall be charged from bins located directly over the weigh hoppers or from conveyor belts. When conveyor belts are used, there shall be a separate belt for each size of aggregate.

Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the batch ingredients are released for discharge. The cement hopper shall be attached to a separate scale for individual weighing.

All Pozzolan that is to be incorporated into the concrete as a separate ingredient shall be weighed. When the cement scales are used for weighing both cement and Pozzolan, the cement shall be weighed first. If separate scales are provided, they shall be accurate to $\pm$ 0.3 percent of the scale capacity.

Scales utilized in the proportioning device may be of the springless dial-type or of the multiple-beam type.

If the dial-type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.

If the multiple beam-type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or under weight. The indicator shall be so designed that it will operate during the addition of the last 400 pounds of any weighing. The over travel of the indicator hand shall be at least ⅓ of the loading travel. Indicators shall be enclosed against moisture and dust.

Weighing equipment shall be as recommended by the Concrete Plant Manufacturer's Bureau and be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading at cutoff shall not vary from the weight designated by the Engineer more than 1 percent for cement, Pozzolan or Cement Pozzolan, 1½ percent for any size of aggregate, nor 1 percent for the total aggregate in any batch.

When proportioned at a central mixing plant there shall be an approved moisture meter, accurate within ½ percent, installed to indicate the moisture in the fine aggregate.

A concrete mix design carrying the producer's designated mix number of the concrete being furnished under these specifications shall be submitted to the Contracting Agency at least once each year. In the event there is any change in the source of material, another mix design shall be submitted.

725.8 MIXING:

Machine mixing will be required in all cases other than those in which it would obviously prove to be impractical; in which latter event hand mixing will be permitted, only to the extent necessary. Regardless of the method employed, mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregates.

The temperature of materials as charged in the mixer shall be such that the temperature of the mixed concrete at the time it is placed in final position does not exceed 90°F. When the atmospheric temperature at the time of placing concrete is less than 40°F., the temperature of the concrete, as placed, shall not be less than 60°F.

All concrete mixers shall be of such design and construction, and so operated, as to provide a thoroughly and properly mixed concrete in which the ingredients are uniformly distributed.

725.8.1 Paving and Stationary Mixers: Paving and stationary mixers shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association. They shall be equipped with an accurate automatic timing device so designed and constructed as to lock the discharge lever before aggregate, cement and Pozzolan enter the drum, and release such lever only after the specified mixing time has elapsed. The regulation of the setting of said device shall be under the supervision of the Engineer. Water control equipment as described in this specification shall also be provided with each concrete mixer.

Mixers shall be maintained in proper and serviceable working condition, and any part or portion thereof that is out of order, or becomes worn to such extent as to detrimentally affect the quality of mixing, shall be promptly repaired or replaced.

The proper proportions of aggregate, cement, Pozzolan and water for each batch of concrete shall be placed in the mixer, and shall be mixed for a period of not less than 50 seconds after all such materials are in the drum.

The rotating speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

The total volume of materials mixed in any one batch shall neither exceed the water level capacity of the mixer nor the manufacturer's catalog rated capacity of the mixer.

725.8.2 Transit Mixers: Transit mixers shall be high quality equipment and meet the requirements of the Truck Mixer Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association. Ready mix concrete shall comply with ASTM C-94 except as herein specified.

The total elapsed time between the addition of water at the batch plant and depositing the completed mix shall not exceed 90 minutes. Each mixer and agitator shall have

attached thereto in a prominent place a metal plate or plates, installed by the manufacturer, on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades.

Each mixer shall have an identification number painted on the truck in such a location that it can be easily read from the batching platform.

The total volume of materials introduced into the mixer for mixing purposes shall not exceed the manufacturer's guaranteed mixing capacity. If the concrete so mixed does not meet the uniformity requirements of this section, the amount of materials charged into the mixer shall be reduced.

The rotating speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

The total volume of materials mixed in any one batch shall neither exceed the water level capacity of the mixer nor the manufacturer's catalog rated capacity of the mixer.

Each batch of concrete placed in the mixer shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades, at the speed designated by the manufacturer of the equipment as mixing speed. Additional mixing shall be at the agitating speed designated by the manufacturer of the equipment. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum. Before any portion of the materials for any batch of concrete is placed therein, the drum of the mixer shall be completely emptied of the previously mixed batch.

At the time of delivery to the job site, the Engineer shall be provided with a legible weighmaster's certificate (delivery ticket) which shall contain the following information:

Date and Truck Number.

Name of the Supplier.

Name of the Contractor.

Specific designation of job (name and location).

Number of cubic yards in the batch.

Type of cement.

Type of Pozzolan, if any.

Time the transit mixer is loaded.

Amount of water added at the jobsite at request of receiver, and his signature or initials.

Suppliers' mix design code number.

Type and amount of admixture, if any.

Serial number of the ticket.

The type, capacity and manner of operation of the mixing and transporting equipment for ready-mix concrete shall conform to the current Standards for Operation of Truck

Mixers and Agitators of the National Ready-Mixed Concrete Association and the Truck Mixer and Agitators Standards of the Truck Mixer Manufacturer's Bureau. Water shall not be added to the batch during transit. Additional water may be added at the point of discharge to adjust slump providing the slump after such water addition does not exceed the maximum allowed by these specifications and that water so added is mixed into the batch for a minimum of 30 additional revolutions at mixing speed. Loss of cement mortar during discharge which in the opinion of the Engineer would be of sufficient amount to affect the homogeniety of the concrete will be cause for rejection of the load. The Contractor shall be responsible for all concrete to which water is added at the jobsite.

725.8.3 Hand Mixed Concrete: Hand mixed concrete shall be prepared on a watertight level platform in batches of not to exceed ⅓ cubic yard each. The required amount of coarse aggregate shall first be spread on the platform in an even and uniform layer, over which the proper proportion of fine aggregate shall then be likewise spread. The combined depth of both such layers shall not be greater than one foot. The required quantity of cement shall then be evenly distributed over the fine aggregate; following which the entire batch shall be turned with shovels at least twice before the water is added. The proper amount of water shall then be uniformly sprinkled or sprayed over the batch, which shall thereafter be returned with shovels not less than 3 times before being removed from the platform.

725.8.4 Drybatched Unmixed Concrete: Should the Contractor elect to use drybatched unmixed concrete, an accurate automatic batch weight recorder shall be provided to record the quantities of cement, aggregate and water batched into the containers; the weight of cement shall be recorded on either a separate chart from the aggregate or on the same chart using a separate needle. The recorder shall produce an autographic readable record on a visible chart of the weights of each of the materials batched. After batching, the needle on the chart shall return to zero. The chart scale along the ordinate shall be such that the major portion of the chart is used to record the total weights of the aggregates and water, and the cement. The date of batching, the container number and the batching certificate number shall be recorded on the recorder chart at the time of batching. The recorder charts, or copies thereof, shall become the property of the Contracting Agency and shall be submitted upon request.

All drybatched unmixed concrete delivered to the job site shall be stored in containers so constructed that the cement cannot comingle with the water and aggregate within the container. Any admixture added in powder form shall be added to the cement; added in liquid form, it shall be added to the water.

The contents of the container shall be discharged into a mixer at the job site. Following discharge of the first container into the mixer, the mixer shall be operated at mixing speeds during the discharge of the remaining containers. After the contents of the last container have been discharged into the mixer, the concrete shall be mixed as specified in this specification for transit mixers, and drum or turbine type mixers.

Any spillage of cement, aggregate, water or admixture during the filling, transporting, or the discharging of the container, shall be cause for rejection of the container or the contents of the mixer if any portion of the rejected container is discharged into the mixer.

725.9 LOADING AND TRANSPORTATION OF MATERIALS AND MIXED CONCRETE:

The compartments of trucks or other equipment used for the purpose of transporting proportioned aggregates, bulk cement or mixed concrete, shall be sufficiently high

and tight, and otherwise suitably constructed and adequately protected, to prevent loss or leakage of the contents thereof during transit or charging.

725.10 TESTS:

Concrete specimens for compression tests will be taken in the field by a representative of the Engineer in accordance with ASTM C-172 and C-31 or AASHTO T-23, except as noted hereinafter.

Concrete samples shall be taken from the approximate middle 50 percent of the batch in an uninterrupted stream from the chute directly into the wheelbarrow or similar equipment. Where excessive slump is suspected, a controlling slump test may be made from any portion of the batch, except for the approximate 5 percent on each end of the discharge. If excessive slump is verified, a set of cylinders for compressive strength shall be taken from the batch. The rate of discharge of the batch shall be regulated by the rate of revolutions of the drum and not by the size of the gate opening. Specimens for compression tests shall be stored in the field in accordance with methods approved by the Contracting Agency and protected from vibration and other disturbances, for a minimum of 18 hours and maximum of 76 hours. A maximum storage period would be involved only where weekends or holidays are involved. Cylinders stored in the field for the maximum period shall have the same validity as cylinders that have been stored overnight and brought in the following day.

Not less than 4 cylinder specimens will be made for each 50 cubic yards of each grade of concrete with a minimum of 4 specimens for each grade placed and not less than 4 specimens for each half-day's pour. Specimens will be tested in a laboratory designated by the Engineer in accordance with ASTM C-39 at the expense of the Contracting Agency. One cylinder shall be broken at 7 days and two at 28 days. The average of the two 28-day cylinders shall govern. The fourth cylinder shall be held and tested at an age to be determined by the Engineer or shall be discarded after 60 days' age. If the tests show that the concrete does not meet the compressive strength requirements of these specifications, the Contractor may arrange to have two cores taken within 3 days of the 28-day breaks from the concrete represented by the cylinders (usually 50 cubic yards or half-day's pour, whichever comes first). The cores shall be taken as early as possible from the same concrete from which the cylinders were taken, under the supervision of the Engineer. They shall be tested, in accordance with ASTM C-42, in a laboratory designated by the Contracting Agency. If the cores pass the strength requirements, the Contractor will be reimbursed for the cost of coring and the concrete will be accepted by the Contracting Agency. The Contractor shall bear the expense of coring.

If the strength of the 28-day cylinders and the strength of the cores as calculated in accordance with ASTM C-42 are deficient, the Contractor shall remove all of the concrete represented by the failing test specimens with the exception that if the Contractor believes that the deficient concrete was confined to a single batch, he may immediately cut a minimum of 4 additional cores, two on either side of the affected batch. The cores would be compared with the minimum specified compressive strength, for the purpose of defining the confines of the deficient concrete. All coring done to establish this premise would be at the expense of the Contractor. Evaluation of the cores shall be by the Engineer, or by a substitute agent designated by the Contracting Agency, and his decision shall be final.

725.11 ACCEPTANCE:

Concrete represented by a strength test of at least 95% of the required 28-day compressive strength will be acceptable. All concrete failing to meet this requirement

as evidenced by tests of either standard cylinder or drilled core specimens shall be rejected, removed and replaced by the Contractor at the Contractor's expense.

When concrete is accepted on the basis of strength tests of less than 100% of the required minimum 28-day compressive strength, an adjustment in the contract unit price will be made for the quantity of concrete represented by such strength tests in accordance with the following schedule:

Adjustment in Contract Unit Price for Strength Deficiency

Percent of Specified Minimum 28-Day Compressive Strength Attained (Nearest 1%)	Percent of Concrete Unit Price Allowed
100% or greater	100
98-99	90
96-97	85
95	80

SECTION 726

CONCRETE CURING MATERIALS

726.1 GENERAL:

Curing materials shall consist of waterproof paper, polyethylene film or liquid membrane-forming compounds which, when applied to fresh concrete, will inhibit moisture loss and reduce temperature rise during the curing period. All curing materials and methods shall be approved by the Engineer prior to use. Wet coverings such as burlap, cotton mats, or other moisture-retaining fabrics also may be used, or may be required by special provisions.

726.2 MATERIALS:

(A) Waterproof paper, or polyethylene film, shall conform with AASHTO M-171.

(B) Liquid membrane-forming compounds shall conform with AASHTO M-148. Type 1 compound with either a Class A or Class B vehicle shall be used for concrete structures, except bridge decks. Type 2 compound, with either a Class A or Class B vehicle shall be used for Portland cement concrete pavement, bridge decks and approach slabs.

(C) Burlap cloth made from jute or kenaf shall conform to AASHTO M-182. Cotton mats shall conform to AASHTO M-73 "Specification for Cotton Mats for curing Concrete."

SECTION 727

STEEL REINFORCEMENT

727.1 GENERAL:

The following specifications set forth the requirements for bar reinforcement, wire reinforcement, and wire mesh reinforcement. The reinforcement shall conform accurately to the dimensions and details indicated on the plans or otherwise prescribed and before being placed in any concrete work, shall be thoroughly cleaned of all loose rust, mill scale, mortar, oil, dirt, or coating of any character, which would be likely to destroy, reduce, or impair its proper binding with the concrete.

No reinforcing steel will be accepted under this specification until it has been approved by the Engineer. When required by the Engineer, the Contractor or supplier shall furnish a spot sample taken on the project and notify the Engineer as to when and where they will be available. Such samples shall be furnished at the expense of the Contractor or supplier, but the cost of any testing that may be required will be borne by the Contracting Agency. Samples shall only be taken in the presence of the Engineer. The Contractor shall furnish 3 certified mill test reports or certificates of compliance for each heat or size of steel which can be clearly identified with the lot. When such information has been furnished, placing of the steel will not be held up until results of spot samples have been received. Unless otherwise specified, all reinforcing steel bars shall be deformed intermediate grade 40 billet steel conforming with ASTM A-615 and the shapes shall conform with ASTM A-670.

In testing bar reinforcement, only the theoretical cross-sectional area will be used in all computations.

Bending of steel shall conform to the requirements of ACI-318.

The various grades of steel shall not be used interchangeably in structures.

727.2 WIRE REINFORCEMENT:

Wire reinforcement shall in all respects fulfill requirements prescribed in ASTM A-82.

727.3 WIRE MESH REINFORCEMENT:

Mesh reinforcements shall conform to ASTM A-185. The gage of the wire and the dimension of the mesh will be specified in the special provisions or shown on the plans. The wire mesh reinforcement shall be so constructed as to retain its original shape and form during necessary handling. The effective cross-sectional area of the metal shall be equal to that specified or indicated on the plans.

727.4 WIRE TIES:

Wire for ties shall be black, annealed, not lighter than 16 gage.

SECTION 729

EXPANSION JOINT FILLER

729.1 PREMOLDED JOINT FILLER:

Expansion joint filler material shall consist of premolded strips of a durable resilient compound and comply with ASTM D-1751, D-1752 or D-2628, as specified by the Contracting Agency.

729.2 POUR TYPE JOINT FILLERS:

Pour type joint fillers shall comply with ASTM D-1850, D-1190, D-1854, or with the following formulation, as specified by the Contracting Agency.

Asphalt latex joint filler shall consist of asphalt latex emulsion and sodium fluosilicate furnished in separate containers and mixed on the site. The emulsion shall consist by volume of 60 parts AR-1000 asphalt conforming to the requirements of Section 711, 40 parts of synthetic latex, GRS-Type 4, and 5 to 10 parts of sodium fluosilicate, half strength. The emulsion and sodium fluosilicate shall not be mixed until the joint is ready to be filled. The amount of sodium fluosilicate to be mixed with the emulsion shall be approximately 3 to 5 percent by weight of the emulsion. The joint to be filled shall be thoroughly cleaned and surface dry.

The sealing compound shall consist of paving asphalt, Grade AR-1000 conforming to the provisions of Section 711, emulsified with rubber latex in the presence of a suitable emulsifying agent. Rubber latex designated as GRS-Type 4, or any other approved type, containing approximately 40 percent solids.

The resulting emulsion shall consist of a minimum of 55 percent of paving asphalt and a minimum of 36 percent of rubber latex and shall conform to the requirements set forth in the following table.

TABLE 729			
ASPHALT-LATEX EMULSION JOINT SEALING COMPOUND			
SPECIFICATION DESIGNATION	**TEST METHOD**	**LIMITS**	**REMARKS**
Furol Viscosity at 77°F.	AASHTO T-72	50-250 seconds	Before adding gelling agent.
Sieve Test	AASHTO T-59	1% Max.	Before adding gelling agent.
Penetration at 77°F.	ASTM D-217	50-250	The penetration test is made on a specimen prepared by stirring 5% of sodium fluosilicate into the asphalt latex emulsion in a 6 ounce deep ointment can. The specimen is then allowed to stand in the air at a temperature of 77°F. ±2° for a period of 30 minutes and is then penetrated with a grease cone under a total load of 150 grams.
Elasticity		70% Min.	After addition of 5% of sodium fluosilicate and curing for 24 hours at 100°F. ±2°, the specimen shall have an elastic recovery of not less than 70%.
Dehydration		Loss 30% maximum	Twenty-five grams of emulsion, prior to adding the gelling agent, is placed in an 8 ounce flat ointment can and dehydrated in a suitable oven maintained at a temperature of 200°F. ±2° for a period of 24 hours.
Time of Set		15-60 minutes	After mixing the emulsion with 1% to 4% by weight of powdered sodium fluosilicate the emulsion shall harden or develop a set in from 15 to 60 minutes, under field conditions.

SECTION 729

729.3 TEST REPORT AND SHIPMENT CERTIFICATE:

Each shipment shall be accompanied by a certificate in triplicate from the supplier that the material will comply with the above specifications and such certificate shall be delivered to the Engineer. The certificate shall show the shipment number for the entire lot of material contained in the shipment and shall also show a list which will enable the Engineer to identify each individual container by the supplier's batch number, with which each container shall be plainly marked.

729.4 APPLICATION:

At no time shall emulsion types be subjected to a temperature below 40°F. Prior to application, the material may be warmed, if necessary, to permit proper pouring of the joints. The method of heating shall be carefully controlled to avoid overheating of any part of the container or mixture and under no circumstances shall emulsions be heated to a temperature greater than 130°F.

Joints and cracks shall be thoroughly cleaned by hand or mechanical means immediately in advance of pouring the filler material. When new pavement has been cured by the Pigmented Sealing Compound Method, the joints and cracks shall be thoroughly scrubbed by means of a wire brush or a cloth mop saturated with gasoline or by other approved means.

All joints and cracks shall be surface dry before application of the joint sealer. No sealer shall be placed during unsuitable weather or when the atmospheric temperature is below 50°F., or when weather conditions indicate that the temperature may fall to 32°F. within 24 hours.

The joints and cracks shall be filled in a neat and workmanlike manner by means of a cornucopia pot or other approved method.

SECTION 735

REINFORCED CONCRETE PIPE

735.1 GENERAL:

These specifications cover reinforced concrete pipe and related structures intended to be used for conveyance of sewage, industrial waste, storm and irrigation water.

The size, type, and D-load of the concrete pipe to be finished shall be as shown on the plans, or as specified under the item of work for the project of which the pipe is a part and shall be for pipe installed by the open-cut method of construction.

When specified in the special provisions, four sets of pipe line layout drawings shall be furnished to the Engineer prior to the manufacture of the concrete pipe. Catch basin connector pipe need not be included in the pipe line layout; however, pipe stubs shall be included. In lieu of including catch basin connector pipe in the pipe layout, a list of catch basin connector pipes shall accompany the layout. The connector pipe list shall contain the following information.

(A) Size and D-load of pipe.

(B) Station at which pipe joins main line.

(C) Number of section of pipe, length of section, type of sections (straight, horizontal bevel, vertical bevel, etc.).

The pipe layouts will be used by the Contracting Agency for reference only, but their use shall in no way relieve the Contractor of the responsibility for the correctness of the layout.

(D) All pipe installed in tunnels shall be ASTM C-76, Class III. Pipe stronger than that specified may be furnished at the Contractor's option, and at no additional cost to the Contracting Agency, provided such pipe conforms in all other respects to the applicable provisions of these specifications.

Whatever struts or other protective methods proved necessary to furnish and install the pipe to meet the limitation of cracks as specified herein, shall be provided and maintained throughout pipe handling and transportation.

735.2 QUALITY:

Reinforced concrete pipe shall be manufactured and tested in conformance with the requirements of ASTM C-76, except as modified herein.

All reinforced concrete pipe less than 36-inch inside diameter shall include an area of reinforcing steel in the bell not less than the area required for the circumferential reinforcement in the wall of the pipe.

735.3 CURVES, BENDS AND CLOSURES:

Horizontal and vertical long-radius curves shall be formed by bevel adapters or by beveling the straight pipe joint. The bevel of the pipe shall not exceed 5 degrees and the total angular deflection, for beveled pipe, shall not exceed 10 degrees. Small angular changes may be made with straight pipe provided that the joint opening does not exceed ¾ inch. Short radius curves and closures shall be formed with fabricated specials; however, the angular deflection of any segment of the fabricated section shall not exceed 10 degrees.

735.4 MATERIALS:

Except when otherwise permitted by the Engineer, no materials shall be used in the manufacturing of the pipe other than water, portland cement, mineral aggregates and steel used in manufacturing pipe conforming to ASTM C-76, with the following exception:

(A) Cement shall comply with ASTM C-150, Type II, low alkali. The pipe manufacturer shall supply a cement mill certificate in triplicate for each load of cement delivered, showing the specification, type, chemical analysis, and quantity. In lieu of the above, on stockpiled pipe the manufacturer shall certify that the type of cement used meets this specification. The pipe manufacturer shall also certify in writing that the cement content of the concrete complies with the specifications as to yield per cubic yard of concrete poured.

Satisfactory facilities shall be provided for identifying, inspecting, and sampling cement at the mill, the warehouse, and the job site of the work. The Contracting Agency shall have the right to inspect the cement and obtain samples for testing at any of these points.

Cement shall be stored in weathertight, dry, well-ventilated structures approved by the Engineer.

Cement containing lumps will be rejected and shall immediately be removed from the site of work.

If the temperature of the cement exceeds 150°F., it shall be stored until cooled to that temperature.

(B) Mixture: The proportion of portland cement in the mixture shall be not less than 564 lbs. per cubic yard of concrete.

(C) Concrete Admixtures: The pipe manufacturer shall certify in writing that no calcium chloride or admixture containing calcium chloride has been used in the manufacture of the pipe. Other admixtures may be used if approved by the Engineer. The pipe manufacturer shall certify to the brand and chemical content of such admixtures used.

(D) Steel Reinforcement: The pipe manufacturer shall supply 3 copies of mill certificates showing heat numbers, chemical analysis, and physical tests on reinforcing steel. In lieu of the above, on stockpiled pipe the manufacturer shall certify that the type of steel used meets this specification. The number of steel wraps shall not be less than 5 percent below that shown on the shop drawing for any one pipe.

(E) Rubber Gaskets shall comply with Section 765.

735.5 MANUFACTURER'S QUALIFICATIONS AND EQUIPMENT REQUIREMENTS:

The manufacturer shall be competent to manufacture the type, size and quality of pipe; in addition, he shall have satisfactory curing and storage facilities, and satisfactory financial resources.

Calibration of Cement and Aggregate Scales: The pipe manufacturer shall make whatever alterations are necessary to his equipment to enable the Contracting Agency's Sealer or State Inspector of Weights and Measures to check, calbrate, and seal the aggregate and cement scales used in pipe production.

735.6 CURING OF PIPE:

(A) Steam Curing: The manufacturer shall provide adequate steam plant, piping, enclosures, and other facilities for curing the pipe. The enclosures shall be such that the temperature is maintained continuously between 110 and 150°F.

(B) Curing of the pipe shall not commence until the concrete has attained its initial set, but in any event not sooner than 1 hour nor later than 8 hours after placing of the concrete. Rate of rise of temperature shall not exceed 30° per hour.

(C) Water Curing: The pipe shall be kept moist during daylight hours. The pipe, including the ends, shall be covered with burlap for the first 3 days, except that, if the pipe is kept constantly and completely wet with fog sprays during the daylight hours, the burlap covering may be omitted. If the manufacturer fails to proceed immediately with the required water curing he shall seal the surfaces of the concrete, except joint surfaces that are to be grouted, with an approved, white pigmented sealing compound in accordance with Section 726.

735.7 TESTS AND ACCEPTANCE:

(A) Basis of Acceptance: The basis of acceptance for the reinforced concrete pipe shall be in accordance with ASTM C-76 by the method stated in the special provision and as amended herein. However, the purchaser may, at his option, make concrete cylinder tests for the purpose of determining release dates for shipment of the pipe and for his information in regard to general quality of the concrete.

(B) Segregation of Material: The slump of the concrete mix shall not exceed 4 inches so as to preclude excessive segregation of the materials used and shall be proportioned

so that the result shall be a homogeneous concrete mixture of such quality that the pipe will conform to the tests and design requirements of these specifications.

(C) A pipe has failed the D-load test when the opening crack exceeds .01 inch for a distance of 1 foot when measured at close intervals. These measurements are taken within the 1 foot measured span only where the crack line is more or less parallel to the axis of the pipe, as it is obvious that where the crack deviates substantially from parallel, and approaches a direction normal to the axis, that the edges of the crack tend to slip past each other, instead of opening up under load. The intent of the test is to measure the crack opening under stress.

(D) Porous or honeycomb concrete areas 6 inches or less in diameter may be removed and repaired. Pipe having defects or repairs greater than 6 inches in diameter will not be accepted.

(E) Any crack exceeding 1 foot in length that goes completely through the pipe, is not considered acceptable whether repaired or not, except that a single end crack that does not exceed the depth of the joint as measured from the end to the inside shoulder is acceptable.

(F) Any crack that is .01 inch in width for one-sixteenth inch in depth or deeper, for a length of 1 foot or more and continues as a hairline crack down to the reinforcing steel for over ½ the length of the pipe is not considered acceptable whether repaired or not.

(G) A single continuous hairline crack which does not extend to the reinforcing steel and not in excess of .01 inch in width for a distance of 1 foot is acceptable without repair. This type of crack, longer than 1 foot shall be repaired.

(H) Repairs shall be made by filling the defect with epoxy under pressure or by chipping out a V-section to the full depth of the defect and repairing with an approved patching compound. The composition of the patching compound shall be furnished to the Engineer for approval.

(I) The words regarding acceptability and repairability in the above paragraphs shall also apply when the crack occurs after loading of the pipe in the trench with backfill. Cracks wider than .01 inch shall be assumed to indicate overstress of the steel. In such case, the defective portion of the installation shall be replaced or repaired in a manner acceptable to the Engineer. After structural repairs are completed, the remaining cracks shall be filled as required above. All corrective measures shall be at the expense of the Contractor.

(J) Blisters: All pipe joints having blisters involving less than ¼ the interior surface area shall be repaired by removing all loose material and exposing all hollow area and replacing with fresh concrete properly bonded, with an acceptable bonding agent, and curing the repair with membrane coating. Blisters with larger areas are not considered to be repairable or acceptable.

(K) Painting of pipe, or portion of pipe, with grout to cover defects, minor or major, will not be permitted until approved by the Engineer.

(L) Where the modified or special design method, under ASTM C-76 is elected, acceptance on the basis of material tests and inspection of manufactured pipe for defects and imperfections shall be as stated in ASTM C-76, and as amended herein. However, one joint of each size and D-load shall be selected by the Engineer for test purposes, and shall be tested for strength by the 3 edge bearing method, ASTM C-497, with the results being used for confirmation of the submitted design for this D-load. If the pipe section tested fails in compression or shear before reaching the

D-load specified, the test shall be considered a failure. Additional sections of the same diameter size and class shall be tested as specified above until the load requirements are met for the D-load strength. This test procedure shall be accomplished only once per manufacture regardless of the number of contractors he supplies. Placing of reinforcing steel in the test section of pipe to control shear cracks will not be permitted.

Requirements regarding defects shall be the same as stated above for standard pipe.

Concrete test requirements specified under compression tests of ASTM C-76 shall be amended in part to read as follows: "The average of any 5 consecutive strength tests of the laboratory-cured specimens shall be equal to or greater than the specified strength set forth in Tables III, IV, or V, and not more than 20 percent of the strength tests shall have values less than the specified strength. If more than 20 percent have values less than the specified strength, the lot represented shall be considered to be defective and not acceptable. In no case shall any cylinder tested fall below 80 percent of the specified design strength. If any one cylinder falls below 80 percent of the specified design strength, then the entire production represented by that cylinder will not be accepted for purchase by the Contracting Agency unless the Contractor can demonstrate by coring to the satisfaction of the Engineer, that the cylinder in question is not representative of the entire production, or is representative of only a portion of the entire production."

During the fabrication of the pipe, concrete cylinders shall be made from a representative sample of the concrete. Concrete cylinders and slump tests shall be made by the Engineer or under his direct supervision. A set of cylinders shall consist of three. A minimum of one set shall be made for each day's production.

In vibrated and spun pipe, where the slump of the concrete approaches 0, the cylinders shall be made as follows:

Fill the cylinder can in 3 equal layers. Each layer shall be vibrated and assisted by rodding or other mechanical contrivance simultaneously until the moisture comes to the surface. Care shall be taken that the material is not over-vibrated which will cause segregation. When the moisture rises to the surface of the third layer, it is struck off and leveled. The cap is put on the cylider and it is marked for identification. It shall then be steam cured in the same manner as the pipe, at the conclusion of which, the cylinders shall be brought into the laboratory for standard moist curing until the prescribed time for the compressive test.

The cylinders shall be made according to ASTM C-31 where the pipe is manufactured with concrete that has enough slump for the mateiral to be hand rodded.

735.8 DOWNGRADING OF PIPE:

For the purpose of these specifications, downgrade pipe shall be defined as pipe which is to be used under loads less than that for which they have been designed.

735.9 SANITARY SEWER PIPE:

In addition to the above, sewer pipe shall meet the requirements of ASTM C-76, reinforced concrete pipe having O-ring Rubber Gasket Joints with an interior lining of plastic liner plate in accordance with Section 741.

(A) Pipe Design: The wall thickness and the amount of circumferential reinforcement shall not be less than that required for the D-load indicated on the plans and required by the specifications. The calculations for wall thickness and amount of steel

area per foot of pipe, having concrete lining, shall be for a pipe 2 inches larger in internal diameter than that specified on the plans. The additional concrete lining shall not be considered in the calculation for the area of steel required, nor in any of the load calculations.

D-load class of pipe and the date poured shall be plainly marked inside each pipe section. Specific approval must be obtained, prior to submitting a bid, to decrease the cover over the reinforcing steel at the joint should the steel interfere with the rubber gasket in the groove at the spigot end.

(B) Pipe Construction: Tamped or packer head pipe will not be allowed. Pipe having concrete lining shall have the internal diameters indicated on the plans, measured to the inside of the additional 1 inch of covering. The various sizes of pipe shall be centrifugally spun. Pipe having plastic liner plate shall be vibrocast to ½ inch tolerance to match the unlined pipe of the D-load indicated on the plans.

(C) Test and Acceptance: In addition to the statements above, any crack that goes completely through the pipe, regardless of length of crack is not considered acceptable whether repaired or not, except that a single end crack that does not exceed the depth of the joint as measured from the end to the inside shoulder is acceptable.

735.10 ACCEPTANCE MARK:

The Engineer may, at the place of manufacture, indicate his acceptance of the pipe for delivery to the job by marking the pipe with the Contracting Agency's mark. Such acceptance, however, shall not be considered a final acceptance.

If the pipe is subsequently rejected, the mark placed thereon by the Engineer shall be defaced.

SECTION 736

NON-REINFORCED CONCRETE PIPE

736.1 GENERAL:

The size and classes of the non-reinforced concrete pipe to be furnished shall be as shown on the plans, or as specified under the item of work for the project of which the concrete pipe is a part.

Strength classes of non-reinforced concrete shall be as identified in ASTM C-14, Class 1 non-reinforced concrete pipe. Class 2 non-reinforced concrete pipe, or Class 3 non-reinforced concrete pipe.

Unless otherwise specified, Class 3 non-reinforced concrete pipe will be used.

736.2 MATERIALS:

Materials used in manufacturing the pipe shall be as specified in ASTM C-14, with the following exception:

Cement shall conform to ASTM C-150, Type II, low alkali. Samples and testing shall conform to the methods designated therein. The pipe manufacturer shall supply a cement mill certificate, in triplicate, for each load of cement delivered, showing the specification, type, chemical analysis, and quantity. On stockpiled pipe in lieu of the above, the manufacturer shall certify that the type of cement used meets this specification. Satisfactory facilities shall be provided for identifying, inspecting, and sampling cement at the mill, the warehouse, and the site of the work. The Contracting

Agency shall have the right to inspect the cement and obtain samples for testing at any of these points. The cement shall be stored in a weathertight, dry, well ventilated structure approved by the Engineer. Cement salvaged by cleaning cement sacks, mechanically or otherwise, shall not be used in the work. Cement containing lumps will be rejected and shall immediately be removed from the site of the work. If the temperature of the cement exceeds 150°F., it shall be stored until cooled to that temperature.

736.3 PIPE JOINTS:

The joints may be tongue and groove mortared joints, or similar to R-4 or modified R-4 Bureau of Reclamation Through-Bell type joints using O-ring rubber gaskets. With rubber gasket joints, inside mortaring and outside grouting is not required. Tongue and groove joints shall be mortared inside and grouted outside. Grouting of outside joints shall be by the diapering method.

736.3.1 Cement Mortar Joints:

(A) The mortar or grout shall consist of 1 part portland cement and 2 parts sand, by volume. The quantity of water in the mixture shall be sufficient to produce a soft workable mortar, but shall in no case exceed a water-cement weight ratio of 0.53. Where outside joints are made by the diaper method, the grout shall be composed of 1 part cement to 3 parts sand, and shall be mixed to the consistency of thick cream. The sand shall conform to Section 701, and the cement shall conform to Section 725.

(B) The pipe ends shall be thoroughly cleaned and wetted with water before the mortar or grout is placed. No backfilling around the joints shall be done until the joints have been fully inspected and approved.

(C) Mortar joints shall be cured by keeping them wet for 3 days or by using a curing compound.

736.3.2 Rubber Gasket Joints: Rubber gaskets shall comply with Section 765.

736.4 CURVES, BENDS AND CLOSURES:

Horizontal and vertical long-radius curves shall be formed by slight deflection at the joints, provided that the maximum joint opening caused by such deflection shall not exceed ¾ inch. Short radius curves shall be formed by straight pipe in which the joints are beveled. The bevel of the pipe shall not exceed 5 degrees, and the total angular deflection for beveled pipe shall not exceed 10 degrees at any joint.

736.5 CARE OF PIPE AND MATERIALS:

All pipe and materials shall be manufactured, handled, loaded, shipped and unloaded in such manner as to be undamaged and in sound condition, in the completed work. Particular effort shall be exercised to protect the ends of pipe. Repairs on damaged pipe shall be made to the satisfaction of the Engineer, otherwise they shall not be used in the work and shall be replaced with an equal pipe or special in an acceptable condition. At all times rubber gaskets shall be stored in a cool, dark place until ready for use.

736.6. TESTS:

Before pipe is delivered to the job site for use in any work under the contract, test pipes shall meet the requirements of the hydrostatic pressure test and the loading test

described in ASTM C-14. The test shall be made at the point of manufacture and shall be made under the presence of the Engineer.

SECTION 737

ASBESTOS-CEMENT PIPE AND FITTINGS FOR STORM DRAIN AND SANITARY SEWER

737.1 GENERAL:

This specification covers storm drain and sanitary sewer pipe for conveying storm water and sewage in nonpressure pipe for gravity flow systems. Pipe, couplings and fittings shall conform to:

(A) Storm Drain: ASTM C-633, Type 1.

(B) Sanitary Sewer: ASTM C-428, Type II and lined as specified below.

737.2 CLASSES:

All asbestos-cement storm drain and sanitary sewer pipe shall be designated as either Class 1500, 2400, 3300, 4000, or 5000 based upon the respective crushing strength for which it is designated and tested. Pipe and fittings shall be furnished in the size and class designated on the plans.

737.3 LENGTH OF PIPE:

At least 90 percent of the total footage of any one size and class, excluding short lengths, shall be in standard lengths. The remaining footage may be in random lengths of not less than 7 feet, however, short lengths for making connections to manholes or other structures are permitted as indicated in the following paragraph.

Pipe directly connected to or supported by rigid structures shall not have a length beyond the rigid support provided by the structure in excess of that shown in the following table. Such structures include manholes and foundation walls and cradles. This length limitation need not apply (full length may be used) if a flexible joint is provided at the point of juncture and the pipe from that point on does not rest on the structure.

TABLE 737

Pipe Size	Allowable Length of Pipe
6″	3′-3″
8″-24″	6′-6″
30″-36″	13′-0″

737.4 COUPLINGS:

Couplings shall conform to the same physical requirements as for the class of pipe with which they are to be used. Storm drain couplings may be plastic collars sized to fit the machined end of the pipe and composed of a plastic conforming to ASTM D-1248, Type II, Grade 3.

SECTION 737

737.5 FITTINGS:

Asbestos-cement storm drain and sewer pipe wyes, tees, elbows or other fittings shall conform to the same physical requirements as for the class of pipe with which they are to be used.

737.6 RUBBER RINGS:

Each asbestos-cement coupling shall have 2 joint sealing rings conforming to the requirements of ASTM D-1869. This material specification shall also apply to the rings furnished for use with fittings.

(A) Storm drain pipe shall have synthetic or natural rubber rings, where resistance to oil or solvents is not required.

(B) Sanitary sewer pipe shall have synthetic rubber rings, where resistance to oil or solvents is required.

737.7 INSPECTION AND TESTING:

The uncombined calcium hydroxide in the asbestos-cement pipe, fittings and couplings shall not exceed;

(A) Three percent for storm drains

(B) One percent for sanitary sewers

When tested in accordance with ASTM C-500. Certified copies of all tests shall be submitted to the Engineer for each lot of pipe furnished.

In addition the Contracting Agency may require all inspection and testing to be performed in the United States of America at the manufacturer's plant or at a testing laboratory approved by the Contracting Agency.

737.8 SANITARY SEWER PIPE LINING:

Asbestos-cement pipe and fittings used for sanitary sewers shall be lined with an epoxy resin base of 100 percent solids content (solvent free) with a minimum lining thickness of 32 mils. The lining and its application shall conform in all other respects to ASTM C-541 and NSF Criteria C-7.

SECTION 741

LINING FOR REINFORCED CONCRETE SANITARY SEWER PIPE

741.1 GENERAL:

The interior area of the reinforced concrete pipe as indicated on the plans, shall be sealed and protected with either Type 'A' or Type 'B' lining, as specified below.

The installation and application of the pipe lining shall be accomplished by the supplier of the reinforced concrete pipe.

All work for and in connection with the installation of lining in concrete pipe and the field sealing of joints shall be done in strict conformance with all applicable published specifications, instructions and recommendations of the approved lining manufacturer. The pipe supplier shall furnish all labor, material and equipment to successfully accomplish the lining.

741.2 TYPE 'A' LINER:

741.2.1 Material Composition: The material shall be a liner plate which is a combination of inert, synthetic resins, pigments, and plasticizers, compounded to make permanently flexible sheets.

The liner plate shall be resistant to the following: Oxidizing agents, sulfuric, phosphoric, nitric, chromic, oleic, and stearic acids; sodium and calcium hydroxides; ammonia, sodium, calcium, magnesium, and ferric chlorides; ferric sulfate, petroleum oils and greases; vegetable and animal oils, fats, greases and soaps.

Liner plate shall be impermeable to sewage gases and liquids and shall be nonconducive to bacterial or fungus growth. All liner plates shall be factory checked electrically to insure freedom from any porosity with a high voltage holiday detector set at a minimum of 20,000 volts.

Joint strips and welding strips shall have the same composition and corrosion resistance as liner plate, but shall not have locking extensions.

The lining shall have good impact resistance, shall be flexible and shall have an elongation sufficient to bridge up to 1/4 inch settling crack which may take place in the pipe or in the joint after installation, without damage to the lining.

Once cast into the pipe, the lining shall be permanently and physically attached to the concrete by a locking extension and shall not rely on an adhesive bond.

741.2.2 Material Details and Dimensions: The liner plate shall not be less than 0.065 inches in thickness. Locking extension shall be of the same material as the liner and shall be integrally extruded with the sheets. If steel bands are used to secure the liner plate to the forms transversely, strap channels shall be integrally molded into the sheet.

Liner plate shall be supplied as pipe size sheets fabricated by shop welding together the basic size sheets.

Joint straps shall be 4 inches $\pm$ 0.25 inches in width and shall have each edge beveled prior to application.

Welding strips shall be 1 inch $\pm$ 0.125 inch in width and shall have the edges beveled at time of manufacture.

The Contractor shall submit a shop drawing showing liner plate details for approval by the Engineer, prior to fabrication of the pipe.

741.2.3 Installation of Liner Plate: The installation of liner plate, including the welding of all joints, shall be done in accordance with the manufacturer's recommendations. Nailing through the plate will not be tolerated. Liner plate shall be installed with locking extensions parallel with the longitudinal axis of the sewer, unless otherwise shown on the plans. All joints between individual sheets or sections of liner plates shall be continuously heat-welded by the use of welding strips of the same kind and equivalent thickness of material as the liner plates (with the exception of the integral extension ribs).

Liner plate shall be held snugly in place against inner forms by means of light gage steel wire, light steel banding straps or other suitable means. If steel banding straps are used, they shall be applied in strap channels provided for this purpose.

Locking extensions (T-shaped) shall be integrally extruded to all lower, terminal or longitudinal edges of liner plate as applied to concrete pipe. If banding straps are used, a steel rod 1/4-inch in diameter may be inserted in each locking extension

along the longitudinal edges of each sheet of liner plate for concrete pipe or some other approved method for holding the lower edge of the liner plate snugly against the form shall be provided.

Concrete poured against liner plate shall be compacted in a careful manner so as to protect the liner plate and to produce a dense, homogeneous concrete securely anchoring the lock extensions into the concrete.

In removing forms, care shall be taken to protect liner plate from damage. Sharp instruments shall not be used to pry forms from lined surfaces. All holes and cut, torn or seriously abraded areas in the liner plate shall be patched. Patches made entirely with welding strip shall be fused to the liner plate over the entire patch. Larger patches may consist of smooth liner plate applied over the damaged area with adhesive. All edges must be covered with welding strip fused to the patch and the sound liner plate adjoining the damaged area.

The Contractor shall take all necessary measures to prevent damage to installed liner plate from equipment and materials used in or taken through the work.

The applied lining shall be free from bubbles due to poor workmanship, and the Contractor shall cut out said bubbles and weld a similar sheet in place of the bubble, unless otherwise directed by the Engineer.

Application on Concrete Pipe-Special Requirements: Liner plate shall be set flush with the inner edge of the bell or groove end of a pipe section and shall extend to the spigot or tongue end or to approximately 3-inches beyond the tongue end, depending upon the type of liner plate to be made with the adjoining concrete pipe.

Wherever concrete pipe, which are protected with liner plate, join structures not so lined, such as brick structures, concrete pipe, cast-in-place structures or clay pipe, the liner plate shall be extended over and around the end of the pipe and back into the structure for not less than 4-inches.

Where a pipe spur, not of plastic lined concrete, is installed through lined concrete pipe, the liner plate shall be returned 4-inches at the surfaces of contact. The seal between the liner plate and the spur shall be made using an approved adhesive material and strapped in place.

If the joint space is too wide or the joint space surface too rough to allow satisfactory sealing with this adhesive, the joint space shall be filled with 2 inches of densely caulked lead wool or other approved caulking material.

Lined concrete pipe may be cured by standard curing methods. Care shall be exercised, in handling, transporting and placing lined pipe to prevent damage to the liner plate. No interior hooks or slings shall be used in lifting pipe. All handling operations shall be done with an exterior sling or with a suitable fork lift.

No pipe with damaged lining will be accepted until and unless the damage has been repaired to the satisfaction of the Engineer.

741.2.4 Field Joints: The Contractor shall obtain the services of qualified personnel to weld the liner plate field joints. Pipe joints must be dry before the liner plate joints are made. All mortar and other foreign material shall be removed from liner plate surfaces adjacent to the pipe joint, leaving them clean and dry.

No liner plate joints shall be made until the trench has been backfilled.

Field joints in the liner plate at pipe joints may be either of the following described types:

Type P-1 — The joint shall be made with a separate 4-inch joint strip and 2 welding strips. The 4-inch strip shall be centered over the joint, secured to the liner plate with an approved adhesive, or other approved means, and welded along each edge to adjacent liner plate with a 1-inch weld strip. The width of the space between adjacent liner plate sheets shall not exceed 2-inches. The 4-inch joint strip shall lap over each liner plate a maximum of 1 inch.

Type P-2 — The joint shall be made with a plastic strip, without locking extensions integrally extruded with the liner plate and extending approximately 3-inches beyond the spigot end. A 1-inch welding strip is required. The joint strip shall overlay the liner plate a minimum of 1-inch on the downstream side of the pipe joint. An approved adhesive, or other approved means, shall be used to hold the lap in place during the welding. The joint strip on beveled pipe shall be trimmed to a width, measured from the end of the spigot, of approximately 3-inches for the entire circumferential length of the liner. Distortion in bending back the strip to expose the pipe joint during the laying and joint mortaring shall be avoided. All welding of joints is to be in strict conformance with liner plate manufacturer's specifications.

Type P-4 — The joint shall be made with a 4-inch weld strip. The 4-inch weld strip shall be centered over the joint and welded in place to the lining in adjacent joints of pipe. The weld strip shall lap over each liner plate a minimum of 1 inch.

741.2.5 Testing and Repairing Damaged Liner Surfaces: After the pipe is installed in the trench, all surfaces covered with liner plate shall be tested with an approved electrical holiday or flaw detector set at a minimum of 20,000 volts. All welds shall be physically tested by a non-destructive probing method. All patches over nail and form tie holes, or repairs to the liner plate wherever damage has occurred, shall be done in conformance with the instructions and recommendations of the liner plate manufacturer.

Each transverse welding strip which extends to a lower edge of the liner plate shall be tested. The welding strips shall extend below the liner plate, providing a tab. A 10-pound pull will be applied normal to the face of the pipe by means of a spring balance. Liner plate adjoining the welding strip will be held against the concrete during application of the force. The 10-pound pull will be maintained if a weld failure develops, until no further separation occurs. Defective welds will be re-tested after repairs have been made. Tabs shall be trimmed away neatly after the weld strip has passed inspection. The Contractor shall provide all equipment required to test liner plate in the manner recommended by the manufacturer and as described above. The Contractor shall also provide personnel qualified to perform the testing. Testing shall be performed in the presence of a representative of the Contracting Agency.

SECTION 743

VITRIFIED CLAY PIPE

743.1 GENERAL:

Vitrified clay pipe shall be extra strength in accordance with the requirements set forth in ASTM C-700, except as modified herein.

743.2 MANUFACTURING REQUIREMENTS:

743.2.1 Shape: Pipe ends shall be square with the longitudinal axis, and sockets shall be true, circular, and concentric with the barrel of the pipe.

The ends of the pipe shall be so formed that when the pipes are laid together and the joints made, they shall constitute a continuous and uniform line of pipe and shall have a smooth and regular interior surface.

743.2.2 Stoppers, Branches, Ends: Stoppers shall be used with all branch pipes that are to be left unconnected. Stoppers for branch pipes having flexible compression joints may be either clay discs with flexible compression joints, factory applied, that will mate with the branch joint; or, a resilient material of controlled design and dimensions for mating with the branch pipe to which it is to be applied; or, of other material approved by the Engineer. Wooden stoppers will not be accepted.

Branches shall be furnished with connections of the sizes specified, securely and completely fastened to the barrel of the pipe in the process of manufacture.

"T" branches shall have their axis perpendicular to the longitudinal axis of the pipe. "Y" branches shall have their axis 45 degrees (unless otherwise specified) from the longitudinal axis of the pipe, measured from the socket end.

All branches shall terminate in sockets. Barrel of the branch shall be of sufficient length to permit making proper joint when the connecting pipe is inserted in the branch socket.

743.2.3 Imperfections: The following additional imperfections in a pipe or fittings will be considered injurious and cause for rejection:

(A) Any surface fire crack in the ends of the spigot or bell which exceeds 1 inch in length.

(B) Any piece broken from the bell end of the pipe or fittings when it adversely affects the performance of the joint or connection.

743.2.4 Certification: A certificate from the manufacturer shall be furnished attesting that the pipe meets the requirements of this specification, including test reports for the hydrostatic pressure test and the loading test hereinafter specified.

743.3 TESTS:

In addition to the required tests at the manufacturer's plant, the Engineer's representative may select specimens at random at the point of delivery or at the job site. Tests on these specimens shall be performed at a local testing facility under the supervision of the Engineer's representative. The cost of such supervision will be borne by the Contracting Agency and all other costs shall be borne by the Contractor.

The hydrostatic pressure test shall precede the loading test by not more than 3 hours.

When the pipe is subjected to an internal hydrostatic pressure of 10 psi for the time shown in the following table, the accumulated moisture on the exterior surface shall not run down the sides in such quantity that will exceed 10 milliliters.

TABLE 743-1	
TABLE OF TESTING TIME FOR PIPES	
Thickness of Wall Inches	**Test Time Minutes**
Up to and including 1	7
Over 1 and including 1½	9
Over 1½ and including 2	12
Over 2 and including 2½	15
Over 2½ and including 3	18
Over 3	21

The loading test shall conform in manner to that specified in ASTM C-301 for 3-edge bearing and shall be applied to all specimens selected for testing. Pipe shall withstand the following loads:

TABLE 743-2	
MINIMUM TEST LOADS	
Nominal Size (inches)	Load (lb. per linear ft.)
4	2000
6	2000
8	2200
10	2400
12	2600
15	3100
18	3600
21	4200
24	4800
27	5200
30	5500
33	5800
36	6300
39	6600
42	7000

743.4 IDENTIFICATION MARKS:

Pipe and fittings shall be clearly marked with the name or trademark of the manufacturer, a code number identifying production control and plant location, and extra strength designation.

743.5 JOINTS:

Acceptable joints shall be flexible compression type for bell and spigot pipe or flexible compression couplings for plain-end pipe.

Compression joints and compression couplings shall conform to the requirements of A.S.T.M. C-425.

SECTION 744

ABS TRUSS PIPE AND FITTINGS

744.1 GENERAL

Truss pipe is defined as an internally-braced double-walled ABS composite pipe conforming to ASTM D-2680. When noted on the plans or in the special provisions, gravity sanitary sewer system may be constructed using truss pipe for diameters not exceeding 15 inches.

Truss pipe shall have both ends of each pipe length sealed at the factory such that the inert filler material between the two concentric thermoplastic tubes is impervious. All field cuts shall be sealed according to the manufacturer's recommendations.

744.2 COUPLINGS AND FITTINGS:

Fittings for truss pipe may include couplings, wyes, tees, elbows, caps, plugs adapters, manhole water stops and clamps. All couplings and fittings shall be assembled by a chemically welded method. Solvent shall be of the type recommended by the pipe manufacturer. Each solvent weld type coupling or fitting shall be accurately formed and entirely compatible in joining the pipe to assure a leak-proof joint. Couplings and fittings shall be manufactured from the same material as the pipe except that caps, plugs and adapters may be fabricated or molded from rubber, polyurethane or other suitable compounds. The couplings and fittings shall have chemical and physical properties equal or superior to the pipe itself.

744.3 SOLID WALL PIPE AND FITTINGS:

744.3.1 General: When noted on the plans or in the special provisions, Sewer and Drain Solid Wall Pipe and Fittings may be used for 4-inch and 6-inch service lines, risers and fittings.

744.3.2 Material: Sewer and Drain Solid Wall Pipe shall be manufactured of virgin ABS compound as specified in ASTM D-1788, Types I and IV, excepting that the minimum heat deflection temperature (ASTM D-648) shall be 180°F.

744.3.3 Strength: Test samples of pipe, 6 inches long, shall be cut from full length sections and tested by the method outlined in ASTM D-2412. The pipe shall be deflected at least 35 percent without failure and the stiffness at 5 percent deflection shall equal or exceed the value listed in Table I below after the test samples have been immersed in a 5 percent solution by weight of sulfuric acid and n-Heptain for a period of 24 hours prior to testing. Failure is defined as rupture of the pipe wall.

Stiffness factor may be computed by the method outlined in ASTM D-2412 or by dividing the load in lbs/linear inch by the deflection in inches and 5 percent deflection (F/ΔY in Table 1).

TABLE 1

Minimum Stiffness Requirements

Nominal Size	F/ΔY 2.5% min.
4"	55 lb./in.^{2}
6"	55 lb./in.^{2}

744.3.4 Couplings and Fittings: All couplings and fittings shall be assembled by a chemically welded method. Each solvent weld type coupling or fitting shall be accurately formed and entirely compactible with the Sewer and Drain Solid Wall Pipe to assure a leak proof joint. Couplings and Fittings shall be maufactured from the same material as the pipe except that caps, plugs and adapters may be fabricated or molded from rubber, polyurethane or other suitable compounds. The couplings and fittings shall have chemical and physical properties equal or superior to the pipe itself.

744.4 MANHOLE CONNECTIONS:

A clamp gasket or approved equivalent method shall be provided at manhole entry or connection to reduce infiltration and exfiltration. Where precast manholes are used,

entrance holes must be large enough to allow for proper grouting around the manhole gasket.

744.5 CERTIFICATION:

A certificate from the manufacturer shall be furnished attesting that the pipe meets the requirements of ASTM D-2680.

744.6 IMPERFECTIONS:

Any imperfections which in the opinion of the Engineer may adversely affect the performance of the pipe or joints shall be cause for rejection.

744.7 INSTALLATION AND TESTING:

Truss pipe shall be installed in accordance with applicable provisions of Section 615. In addition to the tests prescribed in Section 615, the Engineer may, at his option, require a deflection test on all or any part of the line. Any pipe which shows deflection in excess of 5% shall be removed and replaced at no cost to the Contracting Agency.

SECTION 745

PVC SEWER PIPE AND FITTINGS

745.1 GENERAL:

This specification covers the requirements of polyvinyl chloride (PVC) plastic sewer pipe and fittings for gravity flow sewers and building connections. When noted on the plans or in the special provisions, gravity sanitary sewers may be constructed using PVC pipe for diameters not exceeding 15 inches. Pipe, fittings, couplings and joints shall be in conformance with the requirements of ASTM D-3034, SDR-35, except as modified herein.

745.2 MATERIALS:

745.2.1 Caps and Plugs: Caps and plugs for building connections may be molded or fabricated from rubber, polyurethane or other suitable compound.

745.2.2 Gaskets: Rubber gaskets shall be manufactured from a synthetic elastomer and shall comply in all respects with the physical requirements specified in ASTM F-477.

745.2.3 Lubricant: The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe.

745.4 JOINING SYSTEMS:

Joints for the piping system and fittings shall consist of an integral bell gasketed joint designed so that when assembled, the elastomeric gasket located within the bell is compressed radially on the pipe or fitting spigot to form a positive seal. The joint shall be designed so to prevent displacement of the gasket from the joint during assembly and when in service.

All pipe shall have a home mark on the spigot end to indicate proper penetration when the joint is made.

The bell and spigot configurations for the fittings shall be compatible to those used for the pipe.

Joints shall provide a permanent seal against exfiltration and infiltration. All surfaces of the joint upon which the gasket may bear shall be smooth and free of any imperfections which could adversely affect sealability.

The assembly of the joints shall be in accordance with the pipe manufacturer's recommendations.

745.5 FITTINGS:

Fittings for PVC pipe may include elbows, wyes, tee wyes, double bell couplings, manhole couplings, manhole adapter rings, plugs, caps, adapters and increasers.

Manhole couplings shall be manufactured from asbestos cement and incorporate an elastomeric gasket moisture barrier.

745.5.1 Manhole Connections: A manhole adapter gasket or approved equivalent method shall be provided at manhole entry or connection to prevent infiltration and exfiltration. Where precast manholes are used, entrance holes shall be large enough to allow for proper grouting around the manhole ring.

745.6 CERTIFICATION:

A certificate from the manufacturer shall be furnished certifying that the pipe and fittings meet the requirements of ASTM D-3034, SDR-35, $F/\Delta y = 46$ psi at 5% deflection.

745.7 IMPERFECTIONS:

Any imperfections which in the opinion of the Engineer may adversely affect the performance of the pipe or joints shall be cause for rejection.

745.8 INSTALLATION AND TESTING:

PVC pipe and fitting installation shall be in accordance with the applicable provisions of Sections 601 and 615. In addition to the tests prescribed in Section 615, the Engineer may, at his option, require a deflection test on all or any part of the system. Prior to acceptance by the Agency any part which shows deflection in excess of 5% of the actual inside diameter shall be corrected at no cost to the Agency having jurisdiction.

If the Contracting Agency after acceptance but prior to the termination of the warranty period determines that the long term deflection has exceeded 7½% of the actual inside diameter, that portion of the installation shall be corrected at no cost to the agency.

SECTION 750

IRON WATER PIPE AND FITTINGS

750.1 CAST IRON WATER PIPE:

All cast iron water pipe shall be designed in accordance with AWWA C-101.

Cast iron water pipe may be designed for either 18/40 or 21/45 physicals and shall conform to AWWA C-106 or AWWA C-108.

Except as otherwise provided cast iron or water pipe shall be designed to meet internal pressure of 150 psi, external cover of 5 feet, and standard Laying Condition B.

Cast iron pipe shall be nominal 18 foot lengths.

750.2 DUCTILE IRON WATER PIPE:

All ductile iron water pipe shall be designed in accordance with AWWA C-150 and shall be manufactured in accordance with AWWA C-151. The class shall be as designated in the plans or special provisions.

750.3 JOINT REQUIREMENTS:

Push-on joints for cast iron or ductile iron water pipe shall conform to AWWA C-111 and shall include synthetic rubber gaskets and lubricant.

Mechanical joints for cast iron or ductile iron water pipe shall conform to AWWA C-111 and shall include cast iron glands, synthetic rubber gaskets, and T-head bolts and nuts.

Flanged joints for cast iron or ductile iron water pipe shall be as detailed on the plans or as designated in the special provisions.

750.4 FITTINGS:

Iron fittings shall be either Gray-Iron or Ductile-Iron conforming to AWWA C-110 with a minimum pressure rating of 250 psi. Flanged ends shall conform to AWWA C-110. Push-on and mechanical joint ends shall conform to AWWA C-111.

Fittings shall be cement mortar lined and coal-tar coated in accordance with AWWA C-104.

SECTION 752

ASBESTOS-CEMENT WATER PIPE AND FITTINGS

752.1 GENERAL:

These specifications cover asbestos-cement pressure pipe intended for use in supply lines and distribution systems that carry water under pressure.

752.2 CLASSES:

Asbestos-cement pipe shall be manufactured and tested in accordance with AWWA C-400, except as modified herein, for pipe intended for use in water service at maximum operating pressures of 100, 150, or 200 psi. Pipe shall be designated as Classes 100, 150, or 200 respectively, for the corresponding maximum operating pressures. Unless shown otherwise on the plans or specified in the special provisions the minimum acceptable shall be Class 150.

752.3 MANUFACTURE:

The joining ends of the pipe shall be of such design that they may be properly connected to cast iron fittings and valves which are manufactured within the continental United States that meet applicable AWWA specifications. Pipe in sizes less than 6 inches in diameter may be supplied in either 10 foot or 13 foot lengths, and pipe iu sizes 6 inches or greater in diameter shall be supplied

in 13 foot lengths, except for random and special short lengths in all sizes as permitted in AWWA C-400.

752.4 INSPECTING AND TESTING:

The uncombined calcium hydroxide in the pipe and couplings shall not exceed 1 percent when tested in accordance with AWWA C-400. Certification of all manufacturer's tests in accordance with AWWA C-400 shall be required. In addition, the Contracting Agency may require all inspection and testing to be performed at the manufacturer's plant or at an approved testing laboratory.

All pipe manufactured outside the United States of America will be subject to inspection and testing by the Contracting Agency at the plant site or at an approved testing laboratory. In addition, all pipe shall have the Underwriters Laboratory, Inc. seal of approval and certification that all tests were in accordance with AWWA C-400.

752.5 FITTINGS:

Fittings shall be cast iron and conform to AWWA C-110 for 250 psi working pressure rating cast on fittings. All fittings shall have Ring-Tite, Fluid-Tite, or Weld-Tite bells to fit the class of pipe specified. All fittings shall be cement lined in acordance with AWWA C-104.

752.6 RUBBER RINGS:

Each coupling shall have 2 synthetic rubber joint sealing rings conforming to the requirements of ASTMD-1869. This paragraph shall also apply to the rings furnished for use with fittings. Neoprene shall not be used.

SECTION 753

GALVANIZED PIPE AND FITTINGS

753.1 GENERAL:

All galvanized pipe shall be new galvanized welded or seamless steel pipe, conforming to the requirements of ASTM A-120 standard weight, schedule 40.

753.2 CORROSION PROTECTION:

All buried galvanized pipe and fittings shall be protected from corrosion by the application of a tight fitting, extruded or wrapped coating. Coating shall be not less than 0.030 inches in thickness at any point. Extruded coatings shall be of polyethylene or polyvinyl chloride. Extrucoat or equal. Wrapped coatings shall be of polyethylene, polyvinyl chloride, coal tar or asphalt tape. Protecto Wrap No. 200, Safe-t-Clad FOS No. 655, Tapecoat, Trantex VID-10 or E-12, Polyken No. 900, Scotchrap No. 50 or approved equal Tape shall be edge lapped no less than ¼ inch.

753.3 FITTINGS:

All fittings for screwed galvanized pipes shall be 150 psi, banded, galvanized malleable iron screwed fittings.

753.4 VALVES:

Valves on galvanized pipelines shall be all bronze, double disc, nonrising stem with wheel handle on top, such as Jones, J373 or equal, with bodies, bonnets, yokes and wedges made of material conforming to ASTM B-62.

SECTION 754

COPPER PIPE, TUBING AND FITTINGS

754.1 PIPE AND TUBING:

All copper pipe and tubing shall be new seamless copper pipes and tubes, designed for underground water services, plumbing purposes, etc. They shall conform to all the requirements of ASTM B-88, Type K.

All pipe or tubing shall be made of copper free from cuprous oxide, as determined by microscopic examination at a magnification of 75 diameters.

Type K tubing, when furnished in coils, shall be annealed after coiling.

754.2 FITTINGS:

All fittings used in connection with copper pipe or tubing, shall be copper or bronze fittings as manufactured by Jones, Mueller, or approved equal, as shown on standard details.

SECTION 755

POLYETHYLENE PIPE FOR WATER DISTRIBUTION

755.1 GENERAL:

This specification is intended to describe water service pipe with a hydrostatic design stress of 630 psi for water at 73.4°F. produced from a high density ultrahigh molecular weight polyethylene pipe compound. Polyethylene pipe used for water distribution shall conform to all the requirements of ASTM D-2239 and with the additional provisions listed herein. This specification describes pipe of the nominal I.D. and O.D. size as manufactured by Carlon, Celanese, Orangeburg, Phillips 66 Drisco pipe and Triangle Aycee and shall provide a water pressure tight joint when used with compression type fittings furnished by Hays, Haystite, Ford Meter Box, Ford Pack Joint, or approved equal.

Pipe may be rejected for failure to comply with any requirements of these specifications.

755.2 MATERIAL:

The polyethylene extrusion compound from which the pipe is extruded shall meet the requirements of Type III, Grade 34, Class C, material as described in ASTM D-1248, except that the melt index shall be determined under a higher temperature than ASTM D-1238. The test condition shall be as specified below under tests of pipe.

The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions or other defects. The pipe shall be uniform in color, opacity, density, and other physical properties.

755.3 PIPE DIMENSION AND TOLERANCES:

The average inside diameters, wall thickness, and respective tolerances shall be, for any cross section, as shown in ASTM D-2239, when measured in accordance with ASTM D-2122.

The standard thermoplastic pipe dimension ratio (SDR), the ratio of the pipe diameter to wall thickness, shall not exceed 7 for 160 psi design pressure.

755.4 MINIMUM BURST PRESSURE:

The minimum burst pressure for pipe made from Type III, Grade 34, Class C, polyethylene compound, Designation Code: PE-3406, when determined with at least 5 specimens shall be at least equal to 630 psi for water at 73.4°F. Pressures shall be determined in accordance with ASTM D-1599.

755.5 SUSTAINED PRESSURE:

In addition to passing the sustained pressures given in ASTM D-2239 for a temperature of 100°F. and 73.4°F. the pipe shall withstand, without failing, ballooning, bursting or weeping for a period of at least 300 hours, at 194 ±2°F., 113 psi test pressure for ¾ inch pipe and 112 psi for 1 inch pipe. These test pressures have been calculated on a basis of a 450 psi fiber stress. The test procedure outlined in ASTM D-1598, shall be followed.

755.6 TESTS OF PIPE:

The pipe must be able to meet all tests that are specified in ASTM D-2239, and the following test for melt index, as determined in ASTM D-1238. Pellets of the original resin, placed into the testing device shall have flow rates as follows:

(A) Less than 0.5 grams per 10 minutes at 310°C with a plunger load of 27.5 pounds for pipe or tubing extruded by the Allied Chemical Process.

(B) Less than 3 grams per 10 minutes at 190°C with a plunger load of 47.65 pounds for pipe and tubing extruded by the Phillips Extrusion Process.

755.7 CERTIFICATION BY MANUFACTURER:

Each contractor must be able to furnish a certification from the manufacturer of the pipe that the polyethylene plastic pipe is of uniform quality and will fully comply with these specifications, and that the pipe is manufactured of virgin polyethylene, that no scrap material has been used, and that it is satisfactory for potable water, in accordance with the specifications of the National Sanitation Foundation Testing Laboratories, Inc.

The pipe manufacturer shall further supply a copy of certification from the manufacturer of the polyethylene extrusion compound used to make the pipe that the compound fully complies with these specifications.

The manufacturer must have adequate equipment and quality control facilities to be sure that each extrusion of pipe is uniform in texture, dimension and strength, and have so manufactured this class of pipe in sufficient quantities to be certain that it will meet all normal field conditions of usage.

755.8 PIPE IDENTIFICATION:

The pipe shall be permanently marked indicating size and pressure-temperature rating. The appropriate lettering shall occur on the pipe at least once in every 24 inches. The seal of approval or marking of the testing laboratory shall be included in the marking on all pipe that is intended for transporting potable water.

SECTION 755

P E PIPE MARKINGS

REQUIRED MARKINGS, EXAMPLE

Size	—	Pressure	—	Temp Rating	—	Test Lab. Seal
¾''		160 psi		PE 3406		NSF

OTHER MARKINGS (Not required by Spec. to be marked)
(However pipe must comply)

SDR-7 (Shall not exceed 7)

CS-255-63 (This is a commercial standard designation of the U.S. National Bureau of Standard. Any other number (CS — — —) is wrong)

NOTE: ¾" Pipe has I.D. 0.824", O.D. 1.060" and 3.328" circumference.
¾" Tubing is not acceptable and has I.D. 0.681", O.D. 0.875", 2.747" circumference and an SDR-9 if shown.

SECTION 756

FIRE HYDRANTS

756.1 GENERAL:

Fire Hydrants furnished by the Contractor shall comply with AWWA C-502, supplemented as follows:

756.2 DRAWINGS:

Detail drawings or blue prints showing all components, principal dimensions, construction details and materials used shall be submitted to the Contracting Agency for approval. The Contracting Agency reserves the right to consider the quality, appearance and past performance of fire hydrants when reviewing drawings for approval.

756.3 HYDRANTS:

Fire hydrants shall be dry barrel similar or equal to the Corey or Mueller Improved Type. The inside diameter of the barrel shall be a minimum of 7 inches and the diameter of the main valve seat opening shall be not less than 5 inches. The entire valve assembly shall be effectively sealed against moisture. The net watering area of the barrel and foot piece at the smallest part, exclusive of the main valve opening, shall be not less than 190 percent of the net opening of the main valve. Style of inlet connections shall be bell or mechanical joint with accessories, gland, bolts, gaskets and having a 6 inch diameter inlet connection. Facing of the main valve against seats shall be synthetic rubber or balata. The top of the stem or bonnet shall be equipped with the O-ring seal. Hydrants shall be constructed so that extension sections in multiples of 6 inches, with rod and coupling, can be added to increase barrel length. The hose and steamer nozzle connections shall match the standard size and threads per inch of the Contracting Agency. Operating and outlet nozzle cap nuts shall be of solid pentagonal shape. The pentagon shall measure fifteen-sixteenths to thirty-one thirty-seconds inch on side, 1½ inch from point to flat. All barrels above ground shall have a prime coat and painted with two coats of chrome yellow paint. Hydrants shall

be constructed so that the standpipe can be rotated to at least 8 different positions and the center of the lowest nozzle shall have a ground clearance of not less than 15 inches.

756.4 MANUFACTURER:

The manufacturer shall guarantee that the hydrant is so constructed that the valve stem will not be bent when hydrant is damaged or broken at or near the grade level. A safety breaking flange or thimble, shall be provided. The friction loss must be guaranteed, by the manufacturer, to satisfy Table 756-1.

TABLE 756-1

MAXIMUM PERMISSIBLE LOSS OF HEAD FOR HYDRANTS

No. of Outlet Nozzles	Nom. Diam. of Outlet	Total Flow From Outlet Nozzles GPM	Max. Permissible Head Loss PSI
2	2½"	500	2.0
1	4"	600	2.5

SECTION 757

SPRINKLER IRRIGATION SYSTEM

757.1 GENERAL:

All materials and fittings shall be new, of the manufacturer's most current design, and shall bear the appropriate National Association seal of approval for example, NSF, UL, etc. Similar units shall be procured from the same manufacturer and internal parts shall be common and interchangeable. Parts listing and source of supply for replacement parts will be furnished to the Engineer.

757.2 PIPE AND FITTINGS:

The type of pipe material and fittings shall be as designated on the plans or in the special provisions. The type utilized shall comply with one of the following:

757.2.1 Steel Pipe: All steel pipe shall be newly galvanized, standard weight, Schedule 40 conforming with Section 753.

757.2.2 Plastic Pipe: Plastic pipe shall be rigid, unplasticized polyvinyl chloride, PVC 1120 or 1220, with an SDR of 26 or less, complying with ASTM D-1785. Schedule 40 or 315 psi pipe shall be used for the continuously pressurized run on the supplyside of Control Valves. PVC 1120 to 1220, SDR 26, pressure rated at not less than 125 psi shall be used on the discharge side of all control valves.

757.2.3 Pipe Fittings and Couplings:

(A) Steel Pipe Fittings and Couplings — Steel pipe fittings and couplings shall be galvanized, malleable iron, screwed fittings or couplings, conforming with Section 753.

(B) Plastic Pipe Fittings and Couplings — Plastic pipe fittings and couplings shall be either threaded type or slip fitting tapered socket solvent weld type. Schedule 80 pipe only will be used for threaded joints. Tapered solvent weld fittings may be either Schedule 80 or Schedule 40, but in any case, will be equal to or greater than the Schedule and Pressure Rating of the plastic pipe being joined. Tapered fittings shall be sized so that a dry, unsoftened taper cannot be inserted more than halfway into the socket. Plastic saddles and flange fittings are not permitted.

(C) Copper Pipe Fittings and Couplings — Copper pipe fittings and couplings shall conform with Section 754.

757.2.4 Solvent Cement: The solvent cement shall be a solution of Type 1, Grade 1, unplasticized, polyvinyl chloride molding or extrusion compound as specified in ASTM D-1784, or an equivalent PVC resin. The cement shall be free flowing and shall not contain lumps, microscopic undissolved particles or any foreign matter that will adversely affect the ultimate joint strength. It shall show no stratification or separation that cannot be removed by stirring. Container labeling shall be in accordance with ASTM D-2564.

757.3 VALVES AND VALVE BOXES:

757.3.1 General: Valves shall be of the size, type, and capacity designated on the plans or in the special provisions and shall comply with the requirements specified herein.

All valves except garden valves shall be capable of satisfactory performance at a working pressure of 200 psi. Valves shall be designed to permit disassembly to replace sealing components without removal of the valve body from the pipeline.

757.3.2 Gate Valves: Gate valves in size two inches and smaller shall be all bronze double disc wedge type with integral taper seats and non-rising stem. Sizes two and one-half inches and larger shall be iron body, brass trimmed, with the other features the same as for the two inch. Section 753 applies.

757.3.3 Manual Control Valves: Manual control valves shall be brass or bronze, and shall be straight or angle pattern glove valves, full opening, key operated with replaceable compression disc and ground joint union on the discharge end.

757.3.4 Electrical Remote Control Valves: Remote control valves shall be electrically operated, designed for a 24 volt, 60 cycle system. They shall be brass or bronze with accurately machined valve seat surfaces, equipped for flow control adjustment, and with the capability for manual operation. They shall be readily disassembled for repair and the internal parts shall be easily accessible for service even when installed in the line.

The internal valve shall be a normally closed, diaphragm type with slow opening and closing action as protection against surge pressures. Actuation shall be by an encapsulated type solenoid with the solenoid shunt band, tube, and plunger of stainless steel for corrosion protection. A removable and cleanable strainer shall be provided at the control chamber inlet to prevent debris from entering the solenoid operating section.

757.3.5 Garden Valves: Garden valves shall be brass or bronze except for the handle. They shall have a replaceable compression disc, and shall be ¾ inch straight-nosed, key operated and pressure rated for operation at 150 psi.

757.3.6 Quick-Coupling Valves and Assemblies: Quick-coupling valves shall be brass or bronze with built-in flow control and self-closing valve and supplied in ¾-inch size unless otherwise required. When a quick-coupler assembly is specified, it shall consist of the valve, quick-coupler connection and hose swivel. Keys and hose swivel ells shall be furnished as specified on the plans.

757.3.7 Valve Boxes: Valve boxes with locking covers shall be molded, non-corrosive plastic. Applicable ASTM references: D-638, D-356.

757.4 BACKFLOW PREVENTER ASSEMBLY:

The backflow preventer assembly shall consist of pressure type or reduced pressure type backflow preventer unit and associated components conforming to the governing code requirements and as shown on the plans. It shall be equal in quality and performance to a "Surgical Mechanical Research, Inc. P-711" type.

757.5 SPRINKLER EQUIPMENT:

Sprinkler heads, bubbler heads and spray nozzles shall be of the types and sizes as shown on the plans. All major components shall be brass, bronze, stainless steel, or high impact plastic.

Equipment of one type with similar flow characteristics shall be from the same manufacturer and shall bear the manufacturer's name and identification code in a position where they can be identified after installation.

Fixed head sprinklers shall have a one-piece housing with provisions for interior parts replacement. Pop-up sprinklers shall be designed to rise at least 2 inches during operation. Full or part circle sprinklers shall be interchangeable in the same housing.

Bubbler heads shall be of corrosion-resistant, durable bodies, injection molded out of cycolac, and tapped for ½" I.P.S. threads. The bubbler shall be fully adjustable from 0 to 5 gallons per minute and shall have a minimum discharge of 1.7 gallons per minute under pressure of 15 pounds per square inch and a minimum discharge of 2.4 gallons per minute under pressure of 30 pounds per square inch supplied at the head.

757.6 ELECTRICAL MATERIAL:

All equipment and material shall comply with the requirements of the governing code and shall be listed by Underwriters' Laboratories, Inc.

757.6.1 Conduit: Conduit shall be galvanized steel conforming to Section 753.

757.6.2 Conductors: Service line conductors shall be supplied in the size shown on the plans and shall be THW 600 volts insulation rating conforming to ASTM D-734. Low voltage control conductors shall be Type UF No. 14 AWG copper unless otherwise shown on the plan and shall be UL approved for direct burial installation.

757.6.3 Controller Unit: The control unit shall be fully automatic, with provisions for manual operation, sized to accommodate the number of stations or control valves included in the system and designated on the plans or in the Special Provisions. Outdoor models shall be housed in a vandal-resistant, weatherproof enclosure which has a locking cover.

The unit shall require a standard 117 volt, 60 cycle input and provide a 26.5 volt, 60 cycle output and shall incorporate a 14-day programming capability. The unit shall

have a "Master On-Off" switch which will deactivate the controller but allow the day and hour clocks to continue operation.

In addition, it shall include a resettable circuit breaker for unit protection.

Each station timing dial shall have an "Omit" or "Off" position and incremental dial settings for timing controls up to 30 minutes.

SECTION 760

COATING CORRUGATED METAL PIPE AND ARCHES

760.1 GENERAL:

Corrugated metal pipe, pipe arches, and connectors to be used or furnished under this specification shall be manufactured and inspected in conformance with the requirements of AASHTO M-36, and as hereinafter specified. The size, type, and gage of the pipe to be furnished shall be as shown on the plans or standard details.

760.2 MATERIALS:

Corrugated metal products covered by this specification shall be plain galvanized conforming to the requirements of AASHTO M-36 as modified herein.

The types of bituminous coated pipe shall be as specified by the standard details or special provisions. In addition to the types listed in AASHTO M-190 there will be a Type D.

Type D: Coated and Smooth Lined Pipe — The pipe shall be uniformly coated on the outside as required for Type A pipe. In addition, the pipe shall be paved on the inside for the entire periphery with bituminous material as specified above. The bituminous paving material shall be applied in such a manner that a smooth interior will be formed throughout with all corrugations filled. The pavement shall have a minimum thickness of ⅛ inch above the crest of the corrugations.

760.3 BASE METAL, SPELTER AND FABRICATION:

The nominal pipe diameter shall meet the tolerances of this specification. Elliptical pipe, when specified, shall be shaped after fabrication and coating have been completed.

In lieu of corrugations as specified in AASHTO M-36 corrugations may be 3 inches from center to center, with a depth of not less than 1 inch.

Helically Corrugated Metal Pipe: The pipe shall be fabricated from flat sheets in coils. The base metal, spelter coating, method of sampling, accepted brands of metal, sheet manufacturer's certified analysis and guarantee, workmanship, marking, inspection and rejection, shall meet the requirements of AASHTO M-36. Structures furnished shall be either full circle, or pipe-arch in accordance with Table 4 of AASHTO M-36, or other shape as shown on the plans. The pipe dimensions shall conform to AASHTO M-36 in all respects, except that the corrugations shall be helical instead of annular. The thickness of the galvanized metal shall be in accordance with standard details or as otherwise specified. Pipe with helical corrugations shall have a continuous lock or welded seam extending from end to end of each length of pipe. The seams shall be fabricated in such a manner that they will not affect the shape or nominal diameter of the pipe and so that they will not create an element of weakness in the pipe.

SECTION 760

760.4 COUPLING BANDS:

Watertight joints shall be fabricated for corrugated metal pipe by the use of galvanized couplers or connecting bands, bituminous coated, with each band overlapping by at least 2 inches. Corrugated coupling bands shall be constructed and connected as specified in AASHTO M-36, except as otherwise required herein. Dimple type coupling bands shall be manufactured by Garland Steel Company, American Bridge Company, Republic Steel Company, or shall be of an approved equivalent design and quality conforming to the above requirements. The couplers or bands shall be manufactured of material 2 gages lighter than the gage specified for the pipe material, shall have corrugations or dimples to match the pipe corrugations or may be flat, and shall be fastened with bolts. Dimpled coupling bands shall be 10½ inches wide for diameters 12 through 60 inches, and 17 inches wide for diameters above 60 through 96 inches. The 10½ inch wide bands shall have 2 rows of dimples of not less than 7 dimples per row, and the 17 inch wide bands shall have 4 rows of dimples of not less than 7 dimples per row. The dimple arrangement shall be such that a maximum spread can be attained. The shape of the dimple shall be such that it shall, in general, conform to the standard pipe corrugation. The connecting angles for dimpled coupling bands may be riveted as for standard corrugated coupling bands, or may have slotted angles. The bands shall be attached by means of ½ inch nominal diameter carriage bolts. Two bolts are required for pipes up to 36 inches in diameter, 3 bolts for 36 through 60 inch diameters and 5 bolts for pipes above 60 inches in diameter. Plain flat coupling bands shall have the same width and number of bolts as specified above. Flat coupling bands having a single circumferential corrugation rolled in each edge to match a similar corrugation in the end of each pipe may be 10½ inches wide regardless of pipe diameter and shall be fastened with 2 bolts.

760.5 PERMISSIBLE VARIATIONS IN DIMENSION:

Plain galvanized and Type A pipes: The internal diameter of 12 through 24 inch pipe shall not vary more than ±1.5 percent from the design diameter. The internal diameter of 27 through 108 inch shall not vary more than ±1 percent or ⅜ inch, whichever is greater from the design diameter.

Type D pipe: The design diameter of the metal pipe before paving shall be the diameter shown on the plans plus ¼ inch. The design diameter may vary as above.

SECTION 761

STRUCTURAL PLATE PIPE, ARCHES, AND PIPE ARCHES

761.1 GENERAL:

Structural plate pipe, arches, and pipe arches shall be of the sizes, gages, and dimensions designated on the plans or in the special provision and as specified herein.

761.2 MATERIALS:

Plates, nuts and bolts shall conform to the specifications of AASHTO M-167.

Galvanized surfaces which are damaged shall be repaired in accordance with the provision in Section 771.

Bituminous coating shall conform to the provisions of AASHTO M-190.

Damaged bituminous coatings shall be repaired by the Contractor at his expense by applying bituminous material conforming to AASHTO M-190.

SECTION 761

761.3 IDENTIFICATION:

The gages of structural plates will be identified on the plans in accordance with the following:

Each installation will be designated not only by size, but also by symbol indicating the number and gage of plates required. Thus, (412-18) will be used to designate an installation for 1 plate length composed of 4, 12 gage plates and 1, 8 gage plate, the heaviest to be placed in the invert.

761.4 DISTORTION:

In advance of placing backfill material around circular structural plate pipes, the pipe shall be distorted.

Distortion may be performed either at the fabricating shop or in the field.

If the plates are distorted in the fabricating shop, the plates shall be distorted to provide an increase in the vertical diameter of the pipe, after assembly, of approximately 5 percent for the full length. Plates shall be marked in order to assure that they will be placed in proper position.

If the pipes are distorted in the field the method of distortion shall conform to the details shown on the plans. The vertical diameter shall be increased the approximate percentages listed in the following table, throughout that portion of the pipe between shoulder lines.

Pipes using 1 or 3 gage top and side plates — 1 percent

Pipes using 5 or 7 gage top and side plates — 2 percent

Pipes using 8, 10, or 12 gage top and side plates — 3 percent

Between the shoulder lines and the outer ends of the pipe the distortion may decrease uniformly to zero.

SECTION 765

RUBBER GASKETS FOR CONCRETE PIPE

765.1 GENERAL:

The joints of concrete pipe shall be O-ring rubber gasket joints conforming to ASTM C-361 except the composition and properties of the rubber gaskets shall be as follows:

All rubber gaskets shall be extruded or molded and cured in such a manner as to be dense, homogeneous, and free from porosity and other imperfections. The tolerance for any diameter measured at any cross section shall be ± one-thirty-second inch. All gaskets shall be manufactured from a synthetic rubber compound in which the elastomer is neoprene, exclusively. Said compound shall contain not less than 50 percent by volume of neoprene, shall contain no deleterious substances, and shall conform to the following requirements:

TABLE 765		
RUBBER GASKETS		
Physical Properties	**Value**	**Method of Test**
Tensile strength, Min. psi	2100	ASTM D-412
Elongation at break, Min. %	425	ASTM D-412
Shore durometer hardness, Type A, (1)	50-60	ASTM D-2240
Compression set, Max. % of original deflection, (2)	20	ASTM D-395
Accelerated aging, tensile strength, %, (3)	80	ASTM D-572
Max. increase over original shore durometer value after accelerated aging.	8	ASTM D-2240
Specific gravity	0.95-1.45 $\pm$0.05	ASTM D-297

(1) Pipe manufacturer shall select value suitable to type of joint.

(2) Use Method B, except disc shall be ½ inch long section of rubber gasket stock.

(3) Percent of tensile strength, after aging by the oxygen-pressure chamber (96 hours, 158 $\pm$1.8°F, 300 $\pm$15 psi.), of the tensile strength before aging.

It is the intent of these specifications that the gasket container shall be a preformed rectangular groove so constructed that when 2 pipes are joined together the rubber gasket shall be compressed and for all practical purposes substantially fill and be largely confined within the rectangular groove.

The Contractor shall submit for approval details of the shape and size of the gaskets he proposes to furnish. The Contractor shall also submit certified test results in triplicate showing the physical properties of the materials used in the manufacture of gaskets.

SECTION 770

STRUCTURAL AND RIVET STEEL, RIVETS, BOLTS, PINS, AND ANCHOR BOLTS

770.1 GENERAL:

All steel, unless otherwise designated on the plans or in the special provisions, shall conform to the requirements of ASTM A-36.

Report of Tests: Before fabrication, the Contractor shall furnish to the Engineer a certified mill report in triplicate, for each identifiable melt of steel or iron from which the material is to be fabricated. The report shall include the chemical and physical tests required by the ASTM specifications.

Additional Tests: The Contracting Agency reserves the right to require and to make additional mill and laboratory tests. The number of such additional tests will be

limited as follows, except that in the case of failure of the material to comply with the ASTM requirements, more tests will be made:

Structural steel, 1 complete test for each heat or each 10 tons of identifiable stock. Rivets, 1 complete test for each size. Bolts, 1 complete test for each lot.

Identifiable stock is material for which authentic records of the chemical and physical properties are available.

Test specimens shall be furnished, cut, and machined in accordance with the ASTM specifications, for the material to be tested, as referred to herein. Test specimens shall be furnished and machined by the Contractor at no additional cost to the Contracting Agency.

Mill Tolerances: Rolling and cutting tolerances, permissible variations in weight and dimensions, defects and imperfections shall not exceed the limits for structural steel contained in ASTM A-6.

Stock Material: When the Contractor proposes to use material already in stock, he shall notify the Engineer of such intention at least 10 days in advance of beginning fabrication, to permit sampling and testing.

770.2 STRUCTURAL STEEL:

Stock Materials: The Contractor shall select the material he wishes to use from stock. The Contractor shall furnish 3 certified mill reports for each of the heat numbers. Two samples shall be taken by a representative of the Engineer from each heat number, one for the tension test and one for the coldbend test. If the heat numbers cannot be identified, the representative of the Engineer shall select random test specimens from the unidentifiable heats. The number of such test specimens shall be at the discretion of the Engineer. The cost of all tests on stock material shall be borne by the Contractor.

High Strength Low-Alloy Structural Steel: The material shall conform to the requirements of ASTM A-242, A-440, A-441, A-374, A-375 or A-446 Grades C, D, or E as specified in the special provisions.

Copper Bearing Structural Steel: Copper bearing structural steel shall conform to the requirements of ASTM A-36, A-245, A-570, A-440, or A-446 as specified in the special provisions.

770.3 RIVETS:

Stock Material: Rivets taken from identifiable stock shall be accepted by the Engineer in accordance with this specification.

Rivets from unidentifiable stock, for which authentic records of the chemical and physical properties are not available, shall not be used except where shown on the plans or when approved by the Engineer.

High-Strength Structural Rivet Steel: The material shall conform to the requirements of ASTM A-502.

Structural Rivet Steel: The material shall conform to the requirements of ASTM A-502, except that the test specimen shall be bent upon itself when performing the bend test.

SECTION 770

770.4 BOLTS:

Unfinished Bolts: The bolts shall have square heads and square nuts unless otherwise specified. The bolts shall be long enough to extend entirely through the nut but not more than ¼ inch beyond. Washers shall not be furnished unless specified.

Steel bolts shall conform to the requirements of ASTM A-307, except that steel manufactured by the acid Bessemer process shall not be used.

High Strength Bolts: High strength bolts shall conform to the provisions of the specification for the design, fabrication and erection of structural steel for buildings of the AISC.

770.5 ANCHOR BOLTS:

Anchor bolts shall be manufactured from steel conforming to ASTM A-36 or A-307.

770.6 MILD-STEEL FORGINGS FOR STRUCTURAL PURPOSES:

Steel forgings shall be made from steel of forging quality and shall conform to the requirements of ASTM A-235. They shall be Class C forgings with a maximum carbon content of 0.35 percent and shall be given a thorough annealing. The metal shall have a minimum Brinnel hardness number of 130, and a maximum of 190, when tested in accordance with ASTM E-10.

SECTION 771

GALVANIZING

771.1 GENERAL:

Materials shall be hot-dip galvanized and the weight and uniformity of coating determined in accordance with the standard specifications given in the following table:

TABLE 771		
GALVANIZING SPECIFICATIONS		
Material	**ASTM Spec.**	**Wt. of Coating Oz./Sq. Ft. (Min.)**
Corrugated Metal Pipe	A-444	1.80
Flat Steel or Iron Sheets	A-525	1.25
Iron or Steel Wire	A-116	.80
Chain Link Fabric	A-392	1.20
Barbed Wire	A-121	.50
Steel Pipe Rails	A-120	1.80
Structural Shapes, Tie Rods, Ornamental Iron Railings, Handrails, Manhole and Catch Basin Steps, and Curb Armor	A-123	2.00
Bolts, Nuts, Washers, Anchor Bolts, Packing Spools, Gray Iron and Malleable Iron Castings and Steel Castings	A-153	1.25

771.2 WORKMANSHIP:

The galvanizing shall be applied in such a manner that the spelter will not peel off. The finished product shall be free from blisters and excess spelter, and the coating shall be even, smooth, and uniform throughout. Machine work, die work, cutting, punching, bending, welding, drilling, thread cutting and other fabricating shall all be done as far as is practicable before the galvanizing. No member shall be galvanized which is out of alignment. All members (nuts, bolts, washers, etc.) shall be galvanized before a structural unit is assembled. All uncoated spots or damaged coatings due to poor workmanship, rough handling, or any other reason shall be cause for rejection.

771.3 TEST COUPONS:

Test coupons for determining the quality of the galvanizing shall be wired to the materials to be galvanized before immersion in such a manner as to represent the amount of coating deposited on the materials.

771.4 REPAIR OF GALVANIZED SURFACES:

Unless otherwise specified, where galvanized surfaces are field or shop cut, broken, burned or abraded, thus breaking the galvanizing, the locations thus damaged shall be repaired to the satisfaction of the Engineer with zinc dust-zinc oxide coating conforming to AASHTO M-36.

SECTION 772

CHAIN LINK

772.1 GENERAL:

All material shall be new and the Contractor, upon request, shall furnish to the Contracting Agency, a certificate of inspection stating that the posts, rails and braces have been manufactured, sampled, tested and inspected so as to meet the requirements for its type as specified below.

Unless specifically designated by type in the plans or specification, the Contractor may utilize any one of the three types of posts, rails and braces listed.

772.2 POSTS, RAILS AND BRACES:

The nominal outside diameter of Types A, B, and C shall be in accordance with TABLE 772.

Type A: Shall be black steel pipe, hot dipped zinc coated both inside and outside. The weight of the zinc coating, inside and outside, shall be not less than 1.8 ozs. per square foot ± 0.1 ozs. The base material and manufacturing shall conform to ASTM A-53 and A-120.

Type B: Shall be steel pipe, manufactured from hot-rolled, steel strip ASTM-569. During manufacturing, the outside surface shall have a hot-dipped zinc coating, weight not less than 1.0 ozs. per square foot ±0.1 ozs.; followed by a chromate conversion coating, weight not less than 30 micro-grams per square foot ± 10 micro-grams and an electrostatically applied acrylic coating, .0005 inches thick ± .0002 inches. During manufacturing, the inside surface shall be coated with a zinc based paint, .0005 inches thick ± .0002 inches. The wall thickness shall be such that the product of the yield strength and section modules shall be not less than that of pipe meeting the requirements of ASTM-120.

Type C: Shall be steel pipe manufactured from high strength, cold-rolled, hot-dipped zinc coated, steel, ASTM A-526. The weight of the zinc coating, inside and outside, shall be not less than 1.0 ozs. per square foot ± 0.1 ozs. The wall thickness shall be such that the product of the yield strength and section modules shall not be less than that of pipe meeting the requirements of ASTM-120.

TABLE 772

USE	TYPE	NOMINAL O.D. (Inches)	AISC DESIGNATION NOMINAL DIAMETER (Inches)
End, corner, slope and gate posts for single gates 6′ or less in width and double gates 12′ or less in width for fence 72″ or higher	Pipe	3	2½, Schedule 40
End, corner, slope and gate posts for single gates 6′ or less in width and double gates 12′ or less in width for fence less than 72″ in height	Pipe	2½	2, Schedule 40
Gate posts for single swing gates over 6′ but not over 13′ in width and double swing gates over 12′ but not over 26′ in width or for all slide gates with leaves larger than 6′	Pipe	4	3½, Schedule 40
Gate posts for single swing gates over 13′ but not over 18′ in width and double swing gates over 26′ but not over 36′ in width	Pipe	6⅝	6, Schedule 40
Gate posts for single swing gates over 18′ in width and double swing gates over 36′ in width	Pipe	8⅝	8, Schedule 30
Line posts for fence higher than 72″	Pipe H-Section	2½ 2¼ × 1⅞	2, Schedule 40
Line posts for fence 72″ or lower	Pipe H-Section	2 1⅞ × 1⅝	1½, Schedule 40
Top rail and braces	Pipe H-Section	1⅝ 1½ × 1¼	1¼, Schedule 40
Frame for gates	Pipe	2	1½, Schedule 40
Stiffners for gates	Pipe	1⅝	1¼, Schedule 40

All unit weights shall be subject to the standard mill tolerance of ±5 percent.

Posts shall be fitted with tops designed so as to fit securely over the posts and carry a top rail where specified. They shall have a total length of not less than the depth of the concrete footings, as specified, plus the length required above ground. Where no top rail is required, pipe posts shall be fitted with suitable caps. H-Section posts will require no caps.

Top rail shall be furnished in random lengths of approximately 20 feet where required.

772.3 CHAIN LINK FABRIC:

Chain link fabric shall conform to the requirements of ASTM A-392 or ASTM A-491. The wire used in the manufacture of the fabric shall be 11 gage for all fence 60 inches or less in height and shall be 9 gage for all fence over 60 inches in height unless otherwise specified.

All chain link fabric shall be woven into approximately 2 inch mesh and galvanized after fabrication. Fabric less than 60 inches wide shall have knuckled finish on the top edge, and twisted and barbed finish on the bottom edge. Fabric 60 inches or greater in width shall have twisted and barbed finish on both edges. Barbing shall be done by cutting the wire on the bias.

772.4 TENSION WIRES AND FABRIC TIES:

Tension wires shall be at least 7 gage galvanized coil spring steel wire. Ties used to fasten the fabric to posts, rails, and gate frames shall be not smaller than 11 gage galvanized steel, 6 gage aluminum wire, or approved non-corrosive metal bands.

Tension bars used in fastening fabric to end and corner posts and gate frames shall be galvanized high carbon steel bars not smaller than three-sixteenths inch × ¾ inch.

772.5 TRUSS OR TENSION RODS:

Truss or tension rods used in trussing gate frames and line posts adjacent to end, corner, slope or gate posts shall be adjustable ⅜ inch diameter galvanized steel rod. When used in trussing line posts, adjustment shall be provided by means of galvanized, turnbuckle or other suitable tightening devices.

772.6 FITTINGS:

Fittings, hardware, nuts and bolts shall be galvanized.

Couplings to connect the individual lengths of top rail shall be of the outside sleeve type at least 7 inches long. The bore of the sleeves shall be sufficiently true to maintain adjacent lengths of rail in alignment.

Extension arms for barbed wire on pipe posts shall be of 13 gage steel or heavier, single piece construction and a type that can be attached to the tops of the posts. Extension arms for barbed wire on H-Section posts shall be of the bent post type. Extension arms shall carry 3 wires at approximately 5½ inch centers in a plane approximately 45 degrees from the vertical, inclined as shown on the plans or as directed by the Engineer.

772.7 BARBED WIRE:

Barbed wire shall be 4 point pattern, composed of 2 strands of 12½ gage galvanized steel wire with barbs spaced 5 inches apart and shall conform to ASTM A-121.

SECTION 775

BRICK AND CONCRETE BLOCK

775.1 BRICK:

Brick shall be whole, sound, and hard burned and shall give a clear ringing sound when struck together. They shall be uniform in quality and shall be culled or sorted before delivery to the work.

775.2 MANHOLE BRICK:

Sewer and water manhole brick shall conform, except for dimensional tolerances, to the requirements of ASTM C-32, Grade MM.

Manhole brick shall conform to the following dimensions:

TABLE 775

Brick	Inches Depth	Inches Width	Inches Length
Standard Size	2¼	3½	7½
Allowable Variations	± ⅛	± ⅛	± ¼

The following paragraphs shall be added to the section on visual inspection:

No individual brick shall be rejected unless it shows visual evidence of major cracking. A major crack is defined as one that has at least one complete separation, for a distance of 1¾ inches, through the brick in any direction, including any cored area. Such a crack shall be regarded as affecting the serviceability of the brick and shall be rejected and not used in the structure.

Fifty bricks may be sampled at random intervals from any cube for visual inspection. Of the 50 sampled, 45 must pass visual inspection for major cracks. Should less than 45 pass, the cube of brick shall be rejected and the brick must not be used in the structure.

775.3 BUILDING BRICK:

Building brick shall conform to the requirements of ASTM C-62, Grade MW.

775.4 FACING BRICK:

Facing brick shall conform to the requirements of ASTM C-216, Grade MW, Type FBS. The size, color, and texture shall be as specified on the plans or as approved by the Engineer.

775.5 MORTAR, GROUT AND PLASTER:

The class shall be specified in the special provisions and conform to Section 776.

775.6 CONCRETE BLOCK:

Masonry units shall conform to ASTM C-90 for Grade N-1 (1000 psi) units with the following modifications:

Units shall be fully cured and shall have been made not less than 28 days prior to delivery.

Moisture content at time of delivery shall not exceed 30 percent of the minimum absorption value of the units, and Contractor shall provide any protection he deems necessary to maintain units in this condition until time of use.

The linear change from saturated to cool oven dry shall not exceed .0072 inches per linear foot or .06 of 1 percent.

Except as otherwise called for on the plans or specified, masonry units shall be made with sand-gravel aggregate or lightweight aggregate at the Contractor's option, but all units used in the work shall be of one type. Lightweight aggregates for use in concrete masonry units shall be restricted to expanded clay, expanded shale, scoria, volcanic cinders, pumice or a combination thereof and shall conform to ASTM C-331.

Size of units shall be as indicated on the plans.

Submit for approval of the Engineer at the site not less than 5 samples of units to show the full variance of texture and full range of color. Units used in the work shall match the approved samples. These samples will be tested for strength.

775.6.1 Mortar and Grout: Mortar and grout used for concrete block construction shall conform to Section 776.

SECTION 776

MASONRY MORTAR AND GROUT

776.1 GENERAL:

Masonry mortar and grout shall consist of a mixture of cementitious material and aggregate to which sufficient water has been added to bring the resulting mixture to the desired consistency.

Table 776-1 and 776-2 indicates the average compressive strength obtained when the cementitious material, aggregate, and water (the required amount to provide a flow of 110 $\pm$5 percent) are combined in the proportion shown in Table 776-3 and 776-4.

The mortar or grout to be used will be designated by class in the special provisions and the correct proportions of cementitious materials and aggregate will be combined with the minimum amount of water to provide a workable mixture.

Retempering of the mortar or grout will not be a standard practice and the Engineer's approval will be required for any exception.

TABLES 776-1 & 776-2

MASONRY MORTAR AND GROUT COMPRESSIVE STRENGTH

Table 776-1 Masonry Mortar		Table 776-2 Grout	
Type	**Compressive Strength 28 Days (psi)**	**Type**	**Compressive Strength 28 Days (psi)**
A	5500	Fine Grout	2500
B	5000	Coarse Grout	2500
C	4000		
D	3000		
M	2500		
S	1800		

TABLE 776-3

MASONRY MORTAR PROPORTIONS BY VOLUME

Type	Portland Cement	Hydrated Lime	Aggregate ASTM C-144
A	1	0	1
B	1	0	1½
C	1	0	2
D	1	0	2½
M	1	¼	2¼ to 3
*S	1	½	2¼ to 3

*Masonry Cement Type S may be substituted for the cementitious material. Prior approval of the Engineer is required.

TABLE 776-4

GROUT FOR REINFORCED MASONRY PROPORTIONS BY VOLUME FOR FIELD BATCHING

Type	Portland Cement	Fine Aggregate (ASTM C-404)	Coarse Aggregate (ASTM C-404)
Fine Grout	1	2¼ to 3	0
Coarse Grout	1	2½	1 to 2

776.2 PORTLAND CEMENT:

The cement used shall conform with Section 725. For volumetric proportioning an unopened sack of cement weighing 94 pounds shall be considered as having a 1 cubic foot volume.

In proportioning the cement, it shall be measured loose, without shaking or compacting, in measuring devices of known capacity.

SECTION 776

776.3 AGGREGATE:

The aggregate used shall conform with Section 701. It shall be approved by the Engineer prior to being utilized on the job. Any change of source will require additional approval or this neglect will be considered as sufficient cause for rejection of work.

In proportioning the aggregate, it shall be measured damp, loose without shaking or compacting, in measuring devices of known capacity.

776.4 MASONRY CEMENT:

Masonry cement used shall conform to ASTM C-91 with the exception that the average compressive strength shall not be less than 2500 psi at 28 days.

776.5 HYDRATED LIME:

Hydrated lime used shall conform to ASTM C-207, Type S.

776.6 WATER:

The water used shall conform to Section 725.

776.7 ADMIXTURES:

Admixtures, unless prescribed in the special provisions, will not be used without prior approval of the Engineer.

776.8 TESTS:

776.8.1 Mortar: If in the opinion of the Engineer there is sufficient cause to question the quality of the mortar being utilized, random field test in accordance with ASTM C-780 Annex A-1 and A-6 will be performed. For this area, the penetration of the cone penetrometer correlating to a flow of 110 $\pm$5 percent is 40 $\pm$3 mm.

776.8.2 Grout: If required, tests shall be performed in accordance with Uniform Building Code Standard No. 24-23 Section 24.2301.

SECTION 778

LUMBER

778.1 GENERAL:

Unless otherwise specified or shown on the plans, all lumber shall be Douglas Fir or graded pine and shall be selected as to grade and shall conform in all particulars to the standard grading and dressing rules of the West Coast Lumber Inspection Bureau.

Plywood shall be not less than 3 ply, manufactured and graded in accordance with the standard grading rules of the APA.

Lumber for uses listed shall not be lower than the following grades:

Uses	Grade
(A) Permanent Construction, such as bridges and culverts.	Select Structural, for beams and stringers; Construction, for balance of structure.
(B) Minor permanent construction, such as fences, guard rails and posts, pavement headers, bulkheads, retaining structures, etc.	Construction.
(C) Falsework and studs, and wales for formwork.	Construction, for framing, beams, or timbers.
(D) Form sheeting for nonshowing surfaces of concrete.	Standard, for boards; shiplap; or any grade of plywood.
(E) Form sheeting for showing surfaces of ornamental concrete.	C and Better Industrial clear; concrete form grade of plywood; or overlay plywood.
(F) Form sheeting for curved soffits of bridge & tunnel arches, plastered or unplastered.	Select Merchantable, board; concrete form grade of plywood; or overlay plywood.
(G) Soffits of beams and girders and slabs between beams and girders; for beam and girder sides, except ornamental concrete; and for headwalls or endwalls of culverts or covered conduits.	Concrete form grade of plywood; or overlay plywood.
(H) Form sheeting for showing surfaces of channel walls or interior surfaces, except floors; for covered conduit and all other showing surfaces not specified above.	Tongue and groove flooring equal to C and Better flat grain; concrete form grade of plywood; or overlay plywood.
(I) All other lumber.	Construction.

778.2 REDWOOD:

Redwood lumber shall be selected as to grade and shall conform in all particulars to the standard specifications for grades of California Redwood of the California Redwood Association.

Redwood lumber for the uses listed shall not be lower than the following grades:

Uses	Grade
(A) Bridges, culverts, and guardrail posts.	Dense Structural.
(B) All other Redwood Lumber.	Foundation.

SECTION 778

778.3 GRADE MARKING:

Lumber. Each piece of lumber shall bear an official grade mark which, unless authorized otherwise, shall be the grade mark adopted by one of the following associations:

(A) For Douglas Fir and Pine — The West Coast Lumber Inspection Bureau or other agency approved by the Engineer.

(B) For Redwood — The California Redwood Association.

Plywood: Each sheet of plywood shall bear the official stamp of the APA stating the grading of the sheet.

SECTION 779

WOOD PRESERVATIVES

779.1 GENERAL:

This work shall consist of treating lumber, timber, and piling. Lumber, timber, and piling to be treated shall conform to the requirements of the specification of the AWPA and as specified herein.

Where practical, lumber to be treated shall be cut to size and framed, prior to treatment. Proper allowance for shrinkage in the sizes of lumber shall be made by the Contractor where it is necessary to meet definite dimensions shown on the plans.

779.2 OIL TYPE PRESERVATIVE TREATMENT:

Preservatives under this specification shall be creosote, creosote-coal tar solutions, creosote petroleum solutions, or pentachlorphenol in petroleum oils, conforming to AWPA specifications and as specified by the Engineer.

Treatment: The treating operations shall conform to the applicable requirements of the AWPA specifications.

Unless indicated otherwise on the plans or in the special provisions, the amount of preservative to be retained and the treating process to be used for the various types of service shall conform to the appropriate AWPA specification.

Incising: Unless otherwise specified, timber to be treated under this specification that is 3 inches or more in nominal thickness and 4 inches or more in nominal width, shall be incised before treatment as a means of securing penetration of the preservative. If such thickness is less than 4 inches, the material may be incised on the wide faces only; otherwise, all 4 faces shall be incised.

779.3 WATER BORNE SALT PRESERVATIVES TREATMENT:

Preservatives under this specification shall conform to the requirements of AWPA specifications unless otherwise approved in writing by the Engineer, but restricted to the following preservatives:

Chromated Zinc Chloride (CZC)

Tanalith (Wolman Salts)

Ammoniacal Copper Arsenite (Chemonite)

SECTION 779

Chromated Zinc Arsenate (Boliden Salt)

Chromated Copper Arsenate (Erdalith)

779.4 FIELD TREATMENT OF CUT SURFACES:

When sawing or drilling is necessary after plant treatment, the cut surfaces shall be thoroughly brushed with 2 coats of the same kind of preservative in conformance with AWPA specification. The maximum protection requirement specified therein shall be met in all instances.

SECTION 780

TIMBER PILES

780.1 GENERAL:

All piles shall conform to the specifications of ASTM D-25 for clean peeled Class B piles.

SECTION 781

STEEL PILES

781.1 GENERAL:

Steel piles furnished under this specification shall consist of structural steel shapes that fulfill the requirements prescribed for such material in ASTM A-36 and shall conform to the details and dimensions indicated by the plans and specifications relating directly thereto. The kind and type of steel piling to be used in the work shall be as indicated on the plans or special provisions.

781.2 MANUFACTURING:

Material for sheet piles shall not be made by the acid Bessemer process.

Steel sheet piling shall consist of standard interlocking sheet pile sections.

SECTION 782

CONCRETE PILES

782.1 GENERAL:

Concrete piles furnished shall be precast, cast-in-place, prestressed, or centrifugal cast piles. The type to be furnished will be as specified on the plans or in the special provisions.

782.2 MANUFACTURING:

Concrete shall be mixed and proportioned in accordance with the requirements of Section 725. The class of concrete will be as stated on the plans or in the special provisions.

SECTION 782

The manufacture of prestressed piles shall be performed in accordance with Section 506. Precast, cast-in-place and centrifugal cast piles shall be manufactured as specified in the special provisions.

SECTION 785

STEEL CASTINGS

785.1 GENERAL:

The castings shall be true to pattern in form and dimension and free from pouring faults, sponginess, cracks, blowholes, or defects that would affect the service value of the casting.

Blowholes shall not have a depth sufficient to affect injuriously the strength of the castings. Minor defects which do not impair the strength of a casting may, with the approval of the Engineer, be welded by an approved satisfactory means and after welding, the castings shall be annealed, if so required by the Engineer. Castings which have been welded without the permission of the Engineer shall be rejected.

785.2 FINISH:

The dimensions of the finished castings shall be not less than the specified dimensions. Castings shall not be more than 7½ percent overweight.

The bearing surfaces of rockers and rocker plates shall be machined accurately to the dimensions shown on the plans. The final surface shall be produced by a finishing cut. They shall be straight, smooth, and free from flaws.

Chemical analysis shall be performed in accordance with ASTM E-30.

785.3 TEST SPECIMENS:

Test coupons from which tension test pieces are prepared shall be attached to the castings where practicable. If, in the opinion of the manufacturer, the design of the casting is such that test coupons should not be attached thereon, the test coupons shall be cast attached to separate cast blocks. Sufficient coupons shall be cast to represent each lot with additional specimens for use in case retests should be required. A lot shall be considered as all castings in a melt which have constituted part or all of a heat-treatment charge.

Coupons shall remain attached until after the annealing process has been completed. Coupons may be identified by a representative of the Engineer. Where test coupons are cast separately from the castings, a representative of the Engineer may be present at the time of pouring to identify both coupons and castings. Coupons cast separately from the castings shall not be detached from the block to which they are fastened until identified.

The test coupons shall be of such size that test specimens can be machined to dimensions as specified in the ASTM procedure referred to herein. Where a specimen on machining, appears faulty and a true sample of the lot of castings to which it belongs, the representative of the Engineer may substitute another coupon of the lot in question. Test specimens shall be furnished and machined by the Contractor at no additional cost to the Contracting Agency.

785.4 RETESTS:

If the results of the physical test for any lot do not conform to the requirements specified, the manufacturer may reheat-treat such lot. Representative coupons shall be reheat-treated with the lot to serve as retest specimens.

785.5 HIGH-STRENGTH STEEL CASTINGS FOR STRUCTURAL PURPOSES:

Castings shall conform to ASTM A-148, Grade 80-50 except that the steel shall contain not less than 0.60 percent of manganese and not less than 0.20 percent of silicon.

785.6 MILD-TO-MEDIUM STRENGTH CARBON-STEEL CASTINGS FOR GENERAL APPLICATION:

Castings shall conform to ASTM A-27, Grade 65-35. The metal shall have a minimum Brinell hardness number of 130, when tested in accordance with ASTM E-10.

785.7 CASTINGS FOR HIGHWAY BRIDGES:

Steel castings for highway bridges shall conform to ASTM A-486 or AASHTO M-192.

SECTION 786

BRONZE CASTINGS

786.1 GENERAL:

The castings shall be true to pattern in form and dimensions and free from defects that would affect the service value of the casting. Minor defects may be repaired with the approval of the Engineer. Chemical analysis shall be made in accordance with ASTM E-54.

786.2 PHYSICAL PROPERTIES:

Expansion and bearing plates shall conform to the physical properties as required in ASTM B-22, for alloy C castings.

The physical test shall be performed on coupons cast integrally with the casting, as described in ASTM B-208, double keel block test bar. The coupons shall remain attached during all heating and cooling cycles to which the casting is subjected. In cases where castings are of such a size or design that it is difficult to cast attached coupons, permission may be granted by the Engineer to cast test coupons independently of the castings.

786.3 WORKMANSHIP:

Castings shall be sound, clean, and free from blowholes, porous places, cracks, and other defects.

Castings that show injurious defects revealed by machine operations or by X-ray subsequent to delivery may be rejected and, if rejected, shall be replaced by the Contractor without charge.

No welding or patching of defects in castings will be permitted unless authorized by the Engineer. Any such welding or patching done without authorization shall be cause for rejection.

786.4 ORNAMENTAL TABLETS:

The letters shall be heavily raised and spaced carefully to secure a uniform and balanced effect over the entire area of the panel. The background of the letter panel shall have a finely-pebbled surface. The model of the tablet shall be submitted to the Engineer for approval before castings are made.

Castings shall be boldly filleted at angles, and the arrises shall be sharp and perfect. Castings shall be true to pattern in form and dimension and shall be free from inclusion of foreign material, casting faults, injurious blowholes, or other defects rendering them unsuitable for the service intended.

The faces and edges of lettering and ornaments shall be carefully hand-tooled sharp and clean. Beveled edges shall be hand-tooled sharp, clean, smooth, and true. Outside borders shall be straight and true and shall be thoroughly polished. Filing and other tool marks shall be removed.

The lettering, the ornaments, and the beveled edges shall be given a fine satin hand finish; the lettering, bevels, and rosettes shall be highlighted; the leaves and scrolls slightly highlighted, but well polished. The pebble background shall be finished in dark statuary bronze, polished as the Engineer may direct.

786.5 EXPANSION AND BEARING PLATES:

The sliding contact faces shall be machined smooth to true planes. If practicable, one plate shall be machined at right angles to the other plate in the set.

SECTION 787

GRAY IRON CASTINGS

787.1 GENERAL:

The castings shall be true to pattern in form and dimension and free from pouring faults, sponginess, cracks, blowholes, or other defects in locations affecting their strength and value for the service intended. Castings shall be filleted boldly at angles, and the arrises shall be sharp and true.

Before the castings are removed from the foundry, they shall be thoroughly cleaned and the parting lines, gates, and risers ground flush.

787.2 TEST SPECIMENS:

Test coupons shall be cast separately of the castings, using a mold as described in ASTM A-48. A representative of the Engineer may be present at the time a melt is poured to identify both coupons and castings.

Two test coupons are required for each melt poured. Additional coupons shall be cast for use as replacements or in case a retest is required.

A representative of the Engineer may discard and replace specimens which show obvious lack of continuity of metal or if the machining is defective.

The manufacturer shall machine the tension specimens to the dimension specified for specimen B of ASTM A-48, at no additional cost to the Contracting Agency.

When approved by the Engineer transverse tests may be made in lieu of tensile tests, in which case the castings shall meet the requirements of ASTM A-48.

787.3 MANHOLE FRAME AND COVER SETS:

Castings shall conform to ASTM A-48, Class 30. The bearing surfaces of the frames and covers shall be machined and the cover shall seat firmly onto the frame without rocking. Also the frames and covers shall be coated as specified below.

Covers shall be the types and shall be imprinted as shown on the plans or standard details.

787.4 RAILINGS, RAILING POSTS, AND WHEEL GUARDS:

Castings shall conform to ASTM A-48, Class 40.

787.5 ROCKERS, ROCKER PLATE BEARINGS, AND BEARING PLATES FOR BRIDGES:

Castings shall conform to ASTM A-48, Class 50.

Castings shall be machined and finished as specified on the plans provided that tool marks on sliding contact surfaces shall run in the direction of plate movement, or in the case of rocker plate bearings, perpendicular to the rocker movement. Tool marks shall be not more than 1/32 inch apart.

787.6 UNCLASSIFIED CASTINGS:

All castings not specifically classified, shall conform to the requirements of ASTM A-48, Class 30.

787.7 ASPHALTUM COATING:

Unless otherwise specified, castings shall be painted or dipped in commercial-quality asphaltum paint.

SECTION 790

PAINT

790.1 GENERAL:

Paint shall be homogeneous, free of contaminants, and of a consistency suitable for the intended use. Finished paint shall be well-ground and the pigment shall be properly dispersed in the vehicle according to the requirements of the paint; and this dispersion shall be of such nature that the pigment does not settle appreciably, does not cake or thicken in the container, or become granular or curdled. Paint and paint materials shall be delivered to the job site in new, unopened air-tight containers, appropriately identified with the manufacturer's name, date of manufacture, type of paint or paint material, specifications paint number, and lot or batch number. The container shall have a formula label.

No paint shall be used until at least 7 days have elapsed from the date of manufacture.

790.2 PROPRIETARY BRANDS:

For the purpose of this specification, proprietary brands of paint and paint materials shall be construed to mean paint or paint materials conforming to the requirements of this specification and produced for distribution and consumption through regular wholesale and retail outlets. Whenever paint or paint materials are designated on the plans or special provision by a manufacturer's name or catalog reference, any proprietary brand of equal quality will be permitted, subject to the approval of the Engineer. Information required by the Engineer as proof of the comparative quality shall be furnished by the Contractor.

790.3 PAINT COATS:

The first coat of paint applied to an unpainted surface shall be called the prime coat. The paint applied to field connections, welds, rivets, and all damaged or defectively painted or rusty areas on a prime coated surface shall be called a touch-up coat. The paint applied over the prime coat and touch-up coat shall be called the second coat. The final coat of paint shall be called the finish coat.

790.4 MATERIALS:

Materials shall conform in all respects to the requirements of reference specifications indicated for such material.

Upon request of the Engineer, the Contractor shall furnish a certification from the manufacturer that the material conforms with this specification.

(A) **Vehicles:**	**Specification:**
Raw Linseed Oil	ASTM D-234
Boiled Linseed Oil	ASTM D-260
Water-Resistant Spar Varnish	Navy Department Specification 52V20
Alkyd Resin	TT-R-266C
Driers	ASTM D-600, Class A or Class B, as applicable
Thinners:	
Xylene	TT-X-916B, Grade A
Turpentine (shall be used in paints for timber)	ASTM D-13, Gum Spirits
Petroleum Spirits (Mineral Spirits)	ASTM D-235

(B) **Pigments:**	**Specifications:**
Carbonblack	TT-P-343 Form 1, Class B
Lampblack	ASTM D-209
Red Lead	ASTM D-83
Blue Lead; Basic Sulfate	ASTM D-405
Titanium Dioxide, Non-extended	ASTM D-476, Type II, Class II
Titanium Dioxide, Extended (Titanium Calcium, Rutile)	ASTM D-476
Titanium Dioxide	TT-P-422B, Type III, Class A
White Lead Basic Carbonate	ASTM D-81
Zinc Yellow (Zinc Chromate)	ASTM D-478, Type II
Zinc Oxide	ASTM D-79
Iron Blue	TT-P-385
Iron Oxide, Yellow	TT-P-458A

Iron Oxide, Orange	ASTM D-84
Hansa Yellow G	MIL-H-10330
Organic Green Gold	DuPont YT 562-D or equal, specific gravity 161 ±0.05
Chromium Oxide, Green Graphite	TT-P-347

Graphite shall be natural amorphous material (American product) which shall contain not less than 35 percent nor more than 45 percent graphite carbon. The remainder shall be insoluble siliceous material containing a total of not more than 5 percent calcium and magnesium carbonate and sulfate. The pigment shall be ground to such a fineness that not less than 97 percent shall pass a No. 325 sieve. The graphite paste shall be made by grinding the pigment in pure raw linseed oil in the following proportions:

Amorphous Graphite .....68.0 percent
Linseed Oil .....32.0 percent

(C) **Inert Materials:**	**Specifications:**
Diatomaceous Silica	ASTM D-604, Type A
Magnesium Silicate	ASTM D-605

790.5 MIXED PAINTS:

All mixed paints shall, in general, be machine-mixed and shall consist of the pigment of the required fineness and composition, ground to the desired paste consistency in pure raw or boiled linseed oil, to which shall be added the remainder of the vehicle to make paint conforming to the required formula as herein specified.

Paint which has hardened and thickened in the container such that it cannot be readily broken up to a smooth uniform paint of good brushing consistency shall not be used.

All materials used in mixed paints shall conform to the requirements as herein specified. The paint shall be made to satisfactory workable consistency conforming to one of the following formulas for paint as required on the plans or in the special provisions. All percentages shown are by weight.

Any of the following paints which are too thick to have a satisfactory workable consistency shall be thinned with a suitable thinner from the group of thinners herein specified. In no case shall gasoline be used as a thinner.

Fineness of grind for enamel shall conform to Hegman 7 minimum.

The following paints shall conform to the latest ADOT standard specifications for Road and bridge Construction. All paints, except Paint No. 10 (Aluminum), shall be shipped ready for use.

When Paint No. 1 is specified, it may be Paint No. 1-A or Paint No. 1-B. Paint No. 1-D shall be used only when specifically designated.

SECTION 790

Paint Number	Type
1-A	(Red Lead — Linseed Oil)
1-B	(Red Lead — Alkyd Resin)
1-D	(Zinc Chromate)
4	(Dull Black)
5	(Jet Black)
6	(Black — For Timber Primer Only)
7	(White — For Timber Primer Only)
8	(White)
9	(Light Grey)
10	(Aluminum)
11	(White Enamel)
15	(Zinc)

SECTION 792

DUST PALLIATIVE

792.1 GENERAL:

Since the establishment of grades will not normally be required prior to the application of this palliative, and since there is always the possibility that the Contracting Agency will grade in this area, the Contracting Agency will not assume any responsibility for the maintenance of this work. The Contractor will, however, be responsible for obtaining satisfactory results within the limits of the materials and the requirements of these specifications.

Sufficient grading shall be done prior to treatment to provide reasonable drainage.

Except as stated in the special provisions, the material to be used shall be the type designated by the Engineer.

792.2 TYPE AND APPLICATION OF MATERIALS:

(A) Asphalt Base Type:

Designation	Specification Requirements
(1) SC 70	In Accordance With Section 712
(2) MC 70	In Accordance With Section 712
(3) RC 70	In Accordance With Section 712
(4) PS 300	Fuel Oils, Pacific Specifications
(5) No. 5	Fuel Oils, Commercial Standard Specifications
(6) No. 5	(Heavy) Fuel Oils, ASTM D-396

Sand shall be uniformly applied over the fresh coat of oil. The amount shall be sufficient to serve as a blotter and insure that pickup and tracking will not occur. This will normally range between 10 and 25 pounds per square yard.

The rate of application of the cutback asphalt shall be approximately 0.3 gallons per square yard.

Application shall be made by an approved pressure-type asphalt distributor truck.

Care shall be taken to prevent the splattering of oil on curbs, sidewalks, fences, buildings, etc., and a shield shall be used where so ordered by the Engineer.

The application of the oil shall be restricted to some extent by weather conditions. The spreading of liquid asphalt will not be permitted when, in the opinion of the Engineer, weather conditions are detrimental to performance of first class work.

(B) Petroleum Resinous Type:

The material shall be a light yellow emulsion. Coherex or approved equal, suitable for use as an agglomerant for soil particles. The emulsion shall contain 60 ±3 percent of a thermo-plastic resinous petroleum fraction characterized by the following properties:

Specification Designation	ASTM Test Method	Requirements
Viscosity, SUS at 100°F., Sec.	D-88	6000 min.
Residue, %	D-95	60 ±3
Asphaltenes, %	D-2006	0.75 max.
Saturated Hydrocarbons, %	D-2006	20 max.
Flash Point, CO, °F.	D-92	400 min.
Specific Gravity, 60/60°F.	D-1298	1.00 min.

The emulsion shall be stable, i.e., should not break when stored in clean closed containers at ordinary temperatures, excluding freezing or boiling, for a minimum of 3 months. It shall be miscible with water in all proportions, including a ratio of 1 part emulsion to 5 parts water. The sequestering agents shall make the preparation stable against hard water, thus permitting dilution of the emulsion with almost all types of water. The emulsion shall be non-corrosive to metal containers. The materials shall penetrate into the soil surface and not form a skin at the surface or a crusted surface.

Immediately after compacting, the 1 to 5 diluted emulsion shall be applied in 1 to 3 applications, as required, at a rate of approximately 0.17 gallons per square yard per application. The material shall be applied by means of a thoroughly cleaned bituminous distributor or other approved means.

(C) Lignin Based Types:

Lignin sulfonates, a residual co-product of wood pulping by the sulphite process in the manufacture of cellulose products. This material may be supplied in either the granulated solid or liquid form, liquid form to contain 50 ± percent lignin solids by weight. The application rate shall be such that the residual lignin solids constitute approximately 1 percent by weight of the soil being treated. One gallon of 50 ±2 percent solids lignin sulfonate concentrate* will usually result in the required residual content for a soil volume of 1 square yard 6 inches deep.

*Lignin sulfonates are usually diluted to 10 to 25 percent solids before application. The rate of dilution is variable and shall be determined by the Engineer.

Application of this material may be made by either a pressure type water sprinkling truck or an asphalt distributor; however, the same precautions to prevent contamination of adjacent objects will be required as in the case of the asphalt base products. For other than skin treatments, multiple applications and some scarifying and blading may be necessary.

SECTION 792

792.3 MEASUREMENT:

The Engineer shall order the rate of application of all materials. This is a contingent item and quantities may be increased or decreased as required or eliminated entirely from the contract.

Asphalt base types shall be measured by the ton completed and accepted in place.

Petroleum resinous types shall be measured by the diluted gallons completed and accepted in place.

Lignin based types shall be measured by the pounds of residual solids applied, completed and accepted in place.

Sand for blotting shall be measured by the ton.

792.4 PAYMENT:

Payment will be made for the above items bid in the proposal form for the applicable item and shall constitute full payment for furnishing all materials, equipment, tools, labor, and incidentals necessary to complete the work.

Payment for all asphalt base items shall be by the ton.

Payment for all petroleum resinous types shall be by the diluted gallon at 60°F.

Payment for lignin based types shall be by the pound of solid content of lignin sulfonate and included wood sugars.

Payment for sand for blotting shall be by the ton.

SECTION 795

LANDSCAPE MATERIAL

795.1 GENERAL:

Material used for landscaping purposes shall be in conformance with this Section.

The common and scientific names of plants shall conform to the approved names in Standard Plants Names (SPN) or its successor, American Association of Nurserymen (ASN). For identification and inspection, durable, legible labels, bearing the plant's name in water-resistant ink, shall be attached to all nursery stock or container of stock delivered to the project site.

795.2 TOPSOIL:

Topsoil shall be a fertile, friable soil, obtained from well-drained arable land, and shall be free from nut grass, refuse, roots, heavy clay, clods, noxious weeds or any other material toxic to plant growth. At least 10 days prior to delivery of topsoil to the site, the Contractor shall furnish the Engineer at no additional cost, with a soil sample from each source for analysis and tests.

To be acceptable the pH factor shall not exceed 8.0 or be lower than 5.5, soluble salts shall not exceed 1500 PPM, the plasticity index shall be in the range of 3 and 15 inclusive, and it shall contain approximately 1½%, by dry weight, of organic matter either natural or added. Gradation shall be in accordance with the table shown below:

Sieve Size	Percent Passing
1"	100
½"	95-100
No. 4	90-100
No. 10	70-100
No. 200	15-70

795.3 SOIL FERTILIZING MATERIAL:

Fertilizing material shall comply with the applicable requirements of the State Agricultural Code. All fertilizing material shall be packaged, first grade, commercial quality products identified as to source, type of material, weight and manufacturer's guarantee analysis. It shall not contain toxic ingredients or fillers in quantities harmful to human life, animals or plants. It shall be delivered in unopened containers and shall have the chemical analysis as specified in the plans or specifications. Material which has become caked or otherwise damaged shall not be used.

795.4 ORGANIC SOIL CONDITIONERS:

In general, soil conditioners shall consist of a ground or processed wood product derived from redwood, ground or shredded fir, redwood or ponderosa bark. It shall have a nitrogen content of 1%, a pH not exceeding 7.5, and organic matter not less than 85%. Its gradation shall be such that at least 85% passes the ¼-inch screen. In addition, it shall be treated with a non-toxic agent so as to be hygroscopic.

When manure is used as a soil conditioner, it shall be the product of yard fed cattle, free of weed seeds, straw or any other inert material and aged at least 3 months. This manure shall have been processed by grinding and screening and shall be of a consistency that will readily spread with a mechanical spreader.

795.5 CHEMICAL SOIL CONDITIONER:

Chemical soil conditioners such as soil sulfur, gypsum or iron additive shall be commercially approved brands designated for agricultural use. Material which has become caked or otherwise damaged shall not be used.

795.6 SEEDS:

Seeds shall be fresh, clean seeds, pre-mixed to the specified proportion. They shall be delivered to the site in original, unopened containers bearing the dealer's guaranteed analysis and germination percentage. They shall have a certificate or a stamp or a release accomplished by an agricultural commission.

795.7 PLANTS, TREES, AND SHRUBS:

795.7.1 General: All landscape stock shall be grown in nurseries approved by the State Department of Agriculture. They shall have a growth habit normal to the specie. Stock shall be sound, healthy, and vigorous; free from insect pests, sun scald, excessive bark abrasions and other objectionable disfigurements. They shall have normal, well-developed branch systems and vigorous, fibrous root systems which are neither root nor pot-bound and are free of kinked or girdling roots.

All stock shall have been grown in pots, cans, tubs, or boxes for a minimum of three months and a maximum of one year. They shall have sufficient roots to hold earth

together after removal from the containers. This earth shall be free from noxious weeds including bermuda grass.

Stock shall be inspected and approved by the Engineer at the Contractor's storage site prior to delivery to the project.

795.7.2 Flatted Plants: Flatted plants shall be grown and remain in the flats until transported to the project site. The soil and spacing of the plants in the flats shall insure the minimum disturbance of the root system at transplanting.

795.7.3 Trees: Trees shall be of the specified height, spread and caliper and shall stand erect without support. The height shall be measured from the root crown to the last division of the terminal leader with the branches in a normal position and the caliper shall be measured 12 inches above the crown roots. For palm trees only, the height shall be measured from the ground line to the base of the growing bud.

795.7.4 Shrubs: Shrubs shall be of the specified type, height and spread. They shall be selected from high quality, well-shaped nursery stock.

795.8 MISCELLANEOUS MATERIAL:

795.8.1 Headers and Stakes: Lumber for landscaping shall be construction heart, rough-sawn redwood in the sizes specified; splicing will not be permitted. Stake used with header boards shall be 2 × 4 inches, pointed and at least 18 inches long.

795.8.2 Tree Stakes: Unless otherwise specified, tree stakes shall be 2 × 2 inch redwood posts, free of knots and reasonably straight, and of sufficient length to properly support the tree.

795.8.3 Tie Wires: Tie wire shall be No. 12 AWG zinc coated wire and the cover for this wire shall be ½ inch garden hose.

795.8.4 Decomposed Granite: Decomposed granite shall be as per Section 702.4 with the following exceptions. All material used for a specific project or location shall be from a single source and shall present a uniform appearance. The gradation shall be as shown in the table below. If a specific color or type is required, it will be so indicated in the Contracting Agency's specifications.

Sieve Size	Percent Passing
¾ inch	100%
½ inch	60-70
No. 40	5-20

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