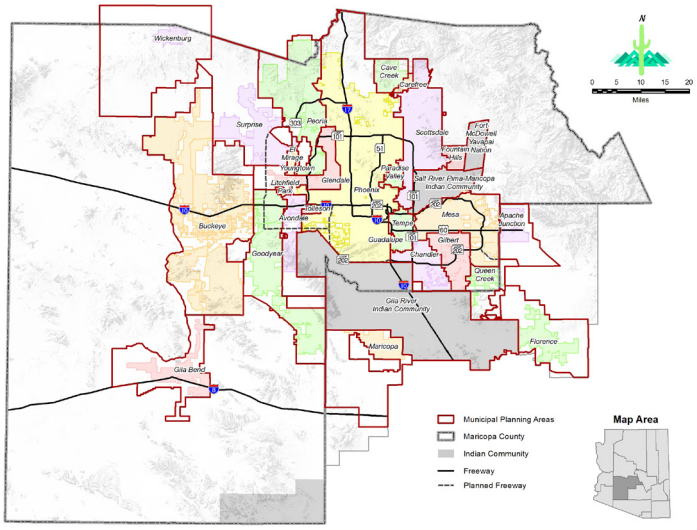
2020 Edition

Uniform Standard Specifications and Details for Public Works Construction



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January 2020

NEW IN THE 2020 EDITION

Uniform Standard Specifications and Details for Public Works Construction—2020 Edition
The MAG Standard Specifications and Details Committee, with assistance from specialized working groups, considered 15 cases during the 2019 session. Of these, 11 were approved and included in this revision. These changes are summarized in the list below. This edition also includes all the updates since the 2015 Edition as listed on the following pages. Finally, the 2020 Edition includes numerous non-content related corrections throughout including: typographic, spelling, hyperlinking, and formatting.

New Specifications:
- Section 627: Painting Sanitary Sewer Manholes with Insecticide
- Section 744: Precast Polymer Concrete Manhole

Specifications rewritten, or with major updates:
- Section 331: Placement and Construction of Asphalt Emulsion Micro-Surfacing Treatments
- Section 332: Placement and Construction of Asphalt Emulsion Slurry Seal Treatments
- Section 713: Emulsified Asphalts Materials
- Section 714: Microsurfacing Materials
- Section 715: Slurry Seal Materials

Specifications with minor updates:
- Section 206: Structure Excavation and Backfill
- Section 321: Placement and Construction of Asphalt Concrete Pavement
- Section 525: Pneumatically Placed Mortar
- Section 618: Storm Drain Construction
- Section 625: Manhole Construction and Drop Sewer Connections
- Section 631: Water Taps and Meter Service Connections
- Section 719: Polymer Modified Asphalt Concrete

Other updates:
- Updated Table of Contents, Index, and Hyperlinks

New detail drawings:
- Detail 238-4: SINGLE CURB RAMP MID-BLOCK RESIDENTIAL STREET W/4” ROLL CURB
- Detail 419-1: POLYMER CONCRETE SANITARY SEWER MANHOLE
- Detail 419-2: PRE-CAST POLYMER CONCRETE MANHOLE BASE
- Detail 419-3: POLYMER CONCRETE MANHOLE BASE

Details that have been updated:
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- Detail 100-2: INDEX (PAGE 2 OF 2)
- Detail 145: SAFETY RAIL
- Detail 200-1: TRENCH BACKFILL AND SURFACE REPLACEMENT
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- Detail 262: WING TYPE ALLEY ENTRANCE (W/ COMBINED CURB & GUTTER)
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- Detail 501-1: HEADWALL
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- Detail 501-3: HEADWALL 42” TO 84” PIPE
- Detail 501-4: HEADWALL IRRIGATION 18” TO 60” PIPE
- Detail 501-5: HEADWALL DROP INLET
- Detail 502-1: TRASH RACK

Title VI Notice to the Public
Maricopa Association of Governments

The Maricopa Association of Governments (MAG) hereby gives public notice that it is the policy of the agency to assure full compliance with Title VI of the Civil Rights Act of 1964, the Civil Rights Restoration Act of 1987, Executive Order 12898 on Environmental Justice, and related statutes and regulations in all programs and activities. Title VI requires that no person in the United States of America shall, on the basis of actual or perceived race, color, or national origin, be excluded from the participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which MAG receives federal financial assistance. Additional protections are provided in other federal and state statutes for discrimination based on religion, sex, disability, age, gender identity (as defined in paragraph 249(c)(4) of title 18, United States Code) or sexual orientation.

Any person who believes they have experienced discrimination under Title VI has a right to file a formal complaint with MAG. Any such complaint must be filed with MAG’s Title VI Coordinator within 180 days following the date of the alleged discriminatory occurrence.
[Complaints should, at a minimum, include the following information:
- Your name and address, and a number at which you can be reached during business hours
- A general description of the person(s) injured by the alleged discriminatory acts
- A description of the alleged discriminatory act(s) in sufficient detail to enable the Title VI Coordinator to understand what occurred, when it occurred, and the basis of the alleged discrimination complaint (race, color, national origin, etc.)
- The letter must be signed and dated by the person filing the complaint or by someone authorized to do so on his or her behalf.]

For more information, or to file a complaint, please contact the Title VI Coordinator at (602) 254-6300.

For more information and links to agency supplements please visit:
http://www.azmag.gov/Programs/Public-Works/Specifications-and-Details/Agency-Supplemental-Specifications-and-Details

Changes made in the 2019 Revision

Uniform Standard Specifications and Details for Public Works Construction—2019 Revision to the 2015 Edition
The MAG Standard Specifications and Details Committee, with assistance from specialized working groups, considered 16 cases during the 2018 session. Of these, 13 were approved and included in this revision.

Specifications rewritten, or with major updates:
- Section 602: Trenchless or Open Cut Installation of Steel Casing
- Section 611: Water, Sewer and Storm Drain Testing
- Section 718: Preservative Seal for Asphalt Concrete
- Section 729: Expansion Joint Filler

Specifications with minor updates:
- Section 321: Placement and Construction of Asphalt Concrete Pavement
- Section 325: Placement and Construction of Asphalt-Rubber Concrete
- Section 326: Placement and Construction of Polymer Modified Asphalt Concrete
- Section 334: Preservative Seal for Asphalt Concrete
- Section 610: Water Line Construction
- Section 630: Tapping Sleeves, Valves and Valve Boxes on Water Lines
- Section 740: Polypropylene Pipe and Fittings for Storm Drain, Irrigation and Sanitary Sewer

Details that have been updated:
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- Detail 360-2: WET BARREL FIRE HYDRANT INSTALLATION

Changes made in the 2018 Revision

Uniform Standard Specifications and Details for Public Works Construction—2018 Revision to the 2015 Edition
The MAG Standard Specifications and Details Committee, with assistance from specialized working groups, considered 15 cases during the 2017 session. Of these, 13 were approved and included in this revision.

New Specifications:
- Section 323: Placement of Pervious Concrete
- Section 723: Pervious Concrete

Specifications rewritten, or with major updates:
- Section 337: Crack Sealing
- Section 415: Flexible Metal Guardrail
- Section 630: Tapping Sleeves, Valves and Valve Boxes on Water Lines

Specifications with minor updates:
- Section 105: Control of Work
- Section 310: Placement and Construction of Aggregate Base Course
- Section 321: Placement and Construction of Asphalt Concrete Pavement
- Section 331: Microsurfacing Specifications
- Section 340: Concrete Curb, Gutter, Sidewalk, Curb Ramps, Driveway and Alley Entrance
- Section 604: Placement of Controlled Low Strength Material
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- Detail 235-1 through 235-5: Single ramp details have been incorporated as options in the 236 RADIAL series and 237 DIRECTIONAL series. Midblock ramps have been moved to a new 238 series.

Changes made in the 2017 Revision

Uniform Standard Specifications and Details for Public Works Construction—2017 Revision to the 2015 Edition
The MAG Standard Specifications and Details Committee, with assistance from specialized working groups, considered 20 cases during the 2016 session. Of these, 16 were approved and included in this revision.

New Specifications:
- Section 326: Placement and Construction of Polymer Modified Asphalt Concrete
- Section 719: Polymer Modified Asphalt Concrete

Specifications rewritten, or with major updates:
- Section 106: Control of Materials
- Section 309: Lime Stabilization or Modification of Subgrade
- Section 340: Concrete Curb, Gutter, Sidewalk, Curb Ramps, Driveway and Alley Entrance
- Section 710: Asphalt Concrete
- Section 717: Asphalt-Rubber Asphalt Concrete
- Section 727: Steel Reinforcement

Specifications with minor updates:
- Section 310: Placement and Construction of Aggregate Base Course
- Section 322: Decorative Asphalt
- Section 331: Microsurfacing Specifications
- Section 415: Flexible Metal Guardrail
- Section 505: Concrete Structures
- Section 608: Horizontal Directional Drilling
- Section 616: Reclaimed Water Line Construction
- Section 711: Paving Asphalt
- Section 725: Portland Cement Concrete
- Section 729: Expansion Joint Filler
- Section 772: Chain Link Fence
- Section 796: Geosynthetics

New detail drawings:
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Changes made in the 2016 Revision

Uniform Standard Specifications and Details for Public Works Construction—2016 Revision to the 2015 Edition
The MAG Standard Specifications and Details Committee, with assistance from specialized working groups, considered 18 cases during the 2015 session. Of these, 14 were approved and included in this revision.

New Specifications:
- Section 322: Decorative Asphalt
- Section 608: Horizontal Directional Drilling

Specifications rewritten, or with major updates:
- Section 321: Placement and Construction of Asphalt Concrete Pavement
- Section 336: Pavement Matching and Surfacing Replacement
- Section 342: Interlocking Concrete Paver Installations
- Section 602: Trenchless Installation of Steel Casing
- Section 718: Preservative Seal for Asphalt Concrete

Specifications with minor updates:
- Section 325: Placement and Construction of Asphalt-Rubber Asphalt Concrete Pavement
- Section 334: Preservative Seal for Asphalt Concrete
- Section 345: Adjusting Frames, Covers and Valve Boxes
- Section 601: Trench Excavation, Backfilling and Compaction
- Section 625: Manhole Construction and Drop Sewer Connections
- Section 710: Asphalt Concrete
- Section 717: Asphalt-Rubber Asphalt Concrete
- Section 735: Reinforced Concrete Pipe
- Section 771: Galvanizing
- Section 772: Chain Link Fence

Specifications that have been deleted:
- Section 744: ABS Truss Pipe and Fittings

Details that have been updated:
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- Detail 225: INTERLOCKING CONCRETE PAVERS
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STANDARD SPECIFICATIONS for PUBLIC WORKS CONSTRUCTION

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2020 Edition

ARIZONA

FOREWORD

Publication of these Uniform Standard Specifications and Details 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 countywide acceptance and use of these standards and details, the Maricopa Association of Governments accepted their sponsorship and the responsibility of keeping them current and viable.

These specifications and details, representing the best professional thinking of representatives of 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 within Maricopa County who could not afford to promulgate such standards for themselves. Agencies in other regions or climes that desire to use these specifications may need to make adjustments for local conditions.

A uniform set of specifications and details, updated and embracing the most modern materials and construction techniques will reduce conflicts, provide clarity and lower construction costs for the benefit of the public.

Use of these standards for projects outside of the right-of-way should be reviewed by professional engineers and architects and applied with care to insure relevance to the planned work.

Specifications and details should be incorporated into project plans and specifications after careful review by the design engineer or architect of specific project needs. Not all specifications contained herein will apply to all projects. Prepared plans and specifications should clearly call out only those specific uniform specifications and details required for the project.

Uniform specifications and details are not a substitute for good engineering judgment. Unique conditions will arise that are outside the scope of these standards. When this happens, professional engineers and architects are required to use their judgment to amend these standards to best meet site-specific project needs in accordance with the rules set forth by the State of Arizona and policy statements made by the Arizona State Board of Technical Registration.

The Uniform Standard Specifications and Details for Public Works Construction are revised periodically and reprinted to reflect the changing technology of the construction industry. To this end a Specifications and Details Committee has been established as a permanent organization to continually study and recommend changes to the Specifications and Details. Interested parties may address suggested changes and questions to:

Standard Specifications & Details Committee
c/o Maricopa Association of Governments
302 North First Avenue, Suite 300
Phoenix, Arizona, 85003

Suggestions will be reviewed by the committee and appropriate segments of the construction industry and revisions will be published the first of each year. A copy of this publication is available for review on the internet at the website listed below. Please follow the links to the publications page and look for *Uniform Standard Specifications for Public Works Construction and/or Uniform Standard Details for Public Works Construction*.

www.azmag.gov

In the interest of regional uniformity, it is hoped that all using agencies will adopt these standards with minimal changes. It is recognized that because of charter requirements and for other reasons, some agencies will find it necessary to modify or supplement certain requirements. In the interest of regional uniformity, it is strongly recommended that using agencies bring desired modifications to the MAG Committee for consideration and inclusion into these standards.

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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 constructed 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
ADA	Americans With Disabilities Act of 1990
ADEQ	Arizona Department of Environmental Quality
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
ARAC	Asphalt-Rubber Asphalt Concrete
ARIZ	Arizona Department of Transportation Test Method
	Arizona Revised Statutes
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
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
CLR	Clear
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
HH	Hand Hole
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
NTS	Not to Scale
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
SWPPP	Stormwater Pollution Prevention Plan
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 by contract.

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

Arizona Test Method: Arizona Department of Transportation Materials Testing Manual test method.

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, see definitions for Initial Backfill and Final Backfill.

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

Bedding: A material layer placed on top of the trench foundation to the bottom of the pipe, typically 4-6 inches in height. The bedding establishes the line and grade for a conduit and provides support that is firm, but not hard.

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 heights of curbs, between the bottoms 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: Every day shown on the calendar.

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

"Careful and prudent manner": means conducting excavation in such a way that when it approaches within twenty-four inches of the underground facility located and marked by the owner or operator, by stakes, paint or in some customary manner, the exact location is manually determined, and the uncovered facility is supported and protected.

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: An existing utility, shown or not shown on the plans is conflicting when any part of the utility falls within the dimensions of the new installation, such that it would be in physical contact with the new installation.

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 therefore 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.

Final Backfill: The material placed in a trench above the initial backfill to the top of the trench or to the bottom of the road base material.

Flooding: Flooding will consist of the inundation of the entire lift with water, puddle 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 a trench, the foundation is the bottom of the required trench excavation. The foundation surface is either native material, or replacement material when unsuitable material occurs, and is removed and replaced at the bottom of the required trench excavation.

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

Haunching: The area of a pipe trench between the bottom of the pipe and the springline of the pipe.

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.

Initial Backfill: The material placed in a trench between the springline and 12 inches above the crown of the conduit.

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: A major item shall be the total of any item of work and/or materials specified in the bid schedule that exceeds the amount established in Table 109-1.

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.

Pipe Embedment Zone: The area of a trench consisting of the bedding, haunching, and initial backfill areas.

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

Plant: The Contractor's and/or subcontractor's 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.

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

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 appurtenant 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.

Springline: The vertical location having a maximum horizontal dimension or in box sections, the mid-height of the vertical wall.

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, end walls, 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 the Arizona Revised Statutes.

Superpave Mix: Asphalt mix in compliance with the Gyratory Mix design requirements of Section 710.3.2.2.

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 finished 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.

"Underground Facility": means any item which shall be buried or placed below ground for use in connection with the storage or conveyance of water, sewage, electronic, telephone or telegraphic communications, electric energy, oil, gas or other substances, and shall include, but not be limited to pipes, sewers, conduits, cables, valves, lines, wires, manholes, attachments and those portions of poles and their attachments below ground.

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.

- End of Section -

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, the contracting agency's supplements 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 a case of a discrepancy or conflict, the order in which the various documents shall govern is as follows from highest to lowest: addenda, special provisions, plans, agency's supplements to the standard specifications, agency's supplements to the standard details, standard specifications and standard details.

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 the 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 GUARANTEES:

No proposal will be read unless accompanied by a proposal guarantee in the proper amount and in the form provided 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.

The proposal guarantee shall be in the form of a certified check, cashier's check, or surety bond for ten percent of the amount of the bid. The surety bond shall be executed solely by a surety company or companies holding a certificate of authority to transact surety business in the State of Arizona issued by the Director of the Department of Insurance. The surety bond shall

not be executed by an individual surety or sureties. In addition, said company or companies shall be rated "Best A-" or better as required by the Contracting Agency, as currently listed in the most recent Best Key Guide, published by the A.M. Best Company.

102.9 SUBMISSION OF PROPOSAL:

The proposal and proposal guarantee shall be submitted in a sealed envelope. The outside, lower right-hand 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.

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 the 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 corporation 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 seven (7) sets of plans and special provisions, for the project from the Contracting Agency, at no cost.

- End of Section -

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 re-advertise 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 50 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 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, within 10 days after receipt of such notice or his proposal guarantee shall be forfeited as provided elsewhere herein. Concurrently with the contract, the Contractor shall submit all documentation required to enable the agency to execute the contract.

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 Arizona Revised Statutes, 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 submittal 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 judgment 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 holding a certificate of authority to transact surety business in the State of Arizona issued by the Director of the Department of Insurance. The bonds shall not be executed by an individual surety or sureties. 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. In addition, said company or companies shall be rated "Best A-" or better as required by the Contracting Agency, as currently listed in the most recent Best Key Rating Guide, published by the A.M. Best Company.

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. Neither the Contractor nor any subcontractor shall commence work under a contract until the Contracting Agency has approved the insurance. The entire project covered by the contract will be at the Contractor's risk until final acceptance by the Contracting Agency.

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

(A) **Public Liability and Property Damage Insurance:** The Contractor shall provide and maintain, during the life of the contract, General Liability, Automobile Liability, and Worker's Compensation Insurance as follows:

INSURANCE	**MINIMUM LIMITS OF LIABILITY**
GENERAL LIABILITY Comprehensive Form Premises/Operations Underground Explosion and Collapse Hazard Exclusions Deleted (where applicable) Products/Completed Operations Contractual Independent Contractors (OCP) Broad Form Property Damage Personal Injury with Exclusion "C" Deleted	$1,000,000 Combined Single Limit —
AUTOMOBILE LIABILITY Owned Hired Non-Owned	$1,000,000 Combined Single Limit

EXCESS LIABILITY Umbrella Form	As required
WORKER'S COMPENSATION & EMPLOYERS' LIABILITY	Statutory Limits
BUILDER RISK/COURSE OF CONSTRUCTION	As required

The Contracting Agency shall have no responsibility or liability for such insurance coverage.

The Contractor shall furnish a Certificate of Insurance on a form approved by the Contracting Agency. The Certificate shall be issued by an insurance company authorized to transact business in the State of Arizona, or be named on the list of Unauthorized Insurers maintained by the Arizona Department of Insurance. Insurance coverage shall not expire until all the work has been completed and the project has been accepted by the Contracting Agency. If an insurance 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 thirty (30) days prior to the expiration date.

(B) **Worker's Compensation and Employer's Liability:** 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 Arizona Department of Insurance to provide Workmen's Compensation and Employer's Liability Insurance in the State of Arizona.

(C) **Builders Risk/Course of Construction**: When the project includes construction of a new building or addition to an existing building, the Contractor shall also obtain insurance coverage for at least, as a minimum, the perils of fire, extended coverage, vandalism and malicious mischief for the full amount of the contract. The Contractor shall be responsible for any deductibles, mutual waiver of subrogation and any co-insurance for the construction that is the subject of this contract.

(D) **Additional Insured**: The Contracting Agency, its officers, agents and employees shall be named as insurers on policies listed in (A) and (C) and this shall also be indicated on the Certificates of Insurance issued to the Contracting Agency. The Contractor's coverage shall be primary for any and all losses arising out of the performance of this contract.

(E) **Owner Protective Policy**: In addition to other insurance the Contractor is required herein to provide and maintain in its own name, the Contractor shall also provide and maintain a separate policy of insurance, at its sole cost and expense, naming the Contracting Agency as the insured and providing primary coverage for the Contracting Agency in an amount not less than One Million Dollars, or other minimum amount determined by the Agency, for personal injury or death, per person and per occurrence, and not less than $500,000 for property damage for any damage or injury suffered as a result of any work performed by Contractor or its employees, representatives, contractors or subcontractors in connection with the Project or Permit. Such policy shall also provide the Contracting Agency coverage, in the amounts specified above, for any and all damages or injury suffered as a result of alleged acts or omissions of the Contracting Agency in connection with, directly or indirectly, the Project or Permit. Such policy shall be primary and not contributory to any insurance maintained by the Contracting Agency. The insurance company writing such policy must have a BEST rating of not less than "A-" and be licensed by the Arizona Department of Insurance to do business in the State of Arizona. The form of the policy must be approved by the Contracting Agency before the notice to proceed will be issued.

103.6.2 Indemnification of the Contracting Agency Against Liability: To the fullest extent permitted by law, the Contractor, its successors, assigns and guarantors, shall pay, defend, indemnify and hold harmless the Agency, its agents, representatives, officers, directors, officials and employees from and against all allegations, demands, proceedings, suits, actions, claims, damages, losses, expenses, including but not limited to, attorney fees, court costs, and the cost of appellate proceedings, all claim adjusting and handling expense, related to, arising from or out of or resulting from any actions, acts, errors, mistakes or omissions caused in whole or part by the Contractor relating to work or services in the performance of the Contract, including but not limited to, any Subcontractor or anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable and any injury or damages claimed by any of the Contractor's and Subcontractor's employees.

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.

- End of Section -

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.

In the event a conflict exists between Contract Documents, the order of precedence listed in descending order shall be as follows:

Change Orders
Addenda
Special Provisions
Project Plans
Contracting Agency's supplements to the MAG Uniform Standard Specifications and Details
MAG Uniform Standard Specifications
MAG Standard Details

Unless otherwise specified in the special provisions, The Contractor 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, motel, 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 provide 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 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.

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.

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

The cost of watering will be included in the proposal price for the construction operation to which such watering is incidental or appurtenant.

104.1.4 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.

At disposal sites and storage sites, other than agency landfills, the Contractor shall be responsible for all required dust control measures. This includes temporary yard or staging areas.

The Contractor shall take whatever steps, procedures or means required preventing 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.

104.1.5 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 any time 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 perform 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.

*Not applicable to Improvement District Projects

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 affected. 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 instructions received involve extra work under the contract, he shall give the Engineer written notice within two work days 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.

- End of Section –

*Not applicable to 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:

The Contractor shall submit, for review, a proposed schedule of shop drawings and product data submittals. This schedule will include concrete and asphalt concrete mix designs unless they are previously approved supplier's mix design. The schedule will show the needed response date for each submittal and will indicate the relationship of the submittal to the project construction schedule.

Shop drawings for major temporary support structures such as falsework, shoring, soldier piles, and other major temporary structures that facilitate construction shall be prepared by and bear the seal and signature of a Professional Engineer. Temporary support structures for Minor Structures as defined in Section 505.1.1 are exempt from this requirement.

The Contractor shall submit five (5) copies of each shop drawing, product data or mix design to the Engineer for review. Each submittal shall be numbered sequentially and shall be submitted in accordance with the schedule established in conjunction with the Contracting Agency so as to cause no delay in the work schedule. The Contractor shall certify, by stamp or letter, that he has reviewed and approved the submittal and that it conforms to the requirements of the contract documents. If this certification is not included, the submittal will be returned without action.

At the time of each submittal, the Contractor shall define and delineate in writing, separate from the certification, any deviations from the contract documents. If the Engineer accepts this deviation, he will authorize the deviation by issuing a change order or if the deviation is minor by endorsement to the letter.

The Engineer will review and return the submittals in accordance with the previously established response date. The review will be only for conformance with the design concept of the work and for compliance with the information contained in the contract documents. The review of a specified item, as such, will not indicate review of the assembly in which the item functions. Review by the Engineer will not relieve the Contractor from responsibility for any errors or omissions in the submittals nor from his responsibility for complying with the contract documents. The only exception is deviations accepted in accordance with the preceding paragraph.

If the submittal is acceptable, one (1) copy with each page stamped "Furnish as Submitted" will be returned to the Contractor. The Contractor shall submit additional copies (as required) to the Engineer.

If the Engineer determines that the submittal requires corrections or is to be rejected, one (1) copy stamped "Furnish as Noted" or "Revise and Resubmit" will be returned to the Contractor. The Contractor will submit five (5) corrected or new copies.

The copy stamped "Furnish as Submitted," returned to the Contractor, will become a part of the contract documents and will be kept at the job site. Any work done prior to the receipt of this review will be at the Contractor's risk and expense.

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 judgment.

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 site 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. The superintendent shall be authorized to receive and fulfill instructions from the Engineer and who shall supervise and direct the work. No less than fourteen days prior to the scheduled/planned Notice to Proceed, the Contractor shall submit to the Engineer for review and approval, the name and qualifications of the proposed superintendent. When the superintendent is approved, he shall not be changed by the Contractor without written approval of the Engineer. 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 comply with the requirements of Arizona Revised Statutes 40-360.21 through 40-360.29 (one-call notification center, Arizona 811) in notification to the interested utility owners prior to start of construction. The Contractor shall resolve all problems with the utility owners concerned.

Where water user's association facilities obstruct construction of the work, the Contractor shall contact officials of the association relative to the shutdown of irrigation water and shall acquaint himself with and conform to the requirements of the association.

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. Any work performed by the Contractor for any utility company, separate from the contract shall be paid for by the utility company and will not be a part of the agency contract.

105.6.1 Notifications Requirement in the Event of Any Damage to or Dislocation of Underground Facilities: In the event of any damage to or dislocation of any underground facility, the Contractor responsible for the excavation operation shall immediately notify the owner of such facility and shall not attempt to repair any facility, except those intended for the conveyance or storage of water and sewage. The excavation shall be left open until the arrival of representatives of the owner. The owner will dispatch its representative promptly to examine the underground facility and, if necessary, make repairs.

105.6.2 Work Within a Railroad Right of Way: When a railroad right of way is included in the work, the Contractor shall:

(A) Comply with the rules and regulations of the railroad company relative to the required manner of constructing said portion of the work; and shall perform the work so as not to endanger or interfere with the safe operation of the track(s) and property of the railroad company and of the traffic moving on such track(s).

(B) Carry the kinds and amounts of insurance and bonds required by the railroad company for the period of time in which work is performed on or adjacent to the railroad company's property, and until such work has been satisfactorily completed and all tools, equipment and materials have been removed from the railroad company's property and such property is left in a clean and presentable condition.

(C) Contact the railroad company at least 48 hours in advance of performing any construction within the right of way of any track(s).

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 interfere 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 roadwork, 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 two 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 benchmark of known location and elevation for use as a reference.

105.9 DUTIES OF INSPECTOR:

The Engineer may provide the Inspector, assistants, and other field staff to assist the Engineer in observing performance of the work of the Contractor. Through onsite observations of the work in progress and field checks of materials and equipment, the

Inspector shall endeavor to provide further protection for the Contracting Agency against defects and deficiencies in the work

of the Contractor; but, the furnishing of such services will not make the Inspector responsible for or give the Inspector control over construction means, methods, techniques, sequences, or procedures or for safety precautions or programs, or responsibility for the Contractor's failure to perform the work in accordance with the contract documents.

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 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, the 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.

- End of Section -

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.

Unless otherwise noted, all materials used in the project shall be new and unused. Additionally, any new materials used in this project that are damaged during the construction of the project and prior to final acceptance, as determined by the Engineer, shall be replaced by the Contractor with new material at no additional cost to the Contracting Agency.

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 issuance of the solicitation for a construction price proposal (aka: 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 Engineer, 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.

106.2.1 Certificate of Compliance: A Certificate of Compliance shall be submitted on the manufacturer's or supplier's official letterhead, and shall contain the following information:

1. The current name, address, and phone number of the manufacturer or supplier of the material or equipment.
2. A description of the material or equipment supplied.
3. Quantity of material represented by the certificate.
4. Means of material identification, such as label, lot number, or marking.
5. A statement that the material complies in all respects with the requirements of the cited specifications. Certificates shall state the name of the specific cited specifications, such as AASHTO M-320, ASTM C494, or specific table or subsection of the Specifications or Special Provisions.
6. A statement that the individual identified in item eight below has the legal authority to bind the manufacturer or the supplier of the material.
7. Project identification: Project name and all associated numbers (agency, Federal, and ADOT TRACS).
8. The name, title, and signature of the responsible individual. The date of the signature shall also be given.

Each of the first six items specified above shall be completed prior to the signing of the certificate as defined in item eight. No certificate will be accepted that has been altered, added to, or changed in any way after the authorized signature has been affixed to the original certificate. However, notations related to project specifics such as project identification, contractor, or quantity shipped are acceptable, provided the basic requirements of the certificate (items one through six) are not affected.

A copy or facsimile reproduction of the original certificate will be acceptable; however, the original certificate shall be made available upon request.

106.2.2 Certificate of Analysis: A Certificate of Analysis shall include all the information required for a Certificate of Compliance and, in addition, shall include the results of all tests required by the specifications.

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 manufacture 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. Unless the name is followed by words indicating that no substitution is permitted, such references shall be regarded as establishing a standard of quality, finish, appearance, performance or, as indicated, a selection based upon compatibility with existing equipment or materials.

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

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

(B) Only substitutions submitted by the Contractor will be accepted for review. The substitution shall be submitted in writing to the Engineer.

(C) The submittal shall certify that the substitution will perform the functions and achieve the results called for by the general design, be similar and of equal substance, and be suited to the same use as that specified.

(D) The submittal shall state any required changes in the contract documents to adapt the design to the proposed substitution. This will include all changes required of other contractors/subcontractors affected by the resulting changes.

(E) The submittal shall contain an itemized estimate of all costs and credits that will result directly or indirectly from the acceptance of such substitution, including costs of design, license fees, royalties, testing, Engineer's evaluation, claims of other contractors/subcontractors, etc. In addition, the submittal shall include any adjustment in the contract time created by the substitution.

(F) The Contractor, on request of the Engineer, shall submit samples or any additional information the Engineer may deem necessary to evaluate the acceptability of the substitution. The Engineer will evaluate the information provided, perform tests when necessary and make comparisons. The Engineer will then make the final decision as to the acceptability of the proposed substitution. The Contractor will be notified in writing by the Engineer as to whether his substitution has been accepted or rejected.

(G) The submittal, for purposes of review, number of copies, etc., shall follow the procedures as outlined in Section 105.2, except in the case of response time. If the Engineer does not respond in a timely manner, which in turn, impacts the substitution, the Contractor shall continue to perform the work in accordance with the contract and the substitution will be considered rejected. In addition, no adjustment in the contract time will be granted for nonacceptance of the substitution.

(H) There will be no additional costs to the Contracting Agency for the substitution. If the substitution yields a net savings in the contract price, the amount of savings shall be divided between the Contracting Agency and the Contractor in a percentage established by the Contracting Agency.

(I) If the substitution is accepted and an adjustment in the contract cost and/or contract time is in order, a change order will be issued to the Contractor for the changes.

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 as 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.

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.

- End of Section -

SECTION 107

LEGAL REGULATIONS AND RESPONSIBILITY TO PUBLIC

107.1 COMPLIANCE WITH LAWS:

The Contractor shall keep fully informed of, observe and comply with 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. The Contractor warrants that all items supplied and work performed under the contract have been sold, produced, delivered and furnished in strict compliance with all such laws, ordinances, regulations, codes, orders and decrees to which the items, work and Contractor are subject. Upon request, Contractor shall execute and deliver to the Agency such documents as may be required by the Agency to evidence compliance with such laws, ordinances, regulations, codes, orders and decrees. The Contractor 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 the Contractor or the Contractor's employees.

107.2 PERMITS:

Permits, bonding and insurance requirements shall be as required by statutes, codes, ordinances or regulations.

The Public Agency, when acting as the Contracting Agency, may obtain some of the required permits. It is the duty of the Contractor to determine that all necessary permits have been obtained. The Contractor shall, at the Contractor's own expense, obtain all the required permits, which have not been furnished. The Contractor shall comply with all permit requirements until the Contract is completed or the permit is closed-out or transferred. The Contractor shall be responsible to close out all permits except those authorized by special provision to be transferred.

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 employees 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 41-865 Arizona Revised Statues. 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 the 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 there under.

107.5.1 Asbestos Materials: If asbestos materials are encountered during any building remodeling/demolition work, the Contractor shall comply fully with the Arizona Administrative Code, A.A.C. R18-2-901 and notify the Engineer. An extension of contract time will be granted for any delay resulting from the asbestos material in accordance with Section 108.

107.5.2 Lead-Containing Paint: Paint and similar surface coating materials that contain lead compounds and in which the lead content exceeds 0.06 percent of the total weight of the non-volatile content of the paint or the weight of the dried paint film is declared a banned hazardous product and will not be used (Consumer Product Safety Act Part 1303 dated 9-1-77).

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.

107.6.1 Contractor's Marshaling Yard: If the Contractor or his subcontractor utilizes property outside the limits of the project in the performance of the contract, the Contractor/subcontractor shall comply with the following:

107.6.1.1 Contractor's Marshaling Yard when the Agency is the Contracting Party:

(A) Prior to occupying the property, the Contractor shall provide written notification as to the number and location of all properties to be used. The notification shall specify in detail how the Contractor proposes to use each property and how he proposes to comply with (B) through (D) below. In addition, the Contractor shall provide a statement, signed by the property owner(s), which gives the Contractor permission to use the property.

(B) The property(s) shall be adequately maintained to control dust, mud, trash and other pollutants from leaving the property.

(C) Work on the property(s) shall be scheduled so as to comply with the Agency Noise Ordinance.

(D) Use of the property(s) such as location of stored materials, service of equipment, etc., shall be conducted to minimize impact on adjacent properties.

(E) The Contractor shall leave the property in a condition, as determined by the Engineer, equivalent to that which existed prior to entry. In no case shall any use cause, or allow to remain, any negative impact to adjoining properties or right-of-way unless such impact existed prior to the Contractors' use.

(F) The Contractor shall obtain a written release signed and dated from each property owner after completion of use. Each release shall state that, at the time of signing, the owner accepts the property in its present condition from the Contractor and relieves the Contractor and the Agency from any or all claims for the use or damage to said property. A copy of each release shall be submitted to the Engineer.

(G) This Subsection also applies to all levels of subcontractors who will need to obtain marshaling yards for the project, which will be separate from that of the Contractor. It will be the responsibility of the Contractor to obtain copies of the various documents from the subcontractors, as required above, and provide them to the Engineer.

107.6.1.2 Contractor's Marshaling Yard when the Agency is not the Contracting Party (private development, utility work, subdivision construction, etc.): All conditions will apply as in Subsection 107.6.1.1 except that the permit holder will be responsible for obtaining all documents. The permit holder will retain the documents and make them available to the Agency upon request.

107.6.2 The Contractor shall comply with the Agency Code concerning work hours and noise level during construction.

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 Contacting 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. The approval by the Engineer for the use of explosives shall not relieve the Contractor from his responsibilities for proper use and handling of the explosives or for any and all damages resulting from their use.

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, the Institute of Makers of Explosives, and the Occupational Safety and Health Administration Regulations (29 CFR 1926.1(U)). In addition to the applicable regulations, the Contractor shall:

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

(B) 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.

(C) 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.

(D) 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.

(E) Blasting shall be accomplished in such a manner that nearby buildings, structures, railways, highways, etc. will be safe from rocks and other projectiles. Adequate blasting mats or other means of protection shall be employed when blasting in congested area or close proximity to any of the above improvements. Steel mats shall not be allowed within 2,000 feet of power lines.

(F) At the time of firing, the Contractor shall station men along the road at sufficient distance from the blasting operation to flag down any 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. Such damage will include but not be limited to landscaped areas. The contractor shall regrade the disturbed area as directed and restore the surface material to match existing in type and quality.

When construction is within temporary construction easements, the Contractor shall restore all disturbed areas to a condition equal to or better than the existing improvements. Such restoration will include but not be limited to asphalt, walkways, fences, lights, sprinklers, landscaping, etc. In the case of landscaping, the Contractor may remove and store sod and plant material. If, in the determination of the Engineer, the sod and/or plant material did not survive the transplanting in good condition, the Contractor shall replace the sod and/or plant material to match in type and quality. In addition, the Contractor may salvage any sprinkler system materials, lighting materials, etc. In the event that it is not feasible to reinstall the salvaged material, new material shall be installed.

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.

The Contractor shall assume full responsibility for damages to any underground facility/utility as a result of failing to obtain information as to its location, failing to excavate in a careful and prudent manner or failing to take measures for protection of

the facilities/utilities. The Contractor is liable to the owner of the underground facility/utility for the total cost of the repair.

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 contact, 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 Contacting Agency will expeditiously make final inspection and notify the Contractor of acceptance. Such final acceptance, however, shall not preclude or stop 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 stopped 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.

- End of Section -

SECTION 108

COMMENCEMENT, PROSECUTION AND PROGRESS

108.1 NOTICE TO PROCEED:

(A) On Bond Issue and Budget Projects, 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 Arizona Revised Statutes 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 two 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 there under 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.

(E) On all contracts for pipeline construction, roadway construction or roadway maintenance, the Contractor shall perform, with his own organization, work amounting to not less than 50 percent of the total contract cost.

On other types of contracts the individual agency shall determine the percentage or waive this requirement.

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.

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

108.4 CONTRACTOR'S CONSTRUCTION SCHEDULE:

The Contractor, when required, shall furnish the Engineer a construction schedule for his review. The Engineer's review of the Contractor's schedule is for purposes of: (1) the Contracting Agency's staffing the project as may be required; (2) to insure general compliance with the contract documents as it relates to the completion of all work; and (3) to monitor and evaluate the construction status for purposes of approving progress payments. In the event the schedule does not contain sufficient information to meet the above purpose, as determined by the Engineer, the Contractor shall resubmit a new schedule with the additional information requested by the Engineer. The right to determine the sequence of the work is a function vested solely in the Engineer and the construction schedule, when established, 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.

Review of a submitted schedule by the Engineer shall in no way be construed as an affirmation or admission that the schedule is reasonable or workable which responsibilities remain the obligations of the Contractor. When the schedule shows a completion prior to the contract completion date, this extra time between the contract completion date and the scheduled completion date (float), may be used by the Contracting Agency without additional compensation to the Contractor. The Contracting Agency shall not be liable to the Contractor for any damages for delay if the Contractor completes the work prior to expiration of the original Contract completion date or as modified by approved change orders, if any.

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 Engineer 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 Engineer, 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.

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

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.

108.8 GUARANTEE AND WARRANTY PROVISIONS:

The Contractor shall guarantee the work against defective workmanship and materials for a period of one 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 one year thereafter.

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

Should any defects develop within one 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.

If defects develop which are determined by the Engineer to be an emergency, the Engineer shall notify the Contractor, via the most expeditious means, regarding the nature and condition of the defects. In turn, the Contractor shall immediately dispatch necessary forces to correct the defect or the emergency condition. If the Contractor, in his initial action, resolves the emergency condition but not the defect, a letter as discussed above will follow and normal procedures for corrections will be employed. If immediate or appropriate action, satisfactory to the Engineer, is not taken by the Contractor, or if the Contractor cannot be contacted, the Engineer will deploy necessary forces to correct and/or secure the deficiency. Costs of the Engineer's action shall be paid by the Contractor and/or his bonding agency. Should it later be determined that the defects requiring such emergency action are not the responsibility of the Contractor, the Contractor will be paid for all costs incurred as a result of these demands in accordance with Subsection 109.5. Such action by the Engineer will not relieve the Contractor of the guarantees required by this Section or elsewhere in the Contract Documents.

In case of work, materials, or equipment for which written warranties are required by the special provisions, 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 warranties and guarantees provided in this subsection of the contract documents shall be in addition to and not in limitation of any other warranties, guarantees or remedies required by law.

108.9 FAILURE TO COMPLETE ON TIME:

For each and every calendar day that work shall remain incomplete 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 Table 108-1, 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 108-1		
LIQUIDATED DAMAGES		
Original Contract Amount		**Daily Charges**
From More Than	To and Including	Calendar Day or Fixed Date
$ 0	$ 25,000	$ 210
25,000	50,000	250
50,000	100,000	280
100,000	500,000	430
500,000	1,000,000	570
1,000,000	2,000,000	710
2,000,000	5,000,000	1,070
5,000,000	10,000,000	1,420
10,000,000	—	1,780

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.

- End of Section -

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

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 D1250 for asphalt or ASTM D633 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 fee 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.

Where the units of measurement shown on the proposal form or the methods of measurement specified in the project special provisions differ from the measurement and payment provisions of the Uniform Standard Specifications, the project documents shall have precedence.

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 by a licensed public weighmaster or the weighmaster's deputy on a device licensed or certified as defined by Arizona Revised Statutes Section 41-2091 and 41-2093. The Contractor shall furnish the Engineer with duplicate Weighmaster's Certificates showing the actual net weights together with the information required by the rules adopted by the Department of Weights and Measures as authorized by Arizona Revised Statutes Section 41-2065. The Contractor shall furnish the Engineer with duplicate Weighmaster's Certificates at the time of delivery unless the Engineer designates a different submittal time. 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 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.

The unit prices shall include all costs for salaries and wages, all payroll additives to cover employee benefits, allowances for vacation and sick leave, company portion of employee insurance, social and retirement benefits, all payroll taxes, contributions and benefits imposed by any applicable law or regulation and any other direct or indirect payroll-related costs. The unit prices shall also include all costs for indirect charges, overhead, mileage, travel time, subsistence, materials, freight charges for materials to Contractor's facility or project site, equipment rental, consumables, tools, insurance costs, all applicable taxes and fees, as well as Contractor's fee and profit. The unit prices shall further include all site clean-up costs, hauling of construction debris, and proper disposal in accordance with all laws and regulations and the project plans and specifications.

Payment will be made for only those items listed in the proposal. All materials and work necessary for completion of the project are included in proposal items. Work or materials not specifically identified by a proposal item are considered as included in the unit price of related proposal items.

Unless otherwise specified, payment will not be made for unused materials.

109.2.1 Taxes and Fees: Taxes are deemed to include all sales, use, consumer and other taxes that are legally enacted at the time of submittal of the project fee proposal, whether or not they are yet effective or merely scheduled to go into effect. Any such taxes shall be paid by Contractor and shall be included in the unit prices.

The Contractor shall also be responsible to contact all municipalities and other governmental agencies having jurisdictional authority over the project or the project area to determine if they will charge the Contractor other fees (e.g., permit fees) for the project work. Unless otherwise specified in the project documents or on the proposal form, the Contractor shall include the cost of such fees in the unit prices on the proposal form.

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:

All compensation due the Contractor for alteration of work shall be documented by a Change Order. Except in emergency situations or as otherwise directed by the Engineer, the Contractor shall not proceed with Change Order work until said Change Order has been approved by the Agency.

***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 price. This does not apply to items labeled as contingent items in the proposal.

*Not applicable to Improvement District Projects

(B) For an increase greater than 20 percent in either the total cost of the contract or the total cost of a major item, any adjustment made will only apply to that cost in excess of 120 percent of the original total cost of the contract or, in the case of a major item, in excess of 120 percent of the original proposed extended unit price. 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 Section 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 cost of accomplishing the work, new unit 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 Section 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 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 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 Section 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 Engineer provides the Contractor with a written order to provide adequate maintenance of traffic, adequate cleanup, and adequate dust control or to correct deficiencies resulting from abnormal weather conditions and the Contractor fails to comply in the time frame specified, the Contracting Agency may have the work accomplished by other sources. The Contracting Agency will deduct the cost of accomplishing the work from monies due or to become due to the Contractor. Computation of the cost will be in accordance with Section 109.5.4.2.

109.4.6 Allowable Mark-Ups: Only the allowable mark-ups as defined in Section 109.5 shall be allowed. Additional compensation for other items, including extended overhead and conditions, shall not be considered or allowed.

***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.

*Not applicable to Improvement District Projects

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

109.5.2 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 profit.

(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 or Other Sources:

109.5.4.1 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 plus the following percentages for administration and supervision.

(A) For the first $10,000 accumulated total of all change order 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 change order work in excess of $10,000 accumulated total performed by subcontractors (less mark-up for overhead and profit), the Contractor will be paid an amount equal to five percent of the accumulated total for administration and supervision.

109.5.4.2 Work Performed by Other Sources: If the Contracting Agency has work performed by other sources, in accordance with Section 109.4.5 (B), the Contracting Agency will deduct, from monies due or to become due to the Contractor, the full amount of the cost of accomplishing the work by other sources plus the following percentages for administration and supervision:

(A) For the first $10,000 accumulated total of work performed by other sources, the Contracting Agency will deduct an amount equal to 10 percent of the accumulated total for administration and supervision. If the accumulated total is $3,000 or less, the Contracting Agency will deduct $300 for administration and supervision.

(B) For all work in excess of $10,000 accumulated total performed by other sources, the Contracting Agency will deduct 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 public liability insurance. No duplication of payment for Contractor's costs included under Section 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 equipment 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 48-523 to 48-613, 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 48-589.

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**: The Contracting Agency will make a partial payment to the Contractor on the basis of an estimate prepared by the Contractor or Engineer for work completed through the last day of the preceding calendar month. Payment will be within 14 calendar days after the estimate has been certified and approved by the Engineer and received by the owner.

*Not applicable to Improvement District Projects

The Contracting Agency will retain 10 percent of all estimates as a guarantee for complete performance of the contract in accordance with Arizona Revised Statutes Section 34-221 or 34-607, unless the Contractor elects to deposit securities in accordance with Arizona Revised Statutes Section 34-221, Paragraph C.5. or 34-607, Paragraph B.5.

When the Contractor is fifty percent completed, one-half of the amount retained shall be paid to the Contractor provided he is making satisfactory progress on the contract and there is no specific cause or claim requiring a greater amount to be retained. After the contract is fifty percent completed, no more than five percent of the amount of any subsequent progress payments made under the contract will be retained providing the Contractor is making satisfactory progress on the project. Except that, if at any time the owner determines satisfactory progress is not being made, ten percent retention shall be reinstated for all progress payments made under the contract subsequent to the determination.

Any material or equipment, which will become an integral part of the completed project, will be considered for partial payment in the Contractor's monthly progress payments. The intent of making partial payments is to provide the Contractor payment for direct material or equipment purchased. The purpose is to minimize the effect of escalating costs by procuring key materials. It is not the intent to pay for all materials but only those meeting the following conditions.

(1) A total value of all items requested for payment must be greater than $20,000. No payment will be processed until the material or equipment has been observed, reviewed or verified by the Contracting Agent representative. Only the material or equipment meeting the requirements of the plans and specifications will be paid. Payment for material or equipment does not constitute final acceptance.

(2) Materials or equipment must be stored or stockpiled either on site, in a warehouse, or secured storage area. The Contractor assumes all responsibility for protection of these materials or equipment and shall insure them to cover loss or damage to same without additional liability or added costs to the Agency for providing this security, insurance, and storage.

(3) The Contractor will provide access to the storage area or warehouse upon request of the Contracting Agent's representative for the purpose of verifying the inventory of items paid for under this Section. None of the materials or equipment paid for under this Section will be removed from the storage site until incorporated into the work of the project. The storage site shall be within the general geographical area of the project.

(4) The Contractor shall provide a paid invoice and/or lien waiver for items paid for under this Section. The Agency will not pay more than the invoice price for the item or items, less retention.

(5) The Engineer may exclude individual payment requests, which in the Engineer's judgment do not warrant storage and prepayment under the intent of this Section.

(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 sixty (60) 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.

If payment will be longer than 60 days after final completion and acceptance, the owner will provide the Contractor specific written findings for reasons justifying the delay in payment.

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.

109.8 PAYMENT FOR DELAY:

The procedures contained in this Section shall not be construed to void any provision of the contract, which require notice of delays, provides for negotiation of other procedures for settlement or provide for liquidated damages.

109.8.1 Failure to Locate or Incorrect Location of Utilities: Arizona Revised Statutes 40-360.28 indicates that "if a person (owner, operator, or agent) fails to locate or incorrectly marks the location of the underground facility in a timely manner, the person (owner, operator, or agent) becomes liable for resulting damages, costs and expense to the injured party." The Contracting Agency will deny any claims for damages or delays if another owner or operator is at fault.

109.8.2 Contracting Agency Delays: Arizona Revised Statutes 34-221 states "A contract for the procurement of construction shall include a provision which provides for negotiations between the Agent and the Contractor for the recovery of damages related to expenses incurred by the Contractor for a delay for which the Agent is responsible, which is unreasonable under the circumstances and which was not within the contemplation of the parties to the contract." In this case, if the Contractor sustains damages, which could not have been avoided by the judicious handling of forces, equipment and plant or by reasonable revision in the Contractor's schedule of operation, the compensation for such damages will be negotiated. The Contractor shall notify the Engineer of the condition in writing by the next work day. Failure to notify the Engineer within this time may be just cause to reject any claims for such damages.

Compensation for such damages will be negotiated as follows:

(A) The Engineer shall be satisfied that the Contractor has made every reasonable effort to prosecute the work despite any delays encountered or revisions in the Contractor's scheduling of work.

(B) The Compensation paid to the Contractor shall be in accordance with Section 109.

109.8.3 Extension of Contract Time: For any such delays, the contract time will be adjusted in accordance with Section 108.7.

109.9 DOLLAR VALUE OF MAJOR ITEM:

TABLE 109-1	
DOLLAR VALUE OF MAJOR ITEM	
Original Contract Amount	Dollar Value of Major Item
$0.00 to $1,000,000.00	$50,000 or 10% of original contract amount, whichever is less
$1,000,000.00 to $5,000,000.00	5.0% of original contract amount
$5,000,000.00 or greater	$250,000.00 or 2.5% of original contract amount, whichever is greater

109.10 PAYMENT FOR MOBILIZATION/DEMOBILIZATION:

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

Mobilization/demobilization will be measured for payment by the lump sum as a single complete unit of work. Payment for mobilization/demobilization will be made at the contract lump sum price. Payment shall be made in equal one-third portions. The first payment will be paid with the Contractor's initial billing. The second payment will be made when the total payments to the Contractor for the pay items, exclusive of payments for mobilization/demobilization, equal greater than one-half of the initial contracted amount, exclusive of mobilization/demobilization. The remaining one-third will be paid as part of the final payment due to the Contractor.

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

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

For projects that do not list mobilization/demobilization as a pay item, a single round trip mobilization/demobilization shall be considered a non-pay item for said projects, the cost of which shall be spread across other appropriate items. Should a second or additional mobilization/demobilization be required at the Engineer's express written request, compensation for such shall be handled as detailed in the foregoing paragraph.

- End of Section -

SECTION 110

NOTIFICATION OF CHANGED CONDITIONS AND DISPUTE RESOLUTION

110.1 GENERAL:

When changes are initiated by the Contracting Agency, or as a result of decisions rendered by the Agency, inaction of the Agency or changed conditions unknown to all parties at the time of bid, the Contractor may request an adjustment to the contract amount and/or contract time. This Section does not preclude the use of legal remedies in the event of claims or litigation brought by third parties. The procedure for this adjustment is a two-step process, (1) Initial Notification and Dispute Resolution and (2) Administrative Process for Dispute Resolution, as discussed below:

110.2 INITIAL NOTIFICATION AND DISPUTE RESOLUTION:

110.2.1 Notification: As required by these Specifications or any time the Contractor believes that the action or decision of the Contracting Agency, lack of action by the Contracting Agency, or for some other reason will result in or necessitate the revision of the contract, the Engineer must be notified immediately. If within two working days the identified issue has not been resolved between the Contracting Agency and the Contractor, the Contractor shall provide a written notice. At a minimum, the written notice shall provide a description of the nature of the issue, the time and date the problem was discovered, and if appropriate, the location of the issue. After initial written notice has been provided, the Engineer will proceed in accordance with Subsection 104.2. In addition to proceeding in accordance with Subsection 104.2, the Contracting Agency and the Contractor must make every effort to resolve the issue identified in the initial notice. Only if the issue cannot be quickly resolved will it be necessary to proceed to the next step in this subsection.

110.2.2 Dispute Resolution: Once the above process has been exhausted or within seven calendar days of the date of the initial written notice, whichever is sooner, the following steps will be taken:

(A) The Contractor shall provide in writing the following information to the Engineer. If known, a cost analysis may be included with the information.

(1) The date of occurrence and the nature and circumstances of the issue for which initial notice was given.
(2) Name, title, and activity of each Contracting Agency or all other persons knowledgeable of the issue.
(3) Identity of any documents and the substance of any oral communication related to the issue.
(4) Basis for an assertion that the work required is a change from the original contract work or schedule.
(5) Identity of particular elements of contract performance for which a change in compensation and/or time may be sought, including:
    (a) Pay item(s) that have been or may be affected by the issue and any adjustments to unit price(s) that are required;
    (b) Labor and/or materials that will be added deleted or wasted by the problem and what equipment will be idled or required;
    (c) Delay and disruption in the manner and sequence of performance that has been or will be caused;
    (d) Adjustments to delivery schedule(s), staging, and contract time due to the dispute and
    (e) Estimate of the time within which the Contracting Agency must respond to the notice to minimize cost, delay, or disruption of issue.
(6) Any other items or information germane to the dispute.
(7) The Contractor's written certification, under oath, attesting to the following:
    (a) The request is made in good faith.
    (b) Supportive data is accurate and complete to the Contractor's best knowledge and belief.
    (c) When provided, the amount requested accurately reflects the Contractor's actual cost incurred.

In complying with this request, the Contractor shall use the Contracting Agency's certification form.

(B) Within ten calendar days after the Contractor's submission in accordance with the above paragraph, the Engineer will respond in writing to the Contractor to:

(1) Confirm that a supplemental agreement is necessary and, when necessary, give appropriate direction for further performance, or

(2) Deny that the contract has been revised and, when necessary, direct the Contractor to proceed with the contract work, or

(3) Advise the Contractor that adequate information has not been submitted to decide whether (1) or (2) applies, and indicate the needed information and date it is to be received by the Engineer for further review. The Contracting Agency will respond to such additional information within ten calendar days of receipt from the Contractor.

110.2.3 Conditions: The failure of the Contractor to comply with the requirements of this subsection constitutes a waiver of entitlement to additional compensation or a time extension.

110.3 ADMINISTRATIVE PROCESS FOR DISPUTE RESOLUTION:

110.3.1 General: If the Contractor rejects the decision of the Engineer in Subsection 110.2.2 (B) above, the Contractor may begin the Administration Process to resolve the dispute.

The notice provision set forth in Subsection 110.2 is a contractual obligation assumed by the Contractor in executing the contract. It is understood that the Contractor will be forever barred from recovering against the Contracting Agency if the Contractor fails to give notice of any act or failure to act, by the Engineer, or the happening of any event, thing, or occurrence, in accordance with Subsection 104.2 Alteration of Work.

The administrative process for the resolution of disputes is sequential in nature and is composed of the following levels:

Level I. (Representative reviewed by: *e.g. Construction Engineer*)
Level II. (Representative reviewed by: *e.g. Assistant County/City Engineer*)
Level III. (Representative reviewed by: *e.g. County/City Engineer*)

Note: The above stated titles may vary depending on the Contracting Agency's organization.

These three levels of review; the specific titles; the financial authority of each: and the names of people assigned to each level shall be provided at the preconstruction conference. The equivalent information regarding the Contractor's organization shall also be provided at the preconstruction conference.

Except as provided elsewhere herein, no dispute will be accorded a particular level of review unless the dispute has been reviewed at the preceding level and the Contractor rejects the decision in writing within the time period specified, or both parties agree that the decision for compensation is above that levels authority.

Unless specifically requested otherwise by the Contracting Agency, submission of additional information by the Contractor or Engineer, at any level of the review process shall cause the process to revert to Level I.

110.3.2 Required Information: At a minimum, the information described in Subsection 110.2 must accompany each dispute. If the following applies, it shall also be provided in addition to the information required by Subsection 110.2.

(A) If additional compensation is sought, the Contractor shall submit the exact amount sought as required by Subsection 110.2.2 (A) (5) broken down into the following categories:

(1) Direct Labor
(2) Direct Materials
(3) Equipment
(4) Job Overhead
(5) General and Administrative Overhead
(6) Subcontractor's Work (broken down as 1, 2, 3 and 4 above)
(7) Other categories as specified by the Contractor.

(B) If additional time is sought, the Contractor shall provide a comprehensive time impact analysis showing the delay(s) and how they affect the critical path. The time impact analysis must include both the original and as-built critical path schedules and must be supported by documentation such as delivery schedules, invoices, correspondence, memoranda of telephone calls, payroll data, daily work schedules, etc.

NOTE: The path of the longest duration of continuous and dependent work activities through the schedule network is identified as the Critical Path and is the minimum amount of time required to build the project as depicted by the schedule.

(C) The Contractor shall also notify the Contracting Agency's Level I Representative in writing that all documentation in support of the dispute has been provided and that the administrative review process should begin. No formal action will be taken by the Level I Representative until this written notification is received. The documentation provided to the Level I Representative shall serve as the basis for evaluating the Contractor's position regarding the dispute throughout the administrative process.

110.3.3 Process: The Contracting Agency's Level I Representative will render a written decision regarding the matter in dispute within two working days of receipt of the Contractor's notification that the dispute resolution process should begin.

The Contractor shall, upon receipt of the decision by the Level I Representative, either accept or reject the decision in writing. If the Contractor does not reject the Level I Representative's decision within two working days of its receipt, the Contractor will be deemed to have accepted the decision, the dispute will be considered withdrawn from the administrative process, and there will be no further remedy.

If the Contractor rejects the decision of the Level I Representative, the dispute will be forwarded by the Level I Representative to the Level II Representative. The Level II Representative will, within seven working days of receipt of the dispute information from the Level I Representative, schedule and hold a meeting to review the dispute with the Contractor. This time limit may be extended by mutual agreement of the parties. The Level II Representative will, within seven working days of the meeting, issue a written decision, with justification, regarding the dispute.

The Contractor shall, within seven working days of receipt of the decision, either accept or reject it in writing. If the Contractor does not reject the Level II decision within seven working days, the Contractor will be deemed to have accepted the decision and the dispute will be considered withdrawn from the administrative process and there will be no further remedy.

If the Contractor rejects the decision of the Level II Representative, the Level II Representative will forward the dispute to the Level III Representative. The Level III Representative will, within fourteen working days of receipt of the dispute information from the Level II Representative, schedule and hold a meeting with the Contractor. This time limit may be extended by mutual agreement of the parties. The Level III Representative will, issue a written decision within fourteen working days of the meeting, with justification, regarding the dispute.

The Contractor shall, within fourteen working days of the receipt of the decision of the Level III Representative, either accept or reject it in writing. If the Contractor does not reject the Level III Representative's decision within fourteen working days, the Contractor will be deemed to have accepted the decision, the dispute will be considered withdrawn from the administrative process, and there will be no further remedy.

If the Contractor rejects the decision of the Level III Representative, there will be no further administrative review of the dispute. The resolution will then proceed as follows:

(A) **Mediation**: Prior to filing for arbitration or litigation, the Contractor may request non-binding mediation by filing a request for mediation in writing with the Engineer. If agreeable, the Engineer will then arrange for a mutually agreeable mediator. Such request for mediation shall be made within thirty calendar days from the date of the Level III Representative's decision as provided for in this subsection.

In connection with the mediation, each party shall bear its own costs, attorney's fees, and expert fees. Any fees and expenses assessed by the mediator shall be borne equally by the parties.

(B) **Dispute Review Board/Arbitration:** The decision of the Level III Representative in relation to the claim shall be final unless the dispute review board or arbitration is chosen as follows:

(1) Where the amount in controversy is less than or equal to the amount authorized in Subsection 110.3.4, the sole remedy shall be the Dispute Review Board as prescribed in Subsection 110.5 unless both parties mutually agree to utilize arbitration

as prescribed in Subsection 110.4.

(2) Where the amount in controversy is more than authorized in Subsection 110.3.4, the Contractor reserves the right to initiate litigation pursuant to Section 12-821 et seq. of the Arizona Revised Statutes, or if mutually agreed upon, the parties may choose to resolve the controversy utilizing either the Dispute Review Board as prescribed in Subsection 110.5 or Arbitration as prescribed in Subsection 110.4.

110.3.4 Amount of Dispute: For the purposes of this subsection, the amount in controversy may not exceed $200,000.00. A claim for adjustment in compensation shall mean an aggregate of operative facts giving rise to the rights of the party for which it is seeking to enforce. That is to say, a claim under this subsection is defined as the event, transaction or set of facts that give rise to a claim for compensation, costs, expenses or damages.

In making a determination whether the amount in controversy is $200,000.00 or less, the parties shall not consider, quantify or take into account any requested extensions of contract time, or the release or remission of liquidated damages assessed or accrued prior to the dispute in question, under Subsection 108.7 and 108.9 of the Specifications.

Any party having a claim, adjustment or dispute for an amount in excess of $200,000.00 may waive or abandon the dollar amount of any such claim in excess of $200,000.00 so as to bring the claim, adjustment or dispute within the scope and coverage of this subsection, provided that the amount allowed to any such party by the arbitration award shall not exceed $200,000.00. Various damages claimed by the party for a single claim may not be divided into separate proceedings to create claims within the $200,000.00 limit.

110.4 ARBITRATION:

If the parties mutually agree to pursue arbitration as prescribed in Subsection 110.3.3, then a Demand for Arbitration shall be filed in writing with the American Arbitration Association or United States Arbitration and Mediation of Arizona, and a copy served thereof upon the Level III Representative or Contractor, whichever applicable. Such Demand for Arbitration shall be made by the party within thirty calendar days of the date of the Level III Representative's decision as provided for in Section 110.3 above, unless a mediation process is already underway, in which case the Demand for Arbitration shall be made within thirty days of the termination of the mediation process. The scope of the arbitration proceeding shall be restricted and limited to the matters originally presented to the Level III Representative for decision or determination and shall include no other matters. All arbitration of claims shall be conducted in Phoenix, Arizona or other mutually selected location in accordance with the rules of the arbitration service hearing the dispute.

The claim shall be submitted to a single arbitrator who shall be selected by the parties from a list of arbitrators furnished by the arbitration service. Each party shall alternately strike names from the list until only one name remains. The person whose name thus remains on the list of arbitrators is their first choice, but if that person is not available to serve, the two persons whose names were last stricken are acceptable, with the one whose name was last stricken being the first alternate.

Unless agreed to otherwise, the parties shall select the arbitrator within ten calendar days after each has received a copy of the list of arbitrators.

Each party to the arbitration shall bear its own costs, attorney fees and expert fees. Any other costs and fees assessed by the arbitration service shall be divided equally between the parties to the arbitration.

The decision or award of the arbitrator shall be supported by substantial evidence and, in writing, contain the basis for the decision or award and findings of fact. The decision or award by the arbitrator when made shall be final and nonappealable except as provided in Section 12-1512, Arizona Revised Statutes. Both parties to the Contract shall be bound by the Arbitration Award for all purposes and judgment may be entered upon it in accordance with applicable law in the Superior Court of Arizona.

110.5 DISPUTE REVIEW BOARD:

If the Dispute Review Board is utilized as prescribed in Subsection 110.3.3, the Engineer shall be notified within thirty days after the Level III Representative decision. The Dispute Review Board is a three-member board independent of the parties involved in the issue. The Agency and Contractor shall each select a member for this board. The third member shall be a mutually agreed upon independent member. This Review Board must be selected within fourteen calendar days after notice to the Level III Representative. Each member shall agree to impartially serve the Agency and Contractor. Fees and expenses of Board Members are to be shared equally by Agency and Contractor. The Dispute Review Board shall meet within thirty days of the selection of the board, unless, by mutual agreement, another date is selected. The scope of the Dispute Review Board shall be restricted and limited to the matters originally presented to the Level III Representative for decision or determination and shall include no other matters. The Board shall consider and evaluate the dispute and render a written decision that assigns financial responsibilities and allocates adjustments in the contact time, if applicable, within seven calendar days after the meeting. The decision of the dispute Review Board will be final.

110.6 FINAL DOCUMENTATION AND PAYMENT:

If at any step in the process a dispute is resolved, the Contractor must sign a supplemental agreement setting forth the resolution of the dispute and including an unconditional release as to any and all matters arising from the dispute. In addition, when the agreement results in a change in contract amount and/or time, a change order shall be prepared by the Contracting Agency for said changes and signed by both parties within 30 days from the date of the agreement. Payment of the change order will be made to the appropriate party(s) in accordance with Section 109.

- End of Section -

PART 200

EARTHWORK

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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 Table 201-1.

TABLE 201-1 EMBANKMENT CLEARING AND GRUBBING	
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 stored 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.

- End of Section -

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 slip out 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 slip out material, which are actually removed as ordered by the Engineer, 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 slip outs 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.

- End of Section -

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. Excavation below grade shall be replaced with the same class of concrete specified for the structure or with 1 ½ sack controlled low strength material as specified in Section 728. When the replacement material is structural concrete, the material shall be placed at the same time as the structure material. Placement of controlled low strength material shall be per Section 604, which will require a time lag between placement of the material and the structural concrete. The placement of the additional material shall be at no cost to the Agency except when over-excavation is directed by the Engineer.

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:

206.4.1 Preparation for Structure Backfill: Prior to the placement of structure backfill, the Contractor shall remove all loose, unstable materials from the sides of the structure excavation that may constitute a safety concern or impact proposed backfill operations. The Contractor shall then compact the bottom of the remaining open structure excavation to a uniform density of not less than 95 percent maximum dry density. With the approval of the compaction of the bottom of the open structure excavation by the Engineer, the Contractor may start the placement of the Structure Backfill.

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

(A) Shall conform to the material and the gradation requirements for Select Material, Type A or B in Table 702-1 unless otherwise approved by the Engineer.

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

(C) Shall be placed in layers not more than 8 inches in depth before compaction, when compacted by pneumatic or mechanical tamping devices.

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

EXCEPTION: Catch basins constructed in accordance with standard details and having the outlet invert depth equal to or less than six feet may place structure backfill when the concrete has attained a minimum compressive strength of 2500 psi in compression as specified in Section 725 and in no case less than 72 hours after casting.

206.4.3 Structure Backfill for Structures Other than Earth Retaining: Structure Backfill placed against concrete structures not designed to retain earth loads:

(A) Shall not be placed until the concrete has attained a minimum compressive strength of 2500 psi in compression as specified in Section 725 and in no case less than 72 hours after casting.

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

206.4.4 Structure Backfill for Structures within Paved Areas: Where a structure is located within an existing street, proposed street, or paved area shall be compacted to the minimum density specified in Table 601-2, for Type I or shall be filled with ½ sack or 1 sack controlled low strength material as specified in Sections 604 and 728.

206.4.5 Structure Backfill for Precast Minor Structures: Minor structures, as defined in Section 505.1.1, when furnished as precast structures, shall be placed on a compacted layer of Structure Backfill at least 6 inches in depth that conforms to the material requirements of Section 206.4.2. The layer shall be shaped to fit the bottom surface of the precast unit and compacted to not less than 100 percent maximum density. The Structure Backfill shall be at or near optimum moisture content, as approved by the Engineer. After the unit has been initially set in place and checked for line and grade, it shall be removed, and any defects in its bearing area or line and grade shall be corrected by trimming and by placing and compacting similarly moistened Structure Backfill and the unit reset in place. If in the opinion of the Engineer the bearing area, line, or grade of a set precast unit is defective, the Contractor shall remove the unit, correct the bearing area and reset the unit at no additional cost to the Agency. Precast units shall be installed on compacted, shape-conformed Structure Backfill in reasonable conformity with the lines and grades shown on the project plans.

206.4.6 Relative Compaction: Unless otherwise provided in the plans and/or special provisions the maximum density shall be determined using procedures defined in Section 301.

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 contract price for the construction or installation of the items to which such excavation and backfill are incidental or appurtenant.

When the Special Provisions identify Structure Excavation and/or Structure Backfill as pay items, the following methods of measurement and payment shall be used:

206.5.1 Measurement:

(A) **Structure Excavation:** Structure Excavation will be measured by the cubic yard, based on the volumes calculated from the measurement/pay limits shown on the Project Plans. If no limits are shown, the measurement for Structure Excavation shall be in accordance with the applicable details shown on the current Arizona Department of Transportation (ADOT) Standard Drawings SD 5.01 and/or SD 6.01-4.

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

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

(B) **Structure Backfill:** Structure Backfill will be measured by the cubic yard, based on the volumes calculated from the measurement/pay limits shown on the Project Plans. If no limits are shown, the measurement for Structure Backfill shall be in accordance with the applicable details shown on the current ADOT Standard Drawings SD 5.02 and/or SD 601-4.

206.5.2 Payment:

Structure Excavation and Structure Backfill: The accepted quantities of Structure Excavation and the accepted quantities of Structure Backfill will be paid for at their respective contract unit prices.

Hauling, placing, and compacting surplus Structure Excavation in embankments, or otherwise disposing of the material, shall be included in the contract price paid for Structure Excavation.

- End of Section -

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 arrangements for obtaining imported borrow and shall pay all costs involved. When designated sources for imported borrow are indicated on the plans, in the special provisions, the material shall be assumed approved by the Engineer.

Borrow material for fill within the roadway prism shall meet the following requirements:

The Plasticity Index (PI) (AASHTO T-90) and the percent passing the number 200 sieve (Minus 200) (ASTM C136) when used in the equation below, shall give a value of X that does not exceed 62.

X = (Minus 200) + 2.83 (PI)

When the percentage of the Minus 200 material is greater than 30, the PI for the soil shall be at least 5 and at the same time in compliance with the X value requirement.

The material shall be free from wood, vegetation, or other deleterious matter. The maximum size of this material shall not be greater than 2/3 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 and material will be allowed.

Borrow pits shall be excavated to regular lines to permit accurate measurement; depth of excavation throughout the area 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.

- End of Section -

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 material, 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 wherever 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 materials in a uniformly distributed layer of 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 2 ½ 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 D6938 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 complete 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.

- End of Section -

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.

- End of Section -

SECTION 220

RIPRAP CONSTRUCTION

220.1 DESCRIPTION:

Riprap construction shall consist of furnishing and placing stone, with or without grout, and underlain with filter material of granular filter blankets or erosion control geosynthetic fabric. The depth and type of riprap shall be as shown on the plans or in the special provisions.

220.2 MATERIALS:

Riprap shall conform to the requirements of Section 703.

Erosion control geosynthetic fabric shall conform to the requirements of Table 796-3 in Section 796.

Waste or sacked concrete shall not be permitted for use as riprap.

The Contractor, at no additional cost, shall provide mechanical equipment, a sorting site, and labor needed to assist in checking riprap gradation.

Granular filter blankets shall consist of processed natural material conforming to the requirements of Section 701, with the gradation and thicknesses as specified on the plans or in the special provisions.

220.3 PREPARATION OF GROUND SURFACES:

The bed for placement of riprap shall be shaped and trimmed to provide even surfaces.

220.4 PLACEMENT OF EROSION CONTROL GEOSYNTHETIC FABRIC:

Fabric shall be placed at the locations shown on the project plans. The Contractor shall provide a surface free of obstructions, depressions, debris, and soft yielding surfaces prior to the placement of fabric. The fabric shall be loosely laid (not in a stretched condition), aligned and placed with no fold over wrinkles.

The fabric shall be placed to provide a minimum 24-inch of overlap for each joint. On horizontal joints, the uphill fabric shall overlap the downhill fabric. On vertical joints, the upstream fabric shall overlap the downstream fabric.

Bedding material shall be placed uniformly on the fabric to the depth specified on the plans and shall be free of mounds, dips, and windrows. Bedding material shall not be compacted.

220.5 RIPRAP PLACEMENT:

Riprap shall be carefully placed on filter material consisting of a granular filter blanket or the bedding material on erosion control geosynthetic fabric. Placement shall not damage the underlying filter blanket or geosynthetic fabric. If the Engineer determines that the placement of stone has damaged or displaced the filter material to the extent that it cannot function as intended, the Contractor, at his expense, shall remove the placed riprap stone and properly correct the damage to, and/or the displacement of, the filter material. Such correction may include the removal of the filter material, re-grading the affected area, and subsequent replacement of the filter material and riprap stone as required by the Engineer.

Riprap shall be placed in a manner, which will produce a dense, reasonably well-graded mass without segregation and with a minimum amount of voids. The larger stone shall be evenly distributed through the riprap mass. The individual placement of larger riprap stones may be required to obtain a uniform distribution of stone size. The riprap placement shall be supplemented by such hand methods as are required to obtain a uniform finished surface. Allowable tolerance from the slope lines and grades shown for the finished riprap surfaces shall not exceed a distance equal to 1/3 of the nominal D_{50} size above or below the design surfaces. The final surface elevations shall be lower than any adjacent apron or pipe invert elevations and shall not obstruct the operation of adjacent structures. The flow line within riprap shall provide positive drainage with minimal ponding. Individual

stones shall depress below the finished grades no lower than a distance equal to 1/2 of the nominal D_{50} size. Special care shall be exercised in placing riprap within 3 feet of structures to avoid damage to such structures.

220.6 GROUTED RIPRAP:

Place riprap as specified in Section 220.5, excluding the use of filter material and secure in place with Portland cement grout meeting the requirements of Table 220-1. Place grout to the depth as shown on the plan but in no case less than 70 percent of the depth of riprap. Consolidate grout into place with suitable spades, trowels or other approved means to provide a dense stone and mortar layer with all voids and interstices filled. After grout has been placed, the rocks shall be thoroughly brushed so that their top surfaces are exposed. If required, use water pressure to clean stone faces after the mortar has achieved sufficient strength. The outer rocks shall project 1/3 to 1/4 their diameter above the grouted surface.

TABLE 220-1			
Grout for Riprap			
Minimum Cementitious Material (lbs.)	**Maximum W/CM Ratio**	**Slump (in)**	**Air Content (%)**
850	**0.60**	**9 +/- 2**	**0 % - 8 %**

The cementitious materials shall meet the requirements of Section 725.2. Up to 25 percent by weight of the Table 220-1 minimum cementitious materials requirements may be an approved fly ash or natural pozzolan. The aggregates shall meet the applicable requirements of ASTM C33, #8 (3/8") coarse aggregate grading and fine aggregate (sand) grading. All Ready Mixed Grout volume calculations shall be based on "absolute volume" with the total volume per cubic yard equal to 27 cubic feet. Coarse aggregate volume shall be a maximum of 35% of the total aggregates volume. All mixing shall be in accordance with the applicable requirements of Section 725.7.

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

220.7 MEASUREMENT:

The completed, in place riprap construction within the limits of the dimensions shown on the plans shall be measured. Measurement will be in cubic yards rounded to the nearest cubic yard.

No separate measurement will be made for erosion control geosynthetic fabric, bedding material, or grout.

220.8 PAYMENT:

Payment for riprap will be made for the accepted complete in-place riprap construction at the contract unit price. Riprap construction shall include excavation, ground surface preparation, erosion control geosynthetic fabric (if used for the project), bedding material, riprap stone, grout (if used for the project) and backfilling.

Payment for riprap shall be full compensation for furnishing all material, labor and equipment for riprap construction.

- End of Section -

SECTION 230

DUST PALLIATIVE APPLICATION

230.1 DESCRIPTION:

This Section shall govern the application of dust control palliatives (agents) on unpaved roads, traffic surfaces, vacant lots, construction sites and road shoulders. Dust palliatives may also be used to protect erosion of slopes, embankments, sediment control and re-vegetated areas.

Dust palliatives may be applied as topical treatments to penetrate an undisturbed surface, or may be applied to larger areas using mixing methods that blend the product with surface material and then compact the mixture to provide a stabilized, dust resistant, surface course.

230.2 MATERIALS:

Materials to be used as dust palliatives shall conform to the requirements of Section 792. The specific dust palliative to be used shall be as shown on the plans or as directed by the Engineer.

Water used for diluting dust palliatives and for pre-wetting of treated subgrade shall be either potable or from a source compatible with dust palliative ingredients.

230.2.1 Product Verification: The Contractor, in the presence of the Engineer or his designee, shall obtain samples of the bulk, undiluted liquid dust palliative/stabilizer product as it is delivered to the job site. Samples shall be taken from each bulk tanker that delivers the liquid dust palliative/stabilizer for product verification testing purposes. If the bulk undiluted liquid dust palliative/stabilizer is delivered in containers, a sample must be taken from each container delivered to the job site. The Engineer will select the exact locations and times of sampling. The obtained liquid dust palliative/stabilizer samples will be split in three equal portions (minimum 2 ounce each), whereby the Contractor may retain one sealed portion for verification testing, and the Engineer will retain two sealed portions. One portion of the Engineer's samples will be provided to an AASHTO accredited test lab chosen by the Contractor. The other sample will be held for backup until the testing is completed. Sample containers will be labeled and sealed under the supervision of the Engineer.

The accredited lab will test the product in accordance with ASTM D2834 to confirm that the liquid dust palliative/stabilizer meets the requirements of Section 792.2 for active solids. Contractor is responsible for the cost of product verification testing.

If the test reports indicate that the minimum acceptable active solids content value as specified in Section 792.2 is not met, the quality of the liquid dust palliative/stabilizer product shall be deemed deficient by the Engineer. The delivery and application of a deficient product shall be stopped. Work shall not resume until all product verification testing is complete or the Contractor replaces the product and initial tests on the new material show compliance.

The Contractor may perform additional verification testing on the split samples. In case of dispute where the verification tests produce different results by the Contractor than the Engineer, the Engineer will hire a different independent AASHTO accredited testing laboratory to perform a third round of testing. Such testing and the results of the testing shall be considered final by both the Engineer and Contractor for verification.

230.3 COMPLIANCE:

At least two weeks prior to the start of work, the Contractor shall provide the Engineer the following Applicator qualifications:

(a) Information showing that the Applicator has at least three years of experience within the last five years serving as either a primary contractor or subcontractor in delivering and applying dust palliative/stabilizer product services,
(b) A minimum 3 local references (including company/organization name, contact person and telephone number) to demonstrates that the Applicator is familiar with local environmental and permitting requirements associated with soil stabilization and dust palliative, and
(c) Copy of the Applicator's State of Arizona Registrar of Contractors License.

At least two weeks prior to the start of work, the Contractor shall provide the Engineer the proposed application methods and equipment for the project. The information provided shall include: (a) curing time for each application method required for the project, (b) application and dilution rates proposed for the project, and (c) equipment to be used during all phases of application that are in conformance with Section 230.4.

Prior to the commencement of any work, the Contractor shall provide copies of all required environmental/dust control permits, any required notices of intent, and the current Material Safety Data Sheet (MSDS) for the dust palliative/stabilizer product. The MSDS must include all chemical compounds present in concentrations greater than 1% for dust palliative/stabilizer product.

230.4 EQUIPMENT:

The Contractor shall provide all equipment necessary to complete the work. The equipment may include but not be limited to motorized graders, distribution trucks, mixing and pulverizing equipment, pneumatic-tired rollers, sprinkler systems, etc. All equipment used for this work is subject to approval by the Engineer. Equipment which fails to provide an acceptable application of properly diluted dust palliative/stabilizer product or does not perform satisfactorily shall be removed from the job and replaced with acceptable equipment meeting the requirement of this specification.

Distributor trucks shall be designed, equipped, maintained and operated so that dust palliative/stabilizer product may be applied uniformly on variable widths of surface up to 16 feet at readily determined and controlled rates from 0.03 to 1.0 gallons per square yard, with uniform pressure, and with an allowable transverse variation from any specified rate not to exceed 10% or 0.02 gallon per square yard, whichever is less. The maintenance and calibration of this vehicle shall be checked periodically. The record of maintenance and calibration shall be submitted to the Engineer for review upon request.

Distributor trucks proposed for use shall have been tested within 6 months from the date of spreading to determine the rate of the transverse spread. If requested, the Contractor shall furnish the Engineer with evidence that the transverse spread of the distributor truck, when the trucks were approved for use, was as uniform as practicable and under no condition was there a variance on any of the test pads greater than the allowable transverse variation; however, the Engineer may require that each distributor truck be tested to determine the rate of the transverse spread. The rate of the transverse spread shall be determined in accordance with the requirements of Arizona Test Method 411.

230.5 PREPARATION OF SURFACE:

All surface preparation shall be in conformance with Maricopa County Rule 310 and 310.01 as applicable.

230.5.1 Topical Preparation: Prior to the application of the dust palliative, the surface shall be graded to provide drainage.

Dust palliatives shall not be applied when the surface is excessively wet or saturated. Surfaces shall be pre-moistened only if required by the product manufacturer.

230.5.2 Surface Course Preparation: Areas to receive dust palliative shall be graded and scarified to at least the minimum depth and width shown on the plans. The soil shall be scarified/loosened by tilling, disking, ripping, or by other soil preparation methods, which achieves uniform results to the minimum depth shown on the plans. The material shall be damp at time of scarification to reduce dust and aid in pulverization. Soil clods shall be pulverized until all material, exclusive of gravel or stone, will past a 2-inch sieve.

All debris, weeds, organic material, stone larger than 4 inches, etc., shall be removed from the site. Surface gravel or stones shall be removed or thoroughly mixed with the surrounding soils to obtain a homogeneous mixture.

If pre-wetting is required, ample amount of water shall be added and mixed with the in-place material to obtain a moisture content near optimum. This moisture content shall be established prior to and maintained until the application of the dust palliative. The methods to establish and maintain the moisture shall be done in accordance with manufacturer's recommendations. The moisture must be uniformly distributed throughout the surface course and over the underlying undisturbed soil. Dust palliatives shall not be applied when the soil is excessively wet or saturated. Moisture content shall be determined in accordance with either ASTM D6938 or ASTM D4944.

230.6 APPLICATION:

230.6.1 General: The dust palliative shall be applied by a pressure type distributor vehicle equipped with a power unit for the pump, full circulation spray bars adjustable laterally and vertically, and computer controls. The distribution vehicle shall be calibrated to ensure a controlled application method. Spray bars and extensions shall be of the full circulating type. Valves, which control the flow from nozzles, shall be of a positive active design so as to provide a uniform, unbroken spread of dust palliative on the surface.

Corners or surface that cannot be accessed by the distributor truck shall be hand sprayed by means of hoses or bars pressurized by a gear pump or air tanks.

Distributor equipment shall be equipped with a tachometer and pressure gauge. To provide for accurate, rapid determination and control of the amount of dust palliative being applied, distributor equipment shall include one or more of the following: accurate volume measuring devices, a calibrated tank, and/or a certified meter or weight tickets and calibration charts relating to the specific gravity of the concentrate and/or dilution.

The dust palliative shall be applied at the dilution ratio and application rate specified in accordance with Section 792, unless otherwise directed by the Engineer. The Contractor shall dilute the dust palliative product as needed, with the dilution ratio adjusted within the ranges specified in Section 792, to bring the mixture to the desired moisture content. Products may be applied in multiple passes at reduced application rates to meet the total application rate specified and/or assure uniform coverage.

The Contractor shall notify the Engineer a minimum of 5 working days prior to any application of dust palliative.

230.6.2 Topical Application: Topical applications shall be rolled only when recommended by the manufacturer. Complete penetration of palliative will be required prior to the surface rolling. Complete penetration occurs when the compaction equipment will not track or pick up the dust palliative and/or the top layer of the surface material.

230.6.3 Surface Course Application: The stabilization product shall be applied, incorporated and thoroughly blended into the soil until the homogeneous mixture is obtained to the full depth of treatment. Mixing shall be done in-place using mixing equipment or by motorized grader (blade mixing). The blending methods utilized shall result in a uniformly treated mixture of soil and dust palliative at or near optimum moisture content (minus any post-compaction dust palliative top coat application quantity). The dilution ratio may be adjusted to bring the mixture to the desired moisture content. The amount of area treated each day shall be limited to that which the Contractor can thoroughly mix and compact within that work day.

Complete penetration of palliative will be required prior to compaction. Complete penetration occurs when the compaction equipment will not track or pick up the blended material.

The blended material shall be shaped to the required grade line and cross-section shown on the plans and be compacted at least 95% of maximum density in accordance with ASTM D698, unless otherwise directed by the Engineer. The final surface shall be rolled to a smooth and even grade. Sufficient grading shall be done to provide reasonable drainage within the limits of existing drainage patterns. Immediately after the compaction, a top coat of dust palliative shall be applied.

230.7 CURING:

No equipment or traffic will be permitted on the treated surface for 24 hours unless otherwise approved by the Engineer. Once cured, the dust palliative final coat shall form a skin at the surface or a crusted surface. For purpose of this work, a “skin” on the surface will be a formation of any palliative on the surface of the soil that cannot be dislodged from the soil by winds. Any formation of the palliative on the soil surface must adhere to the underlying soil to a depth of 1/8th inch when applied topically.

230.8 WEATHER CONDITIONS:

Dust palliative/stabilizer product shall be applied only when the ambient temperature is above 50°F. Application should be avoided during high winds or when there is the chance of rain within the next 8 hours. The Contractor shall be responsible to retreat at no additional cost if the application is degraded by weather within the first 24-hours of placement.

230.9 QUALITY CONTROL:

The Contractor must provide manufacture-trained personnel for on-site technical assistance during initial delivery and application. This technical assistance is to assure that the dust palliative/stabilizer product is applied at proper dilution ratios and application rates on various soil, and subgrade types for optimum results.

At the start of each work day, the bulk tanker will be measured to verify the gallons of liquid dust palliative/stabilizer product brought to the job site. At the end of the day, the bulk tanker will be measured to verify the gallons of liquid dust palliative/stabilizer product remaining at the job site. The distributor truck shall be inspected to insure it is empty at the end of the day. The total gallons of liquid dust palliative/stabilizer product used for the day will be established by the start and end of day measurements of the bulk tanker.

A daily "Gallon Use Report" will be filled out by the distributor truck driver. The report will also identify the size of area treated for the day. It will be verified and signed by the Engineer or his designee. This report will be used to verify application rate and total product used. If the report indicates that the minimum application rate was not achieved, the work shall be deemed deficient by the Engineer.

230.10 DEFICIENCIES AND WARRANTY:

If applied product active solids content is found deficient per Section 230.2.1, the Engineer may allow the Contractor to apply to any surfaces already treated by the deficient product additional topical coats of the dust palliative/stabilizer product to remedy the deficiency. Otherwise, the Contractor shall be required to repeat all work as directed by the Engineer with a different approved liquid dust palliative/stabilizer product that is compatible with the original product and will not result in adverse effects. The Contractor shall bear the cost of all remediation work for deficient product.

If the application rate as determined by the methods described in Section 230.9 or as agreed to in the contract documents is found to be deficient, the Contractor shall apply additional product within 24-hours of the original application to bring the total application rate to at least the minimum specified amount. If liquid dust palliative/stabilizer product was used as a soil stabilizer per Section 230.6.3, as directed by the Engineer, the Contractor shall re-scarify the stabilized section to its full depth and re-apply product at the original application rate. The Contractor shall bear the cost of all remediation work for deficient application rate.

For non-traffic areas (less than 150 vehicle trips per day), application of the dust palliative/stabilizer product placed in accordance with this Section shall provide a surface meeting the stabilization requirements of Maricopa County Rule 310 Section 302 and Maricopa County Rule 310.01 Section 302 for a minimum of 12 months from acceptance by the Engineer.

During the warranty period, the Contractor shall provide and install the product free of charge if the finished product fails to meet the performance requirement and specification/criteria outlined under this technical specification. The Contractor shall provide additional applications when within five working days of notification from the Engineer of performance failure.

230.11 MEASUREMENT:

Dust palliative surface course application shall be measured by the square yard, in place, treated, compacted, to the proper depth and accepted.

Dust palliative materials will be measured by the ton of undiluted material. Any conversion from volumetric quantities shall be done with Contractor-supplied calibration charts relating to the specific gravity of the concentrate and/or dilution.

230.12 PAYMENT:

Payment will be made for the applicable items at the Contract unit price and shall constitute full compensation for the item complete in place.

- End of Section -

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PART 300

STREETS AND RELATED WORK

Section	Last Revised	Title	Page
301	2014	Subgrade Preparation	301-1
306	2010	Mechanically Stabilized Subgrade-Geogrid Reinforcement	306-1
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324	2015	Portland Cement Concrete Pavement (PCCP)	324-1
325	2019	Placement and Construction of Asphalt-Rubber Asphalt Concrete	325-1
326	2020	Placement and Construction of Polymer Modified Asphalt Concrete	326-1
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330	1998	Asphalt Chip Seal	330-1
331	2020	Placement and Construction of Asphalt Emulsion Micro-Surfacing Treatments	331-1
332	2020	Placement and Construction of Asphalt Emulsion Slurry Seal Treatments	332-1
333	2012	Fog Seal Coats	333-1
334	2019	Preservative Seal for Asphalt Concrete	334-1
335	2012	Placement and Construction of Hot Asphalt-Rubber Seal	335-1
336	2016	Pavement Matching and Surfacing Replacement	336-1
337	2018	Asphalt Pavement Crack Sealing and Crack Filling	337-1
340	2018	Concrete Curb, Gutter, Sidewalk, Curb Ramps, Driveway and Alley Entrance	340-1
342	2016	Interlocking Concrete Paver Installations	342-1
343	1998	Exposed Aggregate Paving	343-1
345	2016	Adjusting Frames, Covers and Valve Boxes	345-1
350	2013	Removal of Existing Improvements	350-1
355	2015	Utility Potholes-Keyhole Method	355-1
360	1998	Telecommunications Installation	360-1

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

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

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

Project earthwork quantities when included as separate contract pay items will include removed asphalt/bituminous material volumes, unless otherwise specified in the Special Provisions. All unsuitable material and all excess material shall be disposed of in accordance with the requirements of Sections 205.2 and 205.6, respectively. When additional material is required for fill, it shall conform to Section 210.

301.3 RELATIVE COMPACTION:

The subgrade shall be scarified and loosened to a depth of 6 inches. Rock 6-inches or greater in size that becomes exposed due to scarification shall be removed from the scarified subgrade. 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 minimum compaction, measured as a percentage of maximum dry density when tested in accordance with AASHTO T-99, Method A, and T191 or ASTM D6938 with the percent of density adjusted in accordance with the rock correction procedures for maximum density determination, ARIZ-227c[1] to compensate for the rock content larger than that which will pass a No. 4 sieve. Unless otherwise noted in the project plans or project specifications, compaction shall be performed within 2 percentage points of the optimum moisture content.

(A) Below pavement, curb and gutter, attached sidewalk, roadway shoulders, and other areas within right-of-way subject to vehicular traffic	95 percent
(B) Below detached sidewalk not subject to vehicular traffic	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 1/4 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 3/4 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.

(1) Arizona Department of Transportation test method

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 subbase 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.

301.7 MEASUREMENT:

Measurement for Subgrade Preparation will be by the square yard. The area to be measured will be the total accepted area of new asphalt concrete pavement and new Portland cement concrete pavement (PCCP), including paved shoulders, tapers, turnouts, and unpaved roadway shoulders. Subgrade Preparation area measured will also include the accepted surface area of driveways that are surfaced with aggregate base, or select materials and non-surfaced areas designated for vehicle traffic.

Except for PCCP, the area under Portland cement concrete surfaces such as concrete curb and gutter, sidewalk, concrete driveways and driveway entrances, and concrete alley entrances will not be included in the Subgrade Preparation measurement.

Project earthwork quantities for Roadway Excavation, Borrow Excavation, and Fill Construction shall not be separately measured when they are not listed as separate line items on the fee proposal form. In such case, unless otherwise specified, payment for said earthwork items shall be included in the unit price for Subgrade Preparation.

301.8 PAYMENT:

Payment for Subgrade Preparation will be made only when it is performed for street or roadway paving projects.

Payment shall be compensation in full for stripping, scarifying, grading, excavating, hauling, filling, compacting, and disposing of excess or unsuitable materials, together with all costs incidental thereto.

- End of Section -

SECTION 306

MECHANICALLY STABILIZED SUBGRADE - GEOGRID REINFORCEMENT

306.1 DESCRIPTION:

Mechanically stabilized subgrade shall consist of furnishing and placing a geogrid material within or below untreated base to provide a stabilized platform on which paving materials are placed. Geogrid type, fill thickness, pavement cross-section and associated details, shall be as shown on the contract drawings.

306.2 MATERIALS:

The geogrid material shall be supplied in accordance with and conform to the material requirements of Section 796 and Table 796-4.

306.3 SUBGRADE PREPARATION:

The geogrid shall not be placed when weather or surface conditions do not meet the manufacturer's recommendations for installation.

306.3.1 Placing Geogrid on Soft Subgrade: Prior to placement of geogrid material, soft subgrade shall be lightly proof rolled to provide a firm surface, brought to grade and shaped to conform to the typical sections, lines and grades as shown on the plans. The surface on which the geogrid will be placed shall be free of rock and other material that could damage the geogrid. The placement of the geogrid shall be approved by the Engineer before placement of overlaying materials.

Subgrade tolerances shall be in accordance with MAG Section 301.4.

306.3.2 Placing Geogrid within Untreated Base: Subgrade shall be prepared in accordance with MAG Section 301.

306.4 EQUIPMENT:

Mechanical or manual laydown equipment shall be capable of laying the geogrid properly and smoothly, in compliance with the manufacturer's recommendations.

306.5 GEOGRID PLACEMENT:

The geogrid shall be installed in accordance with the installation guidelines provided by the manufacturer or as directed by the Engineer.

The geogrid may be temporarily secured in place with ties, staples, pins, sand bags or acceptable fill material as required by fill placement procedures, weather conditions, or as directed by the Engineer. A 12-inch minimum secured overlap is required at all joints (both transverse and longitudinal). At transverse joints, the preceding roll shall overlap the following roll in the direction that the aggregate base will be placed. The geogrid shall be rolled out along the alignment in the direction of advancing construction. All wrinkles and folds shall be removed.

The geogrid shall be tensioned by hand and anchored to the ground at the edges, including overlaps, and in the center of the roll at 30-foot intervals along the roll length, at the corners if applicable, or as directed by the Engineer. Securing locations may be reduced or eliminated if it can be shown to the satisfaction of the Engineer that an alternative installation process will provide satisfactory results.

Geogrid shall be placed to obtain full coverage of the indicated area. Placement of geogrid on irregular shaped areas and radii may require cutting of the geogrid material and the use of diagonal overlapping joints. Buckling of geogrid material will not be allowed.

306.6 PLACING AND COMPACTING AGGREGATE FILL:

The aggregate shall be back dumped and spread in a uniform lift maintaining the design aggregate thickness at all times. The aggregate material shall be bladed on the geogrid in such a manner that the aggregate rolls forward onto the grid ahead.

When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over geogrid reinforcement at slow speeds (less than 10 mph). Sudden stops and turning by trucks shall be avoided on the geogrid. Traffic shall not be allowed onto coated geogrid materials. A minimum loose fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles shall be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.

Any ruts, which develop during spreading or compacting aggregate fill, shall have additional aggregate added rather than bladed from surrounding areas. Placing additional aggregate into the rutted areas limits disturbance to the underlying geogrid keeping it intact.

Untreated base shall be compacted as specified in Section 310. Untreated base material shall not be mixed or processed on the geogrid. Base materials will be uniformly blended and sampled for acceptance prior to placement on the geogrid material. Contamination and segregation of base materials during placement shall be minimized.

306.7 REPAIR:

Any geogrid material damaged before, during or after installation shall be replaced by the contractor at no additional cost to the Agency.

Replacement of geogrid reinforcement shall consist of removal and replacement of the geogrid and aggregate fill from the defective area. The aggregate fill shall be removed at least 3 feet beyond the limits of the defective area. The replacement geogrid shall be installed with proper overlaps. Aggregate fill replacement shall not commence until placement of the geogrid material has been inspection and approved.

306.8 PAYMENT:

The surface area of accepted in-place geogrid reinforcement will be measured to the nearest square yard.

Payment for geogrid reinforcement at the contract unit price shall be full compensation for furnishing all labor, material, equipment, and installing complete in place the geogrid as shown on the project plans.

- End of Section -

SECTION 309

LIME STABILIZATION OR MODIFICATION OF SUBGRADE

309.1 DESCRIPTION:

This section shall consist of constructing a mixture of soil, lime and water for the stabilization or modification of subgrade soils. The work shall be performed in conformity with the lines, grades thickness, and typical cross-sections shown on the plans.

According to the National Lime Association, "Stabilization: When adequate quantities of lime and water are added, the pH of the soil quickly increases to above 10.5, which enables the clay particles to break down. Determining the amount of lime necessary is part of the design process and is approximated by tests such as the Eades and Grim test (ASTM D3276). Silica and alumina are released to react with calcium from the lime to form calcium-silicate-hydrates (CSH) and calcium-aluminate-hydrates (CAH). CSH and CAH are cementitious products similar to those formed in Portland cement. They form the matrix that contributes to strength of lime-stabilized soil layers. As this matrix forms, the soil is transformed from a sandy, granular material to a hard, relatively impermeable layer with significant load bearing capacity. The process begins within hours and can continue for years in a properly designed system. The matrix formed is permanent, durable, and significantly impermeable, producing a structural layer that is both strong and flexible."

Lime modification may be used to "Dry-up of wet soil at a construction sites" or "include treating fine-grained soils or granular base materials to construct temporary haul roads or construction platforms."

309.2 MATERIALS:

309.2.1 Soil or Subgrade: For lime stabilization applications, the soil or subgrade material used for this work shall consist of materials on the site or imported, and shall be free of roots, sod, weeds and stones larger than 3 inches and have a plasticity index (PI) greater than 10, when tested in accordance with AASHTO T-146 Method A, AASHTO T-89 Method A, and T-90. For lime modification applications, the allowable soil or subgrade properties will be determined by the Engineer.

309.2.2 Quicklime and Hydrated Lime: Lime used shall be either quicklime or hydrated lime and shall conform to the requirements of ASTM C977. All lime shall come from a single source. If a source change is requested, a new mix design shall be submitted using lime from the proposed new source. The new design must be approved by the Engineer prior to use.

309.2.3 Lime Slurry: Lime slurry shall be a pumpable suspension of solids in water. The solids portion of the mixture, when considered on the basis of solids content, shall consist principally of hydrated lime of a quality and fineness sufficient to meet Section 309.2.2 requirements. Upon request, a Certificate of Compliance shall be provided to the Engineer for each load of lime applied at the project.

309.2.4 Water: Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. The pH (hydrogen ion concentration) of water to be used during construction for mixing or curing shall be within the range of 6.0 to 8.5. The procedure for determining pH values shall be based on the test apparatus used, the test apparatus may use either an electrometric or colorimetric method. The testing procedure shall be in accordance with the methods and instructions furnished by the manufacturer of the apparatus. Water known to be of potable quality may be used without testing.

309.3 COMPOSITION:

309.3.1 Lime Stabilization Mix Design: Before commencing lime treatment work, the Contractor shall submit for approval by the Engineer, a proposed mix design. The proposed mix design shall be prepared by a testing laboratory under the direction and control of an Arizona registered professional engineer. The mix design shall be determined using the soils or subgrade material to be stabilized, water from the source to be used during construction, and lime from the proposed supplier. The mix design shall identify the water source to be used during construction and, if not from a potable source, the water's pH value.

For soil stabilization applications, the mix design shall report and comply with the following requirements:

Untreated Soil:
(a) Sulfates: Tested per ARIZ 733, AASHTO T-290, or ASTM C1580.
(b) Moisture-Density Relationship (Proctor): Tested per ASTM D698 Method A.
(c) Plasticity Index: Test method AASHTO T-146 Method A, AASHTO T-89 Method A, and T-90.
(d) Sieve Analysis and Minus No. 200 Wash: Test methods ASTM C136 and ASTM D1140.

Lime Treated Soil:
(a) pH: Lime saturation content per ASTM C977 APPENDIX or ASTM D6276.
(b) Plasticity Index: Less than 3, per AASHTO T-146 Method A, AASHTO T-89 Method A, and T-90.
(c) Swell Potential: Maximum expansive potential of 1.0 per ARIZ 249 using passing No. 4 sieve material. The maximum expansive potential shall be determined on a sample compacted to approximately 95 percent of the ASTM D698 Method A maximum dry density at approximately 2% below optimum moisture content. The sample should be confined under a 100 psf surcharge and inundated.
(d) Unconfined Compressive Strength: Minimum 160 psi per ASTM D5102 Procedure A, after five days curing at 100°F, sealed in airtight condition.
(e) Mellowing time and mellowing moisture content for treated soil sections b and c to be determined by design engineer. Mellowing time and mellowing moisture content for treated soil section d determined by ASTM D5102.
(f) Hydrated Lime Content: The design engineer shall designate the minimum percentage of lime by dry weight of the dry soil to satisfy the criteria for Section 309.3.2 requirements. The percentage of lime specified shall be sufficient to allow for expected variations during the mixing process. A minimum of 5.0% hydrated lime by dry weight of the dry soil is required for all mix designs.

309.3.2 Lime Modification: For soil modification purposes only, the Engineer shall specify the minimum amount of hydrated lime or lime slurry required to meet the desired improved soil properties.

309.4 CONSTRUCTION:

309.4.1 General: It is the primary requirement of this specification to secure a completed subgrade containing a uniform lime mixture free from loose segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses.

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

Lime shall be applied at the mix design rate for the depth of subgrade stabilization or modification shown on the plans or requested by the Engineer.

When the design requires treatment to a depth greater than 12 inches, the subgrade soil shall be treated in equal layers. The top layer(s) of soil shall be removed and stockpiled. The lower layer of soil to be treated shall then be treated and allowed to cure in place. After final mixing, the lower layer shall be compacted in maximum 12 inch thick compacted lifts. The stockpiled soil shall then be placed, treated, mixed and compacted in successive maximum 12 inch thick compacted lifts.

309.4.2 Weather Limitation: Lime treated subgrade shall not be constructed if the ambient temperature is below 40° F or when conditions indicate that temperatures may fall below 40° F within 24 hours.

309.4.3 Equipment: Contractor shall provide all equipment necessary to complete the work including grading and scarifying equipment, a spreader of the lime, mixing and pulverizing equipment, sheepsfoot and pneumatic rollers, sprinkling equipment and trucks. Gravity feed or tailgate spreading, defined as not having automatic controls, will not be permitted. The spreader shall demonstrate the ability to maintain a consistent spread rate over variable travel speeds. All equipment used for this work is subject to approval by the Engineer.

309.4.4 Application: Lime shall be spread only on that area where the mixing operation can be completed during the same working day. The lime application rate shall be at the design content to +0.5%, based on weight of dry soil. The Engineer

reserves the right to vary the rate of application of lime from the mix design during the progress of construction as necessary to maintain a pH of the lime/soil mixture above 12.0 and the desired characteristics of the treated subgrade.

For all lime applications, the Contractor shall provide the Engineer with daily application quantities.

309.4.4.1 Quicklime Application: Quicklime shall only be applied by approved spreader trucks equipped with operating dust collectors to minimize dust issues while loading. Additionally, dust control measures must be utilized during the spreading and soil mixing of quicklime. Contractor shall exercise safety measures when mixing quicklime with water.

309.4.4.2 Dry Hydrated Lime Application: Hydrated lime shall only be applied by approved spreader trucks equipped with operating dust collectors to minimize dust issues while loading. Additionally, dust control measures must be utilized during the spreading and soil mixing of dry lime.

309.4.4.3 Lime Slurry Application: Lime slurry shall be mixed in a portable mixing unit and spread with trucks equipped with an approved distribution system. Lime slurry shall be applied at a rate that will yield the required lime percentage determined by the mix design.

309.4.5 Mixing: The full depth of the treated subgrade shall be mixed with an approved mixing machine. The use of disc plows or blades are strictly prohibited except in areas specified by the Engineer. To insure a complete chemical reaction of the lime and soil or subgrade, water shall be used as required to maintain moisture content at optimum to +4% above the optimum of the lime treated mix design proctor, prior to beginning compaction. During the interval of time between application and mixing, lime that has been applied, unmixed and exposed to the open air for 10 hours or more will not be accepted. No traffic other than the mixing equipment will be allowed to pass over the spread of lime until after completion of mixing.

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

	Percent
Minimum of clay lumps passing 1-1/2 inch sieve	100
Minimum of clay lumps passing No. 4 sieve	60

309.4.6 Compaction: Compaction of the mixture shall begin after final mixing and shall be accomplished in accordance with the design specifications. Areas inaccessible to conventional rolling equipment shall be compacted to the required density by methods approved by the Engineer. Mellowing time and mellowing moisture content shall be specified by the mix design and performed prior to final compaction.

The material shall be aerated or watered as necessary to provide and maintain required moisture content. A composite of treated soil or subgrade materials from a minimum of five (5) random locations, per soil type, within the area to be stabilized shall be used to determine the maximum dry density and optimum moisture content in accordance with ASTM D698. The field density of the compacted mixture shall be at least 95 percent of the maximum dry density of the field-sampled proctor. The in-place compacted field density shall be determined in accordance with ASTM D1556, sand cone, or ASTM D6938, nuclear gauge. In the event of disputed results, the nuclear gauge density shall be correlated to the referee sand cone density while the nuclear water content shall be correlated to the referee ASTM D2216 water content. The adjustment for rock larger than the no. 4 sieve shall be performed in accordance with ASTM D4718.

After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements and finished requirements, it shall be reworked to meet requirements at no additional cost to the Contracting Agency.

309.4.7 Thickness: The thickness of the lime treated subgrade shall be determined by visual inspection and/or by depth tests taken at intervals so that each test shall represent no more than 1000 square yards per layer. If more than one layer, the method used to remove material to determine the depth of lime treatment may be by shovel and/or pick, coring or other method approved by the Engineer. Phenolphthalein solution shall be used to detect the presence of lime. When the grade deficiency is more than 1 inch, the Contractor shall correct such areas in a manner satisfactory to the Engineer. Contractor shall replace, at no cost to the Contracting Agency, the material where depth tests are taken.

All irregularities, depressions, or weak spots, which develop, shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting. The surface of the course shall be maintained in a

smooth condition, free from undulations and ruts, until other work is placed thereupon or the work is accepted. Compaction and finishing shall be done in such a manner as to produce a smooth dense surface free of compaction planes, cracks, ridges or loose materials.

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

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

Each layer of lime treated subgrade shall be maintained in a moist condition until the next layer of pavement structure is placed. If required, a fog seal for curing, in compliance with Section 333, shall be furnished and applied to the surface of the final layer of the lime stabilized material as soon as possible after the completion of final rolling and before the temperature falls below 40° F. Curing seal shall be applied at a rate between 0.10 and 0.20 gallons per square yard of surface. The exact rate will be determined by the Engineer.

After curing begins, all traffic, except necessary construction equipment shall be kept off the lime stabilized subgrade for a minimum of 7 days or until the final pavement structure layer(s) are placed. As an alternative, the Contractor may place a loose lift of aggregate base course over the curing subgrade. The aggregate base course should be kept moist during the curing process.

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

309.5 MEASUREMENT:

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

The quantity of curing seal shall be measured by the ton.

309.6 PAYMENT:

The lime treated soils measured as provided above, will be paid for at the contract price per square yard, which price shall be full compensation for the item complete, as herein described and specified.

The Owner or Engineer reserves the option to pay for the lime separately. Should this option be chosen, the lime treated soils measured as provided above will be paid for at the contract price per square yard, which shall include full compensation for the item less lime, as herein described and specified. The lime materials will be paid for by the contract price per ton based on hydrated lime. If quicklime in slurry form is used, there will be an additional pay factor of 1.3 applied to determine the actual amount of hydrated lime placed.

Payment for curing seal will be by the ton, based on the rate of application as requested by the Engineer.

- End of Section -

SECTION 310

PLACEMENT AND CONSTRUCTION OF AGGREGATE BASE COURSE

310.1 DESCRIPTION:

Aggregate base course shall comply with Section 702 unless the use of a different type of material is specifically authorized in the special provisions.

310.2 PLACEMENT AND CONSTRUCTION:

The compacted lift thickness shall not exceed 6 inches, unless approved by the Engineer. Based on the type of material, type of equipment and compaction methods used, the Contractor may propose a greater lift thickness to the Engineer for approval.

After distributing, the aggregate base course material shall first be uniformly watered and then graded to a uniform layer that will net, after compacting, the required thickness. The grading operation shall be continued to such extent as may be necessary to minimize segregation. The quantity of water applied shall be that amount which will assure proper compaction resulting in the density required by Section 310.3.

After placement, the aggregate base course surface shall be true, even and uniform conforming to the grade and cross-section specified. In no case shall the aggregate base course vary by more than ½ inch above or below required grade.

310.3 COMPACTION:

The contractor is responsible for providing appropriate equipment and techniques to achieve the compaction results required by this specification. The aggregate base course shall be compacted in lift thicknesses as allowed by Section 310.2.

The laboratory maximum dry density and optimum moisture content for the aggregate base course material shall be determined in accordance with AASHTO T-99 method "C" OR "D," with Rock Correction Procedure. Field 'one-point' maximum dry density and optimum moisture procedures will not be allowed for acceptance.

The in-place density shall be determined in the field by nuclear density testing in accordance with AASHTO T-310 or sand cone density testing in accordance with AASHTO T-191. In the event nuclear density testing is selected, and density results are in question, a sand cone correlation will be performed by the accepting agency at the contractor's request, not to exceed one sand cone for each ten nuclear density tests.

A rock correction, to compensate for rock content larger than the ¾ inch sieves (as required by the laboratory maximum dry density and optimum moisture procedure selected), shall be performed in accordance with AASHTO T-99 Annex A1. Specific gravity of the oversize particles shall be lab measured for use in the rock correction. The specific gravity shall be determined in accordance with AASHTO T-85.

For roadway construction, a minimum of one field density test shall be performed per lift per 660 feet per lane. For other aggregate base course applications, a minimum of one field density test shall be performed for each 800 square yards.

Unless otherwise noted in the project plans or project specifications, the moisture content of the aggregate base course at the time of compaction shall be the optimum moisture content +/- 3%.

The following percent compaction is required:

(A)	Below asphalt concrete pavement	100%
(B)	Below Portland cement concrete pavement, driveways, curb & gutter, sidewalks, and roadway shoulders	95%
(C)	All other areas not subject to vehicular traffic	85%

Areas, which fail initial testing for density and/or moisture content, shall be reworked until passing tests for density and/or moisture content are achieved. Lower moisture content percentages at the time of field density testing may be allowed if significant time has passed since the time of compaction and the required density has been achieved.

310.4 THICKNESS AND/OR PLASTICITY INDEX DEFICIENCY:

When in the opinion of the Engineer there is reason to believe that a deficiency in thickness, or an excess of plasticity exists, measurements or samples 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 in Table 310-1 shall be taken by the Contractor at no additional cost to the Contracting Agency.

TABLE 310-1		
THICKNESS AND PLASTICITY DEFICIENCY		
Type	**Deficiency**	**Corrective Measure**
I	Less than 1/2 inch of the required thickness	No corrective measure required.
II	1/2 inch or more but less than 1inch of the required thickness	(1) The contractor may choose to add additional material and rework the grade to meet the specification requirements. (2) The contractor may choose to increase the thickness of asphalt concrete by the amount of the aggregate base course thickness deficiency at no additional cost to the Owner. Required grade shall be met.
III	Thickness deficiency by greater than 1 inch	(1) The contractor will remove the aggregate base course and regrade the subgrade to allow the required aggregate base course layer thickness to be constructed. (2) If grades allow, the contractor may propose that the thickness of asphalt concrete be increased by the amount of the aggregate base course deficiency at no additional cost to the Owner.
IV	A plasticity index of 6 to 7 inclusive	(1) An Engineering Analysis (EA) that includes R-value testing may be prepared by the contractor to evaluate the expected performance of the aggregate base course layer. The EA may provide mitigation options for the Engineer to consider. If the Engineer accepts the plasticity index as a result of the EA, the material will be accepted at full payment. If the Engineer rejects the EA, the contractor will perform either option 2 or 3 below. (2) The contractor may choose to reprocess or treat the existing material to bring it within specification limits or remove deficient material from affected area and replace with material complying with the specifications. (3) If grades allow, the contractor may increase the thickness of asphalt concrete by ½-inch at no additional cost to the Owner.
V	A plasticity index of over 7	(1) The contractor may choose to reprocess or treat the existing material to bring it within specification limits or remove deficient material from affected area and replace with material complying with the specifications.

310.5 PAYMENT:

Payment for aggregate base course will be made on the basis of the contract unit price per ton unless an alternate basis of payment is provided in the proposal.

- End of Section -

SECTION 311

PLACEMENT AND CONSTRUCTION OF CEMENT TREATED SUBGRADE

311.1 DESCRIPTION:

This item shall consist of a cement treated subgrade 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 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 inches sieve. It shall be demonstrated by laboratory tests that the plasticity and strength characteristics as defined in Section 311.4.5 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 complete soil cement treated layer 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 the 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 at the specified rate. The spreader shall have the ability to maintain a consistent spread rate over variable travel speeds.

311.4 CONSTRUCTION METHODS:

Prior to construction, the contractor shall remove all deleterious material, organic material, and particles retained on the 3 inch sieve from the area to be treated. The soil shall be brought to a compacted condition, true to line and grade as directed by the Engineer or as shown on the plans. The compacted soil and surface shall be approved by the Engineer prior to proceeding with mixing.

The material shall be scarified, pulverized, mixed with water and cement, compacted, finished and cured in lengths permitting the full roadway width to be complete 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: Prior to application of cement, soil to be processed shall be scarified to depth of base. The material shall be damp at time of scarifying to reduce the dust generation and to aid in pulverization. Soil 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 to +4% of optimum moisture content as determined in accordance with ASTM D558. 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 ASTM D558, and D6938, with moisture content periodically corrected in accordance with AASHTO T-217 on representative samples of soil cement mixture obtained from the area being processed. At the time of compaction, 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 Compressive Strength: Laboratory compressive strength testing of the cement treated subgrade is required to evaluate the proposed amount of cement and/or verify the compressive strength achieved during construction. Laboratory compressive strength testing shall be done in accordance with ARIZ-241.

311.4.6 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 ASTM D6938 as specified above.

311.4.7 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 the time the cement is exposed to water. 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.

311.4.8 Thickness Deficiency: The Engineer may choose to have cores obtained to evaluate the thickness of the treated cement stabilized subgrade layer. Should the thickness of the treated layer not meet the project specifications, the Engineer may require the contractor to submit an Engineering Analysis (EA) to address the pavement section. The EA will provide an opinion as to the anticipated performance of the pavement section as a result of the reduced cement treated layer thickness and make recommendations on possible corrective actions. The Engineer shall determine what corrective actions, if any, are required.

311.4.9 Curing: Each layer of cement treated subgrade shall be maintained in a moist condition until the next layer of pavement structure is placed. If required, a fog seal for curing in compliance with Section 333, shall be furnished and applied to the surface of the final layer of the cement stabilized material as soon as possible after completion of final rolling and before the ambient temperature falls below 40º F. Curing seal shall be applied at a rate between 0.10 and 0.20 gallons per square yard of surface. The exact rate shall be determined by the Engineer.

After curing begins, all traffic, except necessary construction equipment shall be kept off the cement-stabilized subgrade for a minimum of 7 days or until the final pavement structure layer(s) are placed. As an alternative, the contractor may place a loose lift of aggregate base course over the curing subgrade. The aggregate base course shall be kept moist during the curing process.

311.4.10 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.

311.4.11 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 or 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.

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 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.

- End of Section -

SECTION 312

CEMENT TREATED BASE

312.1 DESCRIPTION:

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

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 two 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. Moisture content of the material delivered to the grade shall be checked for moisture content a minimum of four times per shift using AASHTO T-217. Batch adjustments shall be made as necessary to correct for deficiencies.

After spreading, the cement treated base shall be compacted to a density of at least 95 percent of the maximum density as determined by the mix design. Density testing shall be performed using ASTM D6938, with moisture content periodically corrected in accordance with AASHTO T-217.

Compressive strength of the cement treated base material shall be tested a minimum of twice per shift using Arizona ARIZ-241. Strength specimens shall be compacted on site and protected from moisture loss or disturbance by any practical means. Specimens shall be kept in this manner on site for 18-24 hours inside a hard outer-shelled container that will protect the specimens from external environmental elements. The specimens shall be carefully transported to the laboratory for moist curing after this initial 18-24 hour cure.

After compaction, the surface of the cement treated base course shall not deviate at any point more than 3/8 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 the 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 that 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, 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 that, when compacted, will produce a base of the depth and width shown on the plans or as one or more windrows that, 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 an 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 Planning 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 overlaying 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 330. 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 310-1 for Type II deficiency shall be taken by the Contractor 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.

- End of Section -

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 330.

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

When so directed, the surface of the complete 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 the 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.

- End of Section -

SECTION 317

ASPHALT MILLING

317.1 DESCRIPTION:

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

317.2 CONSTRUCTION REQUIREMENTS:

Contractor is responsible for locating all milling hazards on and below the surface within the areas to be milled including areas requiring special milling. Special milling is not a separate pay item and shall be paid for as Asphalt Milling.

The milling cut depth shall be the depth indicated on the Plans plus or minus 1/8 inch. The milling machine shall have electronic grade controls. Contractor shall remove the milled material and sweep the roadway clean with a power pick-up broom to the satisfaction of the Engineer.

Asphalt pavement adjacent to manholes, valve boxes, small radius curbs and other fixed objects that produce confined area shall be removed with milling equipment specifically designed to operate in constricted areas. The equipment shall be capable of removing asphalt concrete of the specified thickness without damage to, or displacement of, the adjacent object(s).

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

The Contractor shall immediately notify the Engineer when:

- The existing pavement thickness is found to be less than anticipated and breaking of the underlying material occurs.
- Delamination of underlying material occurs.

The work shall result in a clean milled surface to the specified depth for the area indicated by the construction documents including the areas immediately around and next to any individual hazard within the area to be milled. The edge of milled area shall form a straight clean cut line.

For milled surfaces on major streets (arterial and collector streets) that will be subject to traffic prior to overlay, a tack coat per Section 329 may, when authorized by the Engineer, be applied to the milled surface as a dust control measure. The tack coat shall be applied after sweeping and prior to allowing traffic on the milled surface. The tack coat application rate shall be half of the prescribed tack rate or contract amount or an alternate rate as prescribed by the Engineer. The Contractor shall be responsible for clean-up of any tack coat tracking that occurs.

317.3 MEASUREMENT AND PAYMENT:

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

Payment for Asphalt Milling at the contract unit price shall be full compensation for the work, complete-in-place, including all asphalt milling, milling around structures, removal and disposal of milled materials, and sweeping.

Engineer approved tack coat applied for dust control will be paid at the contract rate for tack coat. No additional payment for the application of dust control tack coat shall be made.

- End of Section -

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 one-half 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 two 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 permissible 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, structure, guardrails, guideposts, 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 successive 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 spread 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 character 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 3 percent 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 centerline of the road, the surface shall vary in no place more than 1/8 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.

- End of Section -

SECTION 321

PLACEMENT AND CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

321.1 DESCRIPTION:

This section is to provide specifications for furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture and asphalt binder to form a pavement course for placement upon a previously prepared base or sub base.

321.2 MATERIALS AND MANUFACTURE:

The materials shall conform to Section 710 for the type specified. Warm Mix Asphalt (WMA) technologies may be used within the mixture provided all requirements of the specifications are met, and the technology is on the ADOT approved product list. The specific required mix type shall be called out in the contract documents or as directed by the Engineer.

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 degrees F. (50 degrees F for Asphalt Concrete lift less than 2-inch thick) or greater. No asphalt concrete shall be placed when the weather is foggy or rainy, or when the base or sub base on which the material is to be placed is unstable. Asphalt concrete shall be placed only when the Engineer determines that weather conditions are suitable.

321.4 APPLICATION OF TACK COAT:

A tack coat shall be applied to all existing and to each new course of asphalt concrete prior to the placing of a succeeding lift of asphalt concrete. If approved by the Engineer, 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.

The application of the tack coat shall comply with Section 329. The grade of emulsified asphalt shall be SS-1h or CSS-1h as specified in Section 713. 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.

The surface to be covered may require repair or patching as directed by the Engineer. This shall be addressed in the project specifications prior to the bidding of the project.

321.5 MIX DESIGN:

The mix design shall be submitted to the Engineer at least five working days prior to the start of asphalt concrete production. Mix designs provided by the agency may be utilized on projects at the Engineer's discretion. The Engineer will review and approve the mix design to assure it contains all of the required information as outlined in Section 710.3.1. If WMA technologies are used within the mix design, the type of WMA technology used shall be indicated on the mix design. The target values for gradations, binder contents, and air voids will be established as the accepted Job Mix Formula (JMF) based upon the mix design. Mix designs not containing all of the information will be returned within five working days of receipt of all mix design information, for action and resubmission by the contractor.

Once the mix design has been approved by the agency and the mixing plant selected, the Contractor and/or his supplier shall not change plants nor utilize additional mixing plants without prior approval of the Engineer.

If the contractor elects to change its source of material, the contractor shall furnish the Engineer with a new mix design, which meets the requirements of Section 710, as amended by the Project Specifications.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing, acknowledged by the Engineer prior to the start of production of a lot, and will remain in effect until such time as any additional changes are implemented. The self-directed target changes must meet the contract requirements for mix design criteria and gradation limits.

TABLE 321-1 ALLOWABLE SELF-DIRECTED TARGET CHANGES	
MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (Sieve Size)	
3/8 inch	± 4% from mix design target value
No 8	± 4% from mix design target value
No 40	± 2% from mix design target value
No 200	+ 0.5% from mix design target value
Binder Content	± 0.2% from mix design target value
Effective Air Voids	None

The contractor may propose target changes, other than self-directed changes, to the approved mix design for the approval of the Engineer. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and gradation limits. The target changes will not be retroactive for the purpose of acceptance.

321.6 MIX PRODUCTION:

All materials shall be proportioned by weight in a hot mix asphalt plant in the proportions required by the mix design to provide a homogeneous and workable mass. Each hot mix asphalt plant shall be inspected in accordance with the provisions contained in the 'Hot Mix Asphalt Production Facilities' by the Arizona Rock Products Association and shall have a current inspection certificate. All measuring devices shall be calibrated at least annually by a technician licensed by the Arizona Bureau of Weights & Measures. Mixing plants shall conform to the requirements of AASHTO M-156, except as modified herein. If WMA technology is being used, any equipment associated with the production of hot mix asphalt shall be calibrated and in proper working order according to the WMA equipment specifications. If there are any deviations in the production or compacting temperatures of the hot mix asphalt with WMA technology, the mix design shall state the differences.

In drum mix plants, the mineral admixture shall be added and thoroughly mixed with the mineral aggregate by means of a mechanical mixing device prior to the mineral aggregate and mineral admixture entering the dryer. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process.

For drum-mix plants, the mineral admixture shall be weighed across a weight belt, or other approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pug mill type mixer that is in good working condition. The rate of the aggregate feed shall not exceed the mixing device's capacity in ton per hour. The mixer shall be constructed to minimize the loss of mineral admixture and shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected. The mixing device shall be capable of effective mixing in the full range of the asphalt concrete production rates.

The hot plant and equipment shall be constructed and operated to prevent loss of mineral admixture through the dust collection system of the plant.

A positive signal system shall be provided and used during production whereby the mixing shall automatically be stopped if the mineral admixture is not introduced into the mineral aggregate. The plant will not be permitted to operate unless the signal system is in good working condition.

The introduction of bituminous material shall be controlled by an automated system fully integrated with the controls or the mineral aggregate and mineral admixture. The production of the plant shall be controlled by the rate required to obtain a uniform mixture of all components. Drying and heating shall be accomplished in such a manner as to preclude the mineral admixture from becoming coated with un-spent fuel.

The completed asphalt concrete may be held in storage for up to 12 hours in insulated or heated silos, providing the minimum temperature noted herein for placement and compaction is met behind the placement device. If the Engineer determines that there is an excessive amount of heat, heat loss, drain down, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

The temperature of the asphalt concrete, with unmodified binders, upon discharge from the mixer shall not exceed 335 degrees F. The discharge temperature may be increased on the recommendation of the binder supplier, when approved by the Engineer. If the asphalt concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphalt concrete will be minimized.

321.7 TRANSPORTATION:

Petroleum distillates or other substances that will have a detrimental effect on the asphalt concrete shall not be used as a release agent.

The beds of all transportation units shall be clean and smooth to allow the free flow of material into the paving machine's hopper.

Tarpaulins shall be furnished on all trucks and used when weather condition warrant, or if directed by the Engineer.

321.8 PLACEMENT:

Placement of asphalt concrete pavement shall not commence until authorized by the Engineer. The Engineer's authorization to allow commencement of asphalt concrete paving will generally require all newly constructed valley gutters, curbing, and curb and gutters which new pavement is to be placed against to be in-place and in an acceptable condition. While it is preferred to have all newly constructed concrete items against which new pavement is to be placed be in an acceptable condition, the Engineer may allow paving to commence based on weather, the amount of defective concrete, or other considerations.

321.8.1 Placing: All courses of asphalt concrete shall be placed and finished by means of a self-propelled paving machine equipped with an automatically actuated control system, except under certain conditions or at locations where the Engineer deems the use of a self-propelled paving machine impracticable.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternatively when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with one of the following devices:

(a) Ski or non-contact device of not less than 30 feet in length, supported throughout its entire length
(b) Taut stringline or wire set to grade
(c) Short ski or sonar sensing units from curb control
(d) Joint matching shoe

Failure of the control system to function properly shall be cause for the suspension of asphalt concrete production. In order to achieve a continuous operation, the speed of the paving machine shall be coordinated with the hot mix plant and transport units.

If the asphalt concrete is dumped from the hauling vehicles directly into the paving machine, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machine by the truck.

If asphalt concrete is dumped upon the surface being paved and subsequently loaded in the paving machine, the loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphalt concrete shall be picked up and loaded into the paving machine.

Self-propelled paving machines shall spread the mixture without segregation or tearing, true to line, grade and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers that will distribute the mixture uniformly in front of an adjustable floating screed. The raising of the hopper wings must be minimized and the paving machine will not be operated when in an empty condition.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective, without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required. In the

case of the screed, auger extensions and vibrators shall be installed wherever the screed is extended more than one (1) foot beyond the end of the base auger or auger extension. However, when placing material against an extremely uneven curb or edge over a short distance, the Engineer may waive the auger extensions and vibrators.

At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers to provide a uniform and smooth layer over the entire area compacted in this manner.

321.8.2 Joints: Transverse joints, before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphalt concrete shall be trimmed to a vertical face for its full depth exposing a fresh face. The fresh face shall be tack coated prior to placement of the new asphalt concrete. After placement and finishing the new asphalt concrete, both sides of the joint shall be dense and the joint shall be smooth and tight. The surface in the area of the joint shall not deviate more than 1/4 inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, parallel to the centerline.

Longitudinal joints of each asphalt course shall be staggered a minimum of 6 inches with relation to the longitudinal joint of the immediate underlying course's cold longitudinal construction joint.

Longitudinal joints with existing or cold (more than 32 hours old) asphalt concrete shall require the existing pavement to be trimmed to a vertical face for its full depth exposing a fresh face. The fresh face shall be tacked prior to placement of the adjacent course. Longitudinal joints with an existing asphalt pavement that is less than 32 hours old that has had its edge protected from damage may have adjacent new asphalt concrete placed after applying the required tack coat. After placement and finishing of longitudinal joints, both sides of the joint shall be dense and the joint shall be smooth and tight. The surface in the area of the joint shall not deviate more than 1/4 inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, in any direction.

321.8.3 Asphalt 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. If a leveling course is being applied on an asphalt surface, a tack coat shall be applied. The compaction requirements contained in Section 321.10 do not apply to leveling courses.

321.8.4 Compaction - Asphalt Base Course and Surface Course: It is the contractor's responsibility to perform Quality Control monitoring and/or testing during compaction operations to achieve the required compaction. The temperature of the asphalt concrete immediately behind the laydown machine shall be at least 265 degrees F, unless WMA technology is being used. If WMA technology is being used then the minimum requirements will be stated within the mix design recommended by the WMA manufacturer. A probe type electronic thermometer with a current calibration sticker attached will be used to measure the temperature of the asphalt concrete mixture. When measuring the temperature of the mat, the probe shall be inserted at mid-depth and as horizontal as possible to the mat. The contractor is responsible to achieve the required compaction.

Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. During the rolling operation, the speed of the roller shall not exceed three miles per hour, unless otherwise approved by the Engineer.

Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

The Engineer will determine the acceptability of the pavement compaction in accordance with Section 321.10.

321.8.5 Smoothness: 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 1/4 inch from the lower edge of a 12-foot straightedge when the straightedge is placed parallel to the centerline of the roadway.

321.8.6 Asphalt Concrete Overlay: Asphalt concrete overlay consists of the placing and compacting plant mix asphalt concrete over existing pavement. The mix design and thickness of the overlay shall be as shown on the plans or as specified in the special provisions.

Except when the existing asphalt surface is to be preheated and remixed, pavement surfaces shall be prepared as follows:

(a) Areas designated for pavement repair by the contract documents (which may include severely raveled areas, severely cracked areas, over-asphalted areas, and other defects) shall be cut out and replaced. Pavement repairs shall be completed and approved before placing asphalt concrete overlay.

(b) Before placing asphalt concrete overlay, raised pavement markers shall be removed, and milling shall be completed. Milling shall be as shown on the plans or specified in the special provisions and shall be in accordance with Section 317.

(c) After pavement repairs and milling have been completed, the entire surface shall be cleaned with a power broom.

(d) After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat per Section 321.4. Traffic will not be permitted to travel over surfaces that have received a tack coat, except when tack coat is applied to milled surfaces in compliance with Section 317.2 for dust control purposes. When the overlay is to extend onto a concrete surface, the concrete surface shall be thoroughly cleaned of loose dust and cement particles and shall be tack coated.

Asphalt concrete overlay shall be placed as specified in Section 321.8.1 and compacted as specified in Section 321.8.4. The surface smoothness shall meet the tolerances specified in Section 321.8.5.

Frames and covers of manholes, survey monuments, valve boxes, clean-outs and other existing structures shall be adjusted in accordance with Section 345 to set flush with the finished surface of the new pavement. During adjustment, if pavement or base materials are removed or disturbed, they shall be replaced with approved materials installed in a manner acceptable to the Engineer.

On roads without curb and gutter, the existing unpaved shoulder elevation shall be adjusted by the Contractor to match the elevation at the edge of the new overlay and slope away from the new pavement surface at a rate that the existing quantity of shoulder material will allow. Shoulder material shall be compacted to a minimum of 95% of maximum density, determined in accordance with Section 301.3. Shoulder adjustment to match the new pavement surface elevation shall not be measured. The cost of shoulder adjustment shall be included in the price paid for the asphalt concrete overlay or other related pay items. When the Engineer determines an insufficient amount of material is available for shoulder adjustment, the Engineer may require the Contractor to provide additional material. Acceptable material for shoulders includes the existing shoulder material, millings, untreated base materials, or a granular material approved by the Engineer. Engineer requested imported material for shoulder adjustment is not included in the price paid for the asphalt concrete overlay.

321.8.7 Pavement Fabric Interlayer: Pavement fabric interlayer shall be used only when specified on the plans or in the specifications. Pavement fabric interlayer shall be in accordance with Table 796-1 and be the class designated on the plans or in the specifications.

Asphalt binder coat used to bond the fabric to the pavement shall be paving asphalt PG 70-10 asphalt cement conforming to the requirements of Section 711. The application and distributing equipment for the asphalt binder shall conform to the requirements of Section 330. The asphalt binder coat shall be uniformly spray applied to the prepared pavement surface at the rate of 0.20 gallons per square yard for Class B fabric or at the rate of 0.25 gallons per square yard for Class A fabric. Some underlying surfaces may require a higher or lower application rate. A test strip may be necessary to determine the proper application rate. The width of liquid asphalt cement application shall be the fabric width, plus six inches.

Neither the asphalt binder coat or fabric interlayer shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. The asphalt binder and fabric interlayer shall only be placed when the pavement is dry, the ambient air temperature is 50 degrees F and rising, and pavement temperature is 40 degrees F and rising.

Equipment for placing the fabric shall be mechanized and capable of handling full rolls of fabric. The equipment shall be able to lay the fabric smoothly to maximize pavement contact and remove air bubbles. Stiff bristle brooms shall be used to smooth the fabric. The equipment used to place the fabric shall be in good working order and is subject to approval by the Engineer.

Pavement fabric interlayer shall not be placed if the in-place binder is hotter than 325 degrees F or has cooled to 180 degrees F or below (as determined by non-contact thermometer).

Pavement fabric interlayer shall be placed onto the asphaltic binder with the heat-bonded side up with a minimum amount of wrinkling or folding. Remaining wrinkles or folds 1-inch and larger shall be removed or slit and shingle-lapped in the direction of paving. Burning or torching of wrinkles is not allowed. Fabric shall overlap three to six inches to insure full closure of the joint. Transverse joints shall be shingle-lapped in the direction of paving to prevent edge pickup by the paver. A second application of hand-placed asphalt binder may be required at laps and repairs as determined by the Engineer to ensure proper binding of the narrow double fabric layer.

All areas where fabric has been placed shall be paved with asphaltic concrete during the same work shift. Placement of the asphaltic concrete shall closely follow fabric lay down. The temperature of the asphaltic concrete immediately behind the laydown machine shall not exceed 325 degrees F, unless modified by the WMA technology being used. If WMA technology is being used then the minimum requirements will be stated within the mix design recommended by the WMA manufacturer. In the event that the asphalt binder coat bleeds through the fabric causing construction problems before the overlay is placed, the affected areas shall be sanded with a sand blotter in compliance with Section 333. Excess sand shall be removed before beginning the paving operation. In the event of rainfall prior to the placement of the asphaltic concrete, the fabric shall be allowed to dry before the asphalt concrete is placed.

Turning of the paving machine or of other vehicles on the fabric shall be gradual and kept to a minimum to avoid damage to the fabric. Should equipment tires stick to the fabric during pavement operations, small quantities of paving asphalt concrete shall be broadcast on the fabric to prevent pick-up. Decrease of binder rate in order to minimize pick-up on tires is not allowed.

321.8.8 Thickened Edge: When the depth of the thickened edge extends four inches or more below the bottom of the asphalt pavement, the portion of the thickened edge extending below the asphalt pavement shall be placed and compacted prior to placement of the asphalt pavement. Placement of tack coat on the surface of the compacted thickened edge asphalt may be omitted when additional asphalt pavement is placed on the same day and the Engineer agrees that the surface of the thickened edge asphalt has remained clean.

When the depth of the thickened edge extends less than four inches below the bottom of the asphalt pavement, the portion below the asphalt pavement may be placed and compacted with the asphalt pavement in a single operation.

321.8.9 Safety Edge: The finished safety edge slope shall be planar forming a 30° ± 5° angle with the adjacent roadway surface and extend a minimum of five inches (5”) below the roadway pavement’s finished surface.

The safety edge shall be constructed with the top or final paving lift of a new pavement or overlay using a device that is mounted to or is a part of the screed portion of the laydown machine. The safety edge device shall be capable of constraining the asphalt concrete material to increase density of the extruded profile by reducing the volume. A conventional single strike-off plate is not acceptable. Compaction obtained from the extruded safety edge shall be acceptable when the extruded shape conforms to the specified shape.

During laydown operations if the extruded safety edge does not conform to the specified shape, the Contractor shall take immediate actions to correct the deficiency and to repair all non-compliant sections of safety edge. The Contractor shall stop paving operations until corrections to the laydown operation have been made and resumption of paving is approved by the Engineer or his designated representative.

321.8.10 Protection for Asphalt Base Course: Arterial roadway traffic shall not be allowed on a new asphalt base course that is less than five (5) inches in thickness without the written consent of the Engineer.

321.9 QUALITY CONTROL:

It is the contractor’s responsibility to perform Quality Control monitoring and/or testing during asphalt concrete production to achieve the required compaction and to perform Quality Control monitoring and/or testing during asphalt concrete production to achieve the required mix properties. The Engineer may obtain samples of any portion of any material at any point of the operations for his own use. Also, the Engineer may order the use of any drying, proportioning and mixing equipment or the handling of any material discontinued which, in his/her opinion, fails to produce a satisfactory mixture.

The asphalt concrete produced shall conform to the requirements of the production tolerances established in Section 321.10.

When the asphalt concrete does not conform to the production tolerances, it shall be reported to the Engineer, and corrective quality control measures shall be implemented, or production shall cease immediately at no additional cost to the contracting Agency.

Requests for referee testing as described in Section 321.11 will only be considered based on quality control test results performed by a laboratory accredited by the AASHTO Accreditation Program (AAP) for the tests being performed or a laboratory listed in the current ADOT Directory of Approved Materials Testing Laboratories for the set of tests in question. The laboratory shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications).

321.10 ACCEPTANCE:

321.10.1 Acceptance Criteria: Asphalt concrete will be divided into lots for the purpose of acceptance. A lot shall be one day's production. Each lot shall be divided into sublots of 500 ton or fraction thereof. Tests used to determine acceptance will be performed by a laboratory accredited by the AASHTO Accreditation Program (AAP) for the tests being performed. The contracting agency shall provide an appropriately accredited laboratory or laboratories to perform the acceptance testing. Laboratories shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications). The acceptance laboratory will take representative samples of the asphalt concrete from each sublot to allow for testing of gradation, binder content, air voids, pavement thickness, and compaction of base and surface courses. Acceptance of each sublot will be based on the test data from the sample(s) from that sublot. All acceptance samples shall be taken using random locations or times designated by the Engineer in accordance with ASTM D3665.

For permit work, testing that does not strictly adhere to the sampling and testing methodology and requirements outlined in this section shall be disregarded and not considered in any acceptance determination. All required retesting shall be at the expense of the permittee.

321.10.2 Gradation, Binder Content and Air Voids: The acceptance laboratory will take a sample of the asphalt concrete in accordance with the requirements of Section 2 or 4 of Arizona Test Methods 104 or AASHTO T-168 from each sublot. The minimum weight of the sample shall be 45 pounds. Asphalt binder content and gradation shall be determined in accordance with AASHTO T-308 using the ignition furnace for each sublot. The acceptance laboratory is responsible for obtaining the necessary materials and performing an ignition furnace calibration as outlined in AASHTO T-308 for each asphalt concrete mixture utilized on the project. The correction factor used for each test shall be clearly indicated on the report. Reports that do not include the correction factor, performed as stated in the previous sentences, shall be considered invalid and not allowed to be used for acceptance. The bulk density for Marshall Mix designs shall be tested in accordance with AASHTO T-245. The bulk density for Gyratory mix designs shall be determined in accordance with AASHTO T-312. The maximum theoretical density shall be determined in accordance with the requirements of AASHTO T-209 including fan drying per AASHTO T-209 Section 15. Effective voids of the laboratory compacted specimens will be determined at a minimum of once per lot in accordance with the requirements of AASHTO T-269. Should the testing for effective air voids not meet the "Full Payment" or "No Corrective Action" requirements of Table 321-5, additional testing for laboratory air voids on the remaining sublots will be performed as necessary to determine the extent of the deficiency. Acceptance testing results will be furnished to the contractor and the supplier within five working days of receipt of samples by the acceptance laboratory.

During production, the allowable deviations from the mix design gradation targets are listed in the tables below. The allowable production tolerances may fall outside of the mix design gradation bands.

TABLE 321-3A
GRADATION ACCEPTANCE LIMITS FOR MARSHALL MIXES

Sieve Size	3/8 inch Mix	1/2 inch Mix	3/4 inch Mix	Base Mix
1 inch	---	---	---	±7%
3/4 inch	---	---	±7%	±6%
1/2 inch	---	±7%	---	---
3/8 inch	±7%	±6%	±6%	±6%
No. 8	±6%	±6%	±6%	±6%
No. 40	±4%	±4%	±4%	±4%
No. 200	±2%	±2%	±2%	±2%

TABLE 321-3B			
GRADATION ACCEPTANCE LIMITS FOR GYRATORY MIXES			
Sieve Size	3/8 inch Mix	1/2 inch Mix	3/4 inch Mix
3/4 inch	---	---	±7%
1/2 inch	---	±7%	±6%
3/8 inch	±7%	±6%	---
No. 8	±6%	±6%	±6%
No. 40	±4%	±4%	±4%
No. 200	±2%	±2%	±2%

If the results from a single acceptance sample fall outside of the acceptance limits in Table 321-3A or 321-3B as applicable, a second sample shall be taken and if the second acceptance sample is also outside of the acceptance limits the Contractor shall cease production of asphalt concrete. Production shall not begin again until calibration test results verify that adjustments made to materials or proportions yield a gradation that falls within acceptance limits in Table 321-3A or 321-3B as applicable.

If the asphalt binder content is within ± 0.40% of the mix design target value, the asphalt concrete will be paid for at the contract unit price. If the asphalt binder content deviates by more than ± 0.40% from the mix design target value, the deficient area will be evaluated within the sublot by coring one additional location at a maximum interval of 100 feet on each side of the deficient sample. The asphalt content of the original deficient sample will be averaged with the asphalt binder content of the two additional cores to determine compliance with the acceptance requirements. If the resulting average of the asphalt binder content deviates by more than ± 0.40% from the mix design target value, then Table 321-4 shall apply to the sublot. If approved by the Engineer, the Contractor may obtain additional cores to assist in formulation of an Engineering Analysis, but the additional cores shall not be used for re-evaluating acceptance.

TABLE 321-4		
ASPHALT BINDER CONTENT ACCEPTANCE AND PENALTIES		
Deviation from that permitted	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Over 0.2% above that permitted	Removal* or EA	Removal* or EA
Over 0.1% to 0.2% above that permitted	$6.00	EA
Over 0.0% to0.1% above that permitted	$2.00	EA
Within permitted range	Full Payment	No Corrective Action
Over 0.0% to0.1% below that permitted	$2.00	EA
Over 0.1% to 0.2% below that permitted	$6.00	EA
Over 0.2% below that permitted	Removal* or EA	Removal* or EA

NOTES: *The Contractor shall remove and replace the entire sublot that is deficient.
EA = Engineering Analysis per Section 321.10.6

If the laboratory air voids fall within a range of 2.8% to 6.2%, the asphalt concrete will be paid for at the contract unit price. If the laboratory air voids are outside of this range, the deficient area will be evaluated within the sublot by coring one additional location at a maximum interval of 100 feet on each side of the deficient sample. The laboratory air voids of the original deficient sample will be averaged with the laboratory air voids obtained from each of the two additional cores to determine compliance with the acceptance requirements. If the resulting average of the laboratory air voids is outside the indicated range, then Table 321-5 shall apply to the sublot. If approved by the Engineer, the Contractor may obtain additional cores to assist in formulation of an Engineering Analysis, but the additional cores shall not be used for re-evaluating acceptance.

TABLE 321-5		
LABORATORY VOIDS ACCEPTANCE AND PENALTIES		
Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Less than 1.5%	Removal* or EA	Removal* or EA
1.5-2.0%	$5.00	EA
2.1-2.7%	$2.00	EA
2.8-6.2%	Full Payment	No Corrective Action
6.3-6.9%	$2.00	EA
7.0-8.0%	$5.00	EA
Greater than 8.0%	Removal* or EA	Removal* or EA

NOTES: *The Contractor shall remove and replace the entire sublot that is deficient.
EA = Engineering Analysis per Section 321.10.6

If an agency or Engineer is purchasing asphalt concrete directly from a commercial material supplier, the agency or Engineer will use Section 321.10, and specifically Tables 321-3A or 321-3B as applicable, 321-4 and 321-5 from Section 321.10, when determining the acceptance of the asphalt concrete with the material supplier.

321.10.3 Surface Testing: If directed by the Engineer, surface drainage test shall be performed. 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 1/4 inch from the lower edge of a 12-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.

All streets shall be water tested for drainage in the presence of the Engineer or designated representative before final acceptance. Any areas not draining properly shall be corrected to the Engineer's satisfaction at the Contractor's expense. Water for this testing shall be provided and paid for by the Contractor.

When deviations in excess of the above tolerance are found, humps or depressions shall be corrected to meet the specified tolerance. The defective pavement shall be cut out along neat straight lines or for multiple course pavements the surface course may be milled out, and the removed pavement 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.

When pavement is cut out along neat straight lines, full depth longitudinal joints shall not be located within a lane wheel path or within forty-eight inches (48") of an asphalt pavement edge. Longitudinal joints shall comply with the restrictions for Type A Trench Repairs in Section 336.3.

321.10.4 Asphalt Pavement Thickness: Asphalt pavement thickness will be determined from cores secured from each lift of each sublot. Such cores will be taken and measured by the Asphalt Concrete Coring Method. This method can be found in Section 321.14. Each core location will be patched by the party responsible for the testing.

Acceptance or assessment of penalties for asphalt pavement thickness will be based on the combined total thickness of all asphalt concrete layers omitting all layers of asphalt-rubber asphalt concrete. If the final total pavement thickness exclusive of all ARAC layers is deficient from the target thickness by 0.25 inches or less, it will be paid for at the contract unit price.

If the thickness deficiency of the pavement core exceeds 0.25 inch, the thickness deficiency shall be evaluated by coring at a maximum interval of 100 feet on each side of the deficient core. The thickness of the original deficient core will be averaged with the thicknesses of the cores taken from each side of it to determine compliance with the acceptance requirements.

If the pavement thickness deficiency is greater than 0.25 inches and the contracting agency is not the owner (i.e. permits) the following will apply:

(1) If the pavement thickness deviates from the target thickness by more than 0.25 inch but not more than 0.50 inch, corrective action will be required. This corrective action shall consist of application of a Type II slurry seal coat in accordance to Section 715. The Contractor may present an Engineering Analysis outlining other proposed remedial measures for the consideration by the Engineer. The Engineer will review the Engineering Analysis and decide within 30 working days whether to accept the proposed remedial measures.

(2) If the pavement thickness deviates from the target thickness by more than 0.50 inch, corrective action will be required. The deficient area shall be overlaid with no less than a 1 inch thick lift, for the full width of the pavement to meet or exceed the designed thickness, with appropriate end and edge milling, with a mixture approved by the Engineer. The Contractor may present an Engineering Analysis outlining other proposed remedial measures for the Engineer's consideration. The Engineer will review the Engineering Analysis and decide within ten working days whether to accept the proposed remedial measures. If the Engineer chooses to reject the Engineering Analysis, the indicated overlay shall be constructed by the Contractor at no additional cost to the Owner.

If the contracting agency is the owner and the pavement thickness deficiency is greater than 0.25 inches but less than 0.50 inches, Table 321-6 will apply. If the pavement thickness deficiency is greater than 0.5 inches, the deficient area shall be overlaid with no less than a 1-inch thick lift for the full width of the pavement to meet or exceed the designed thickness using an asphalt mixture approved by the Engineer. The Contractor shall provide appropriate end and edge milling. The overlay and milling shall be accomplished by the Contractor at no additional cost to the contracting agency.

TABLE 321-6
ASPHALT PAVEMENT THICKNESS PAYMENT REDUCTION
For Thickness Deficiency of More Than 0.25 inches and less than 0.50 inches

Total Specified Asphalt Pavement Thickness exclusive of ARAC (if any)	Reduction in Payment Applied to asphalt concrete Except ARAC layers (if any)
Less than 1.5 inches	50%
1.50 inches to 1.99 inches	33%
2.00 inches to 2.49 inches	25%
2.50 inches to 2.99 inches	20%
3.00 inches and greater	17%

321.10.5 Density:

321.10.5.1 Pavement 1-1/2 Inches or Less in Nominal Thickness:

Compaction shall consist of a "Rolling Method Procedure" using an established sequence of coverage with specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as shown in Table 321-7.

TABLE 321-7				
ROLLING SEQUENCE FOR LIFT THICKNESS 1½" OR LESS				
Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2- 4*
Finish	Static Steel	Static Steel	1-3	1-3
* Based on the roller pattern which exhibits the best performance.				

The Contractor shall select the option for compaction and, when pneumatic-tired compactors are used will designate the tire pressure. Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F. Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

321.10.5.2 Pavement Greater than 1-1/2 Inches in Nominal Thickness:

Achieving the required compaction is the responsibility of the contractor. The number and types of rollers is the contractor's responsibility and shall be sufficient to meet these requirements.

In-place air voids shall be determined in accordance with AASHTO T-269 utilizing cores taken from the finished pavement. The maximum theoretical density used in the determination of in-place air voids will be the average value from the acceptance samples determined for the lot as outlined in 321.10.1.

The Engineer will designate one random test location for each sublot and the acceptance laboratory will obtain one core from that location. Regardless of sublot quantities or boundaries, a minimum of one core will be obtained per residential street and a minimum of one core per travel lane for collector and arterial streets. The outside one foot of each pass of the pavement course or any unconfined edge will be excluded from testing. The Engineer may exclude areas from the compaction lot that are not accessible by normal compaction equipment.

The Contractor shall provide the traffic control to facilitate any coring operations necessary for compaction acceptance.

Cores will be taken per the Asphalt Concrete Coring Method. This method can be found in Section 321.14. Acceptance testing results will be furnished to the contractor within five working days of receipt of samples by the acceptance laboratory.

If the pavement density has in-place voids of between 4.0% and 8.0%, the asphalt concrete will be paid for at the contract unit price. If the acceptance core for a sublot indicates that the pavement density has in-place voids of less than 4.0% or greater than 8.0%, the deficient area will be evaluated by coring two additional locations at maximum intervals of 100 feet from the deficient core. The in-place voids of the original deficient core will be averaged with the in-place voids of the cores taken from 100 feet on each side of it to determine compliance with the acceptance requirements. If the resulting average of the in-place voids is outside the indicated range, then Table 321-8 shall apply to the sublot. If approved by the Engineer, the Contractor may obtain additional cores to assist in formulation of an Engineering Analysis, but the additional cores shall not be used for re-evaluating acceptance.

TABLE 321-8		
PAVEMENT DENSITY PENALTIES		
Limits of In-place Air Voids for design lift thicknesses 1.5 inches and greater	When the contracting agency is the owner Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner i.e. permits Corrective Action
Below 3.0%	Removal* or EA	Removal* or EA
3.0% to below 4.0%	$10.00	EA and Type II Surry Seal
4.0% to 8.0%	Full Payment	No Corrective Action
Greater than 8.0% to less than 9.0%	$6.00	EA
9.0% to 10.0%	$10.00	EA and Type II Surry Seal
Greater than 10.0%	Removal* or EA	Removal* or EA

NOTES: *The Contractor shall remove and replace the entire sublot that is deficient.
EA = Engineering Analysis per Section 321.10.6

321.10.6 Engineering Analysis (EA): Within 10 working days after receiving notice that a lot or sublot of asphalt concrete is deficient and is found to fall within the "Removal or EA" band per Table(s) 321-4, 321-5, and/or 321-8, the contractor may submit a written proposal (Engineering Analysis) to accept the material in place at the applicable penalties along with possible remediation(s) listed in the "Removal or EA" category. Engineering Analysis can also be proposed for non-removal categories of "Corrective Actions" when the contracting agency is not the owner (i.e. permits).

The Engineering Analysis shall contain an analysis of the anticipated performance of the asphalt concrete if left in place. The Engineering Analysis shall also detail the effect of any proposed corrective action to the material(s) in place as it relates to the in-place material's performance. The Engineering Analysis shall be performed by a professional engineer experienced in asphalt concrete testing and mix designs.

If a lot or sublot is accepted for referee testing and the referee test results still show a deficiency, the contractor shall have ten working days to submit an Engineering Analysis beginning upon notification of referee test results.

When an Engineering Analysis recommends that a specific lot or sublot should not be removed, the Engineering Analysis will recommend that the following penalties (Table 321-9) be paid when the contracting agency is the owner, for the specific criteria being reviewed by the EA.

TABLE 321-9		
ENGINEERING ANALYSIS PENALTIES for REMOVAL* LOTS/SUBLOTS LEFT IN-PLACE		
Acceptance Criteria	**Acceptance Limits**	**Penalty When Contracting Agency is the Owner ($/Ton)**
Asphalt Binder Content	Over 0.2% points from that Permitted	$9.00
Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	Less than 1.5% or Greater Than 8.0%	$7.50
Limits of In-place Air Voids	Less than 3% or Greater than 10.0%	$15.00

Within 15 working days, the Engineer will determine whether or not to accept the Contractor's proposed Engineering Analysis.

321.11 REFEREE:

If the Contractor has reason to question the validity of any of the acceptance test results, the Contractor may request that the Engineer consider referee test for final acceptance. Any request for referee testing must describe the contractor's reasons for questioning the validity of the original acceptance test results and must clearly describe which set of acceptance tests are in question. The Engineer may either accept or reject the request for referee testing. When referee testing is accepted the Contractor (at the Contractors own expense) will engage an independent laboratory accredited by the AAP or a laboratory listed in the current ADOT Directory of Approved Materials Testing Laboratories as appropriate the acceptance tests that are being questioned. The independent referee laboratory shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications). For the set of test results in question, the referee laboratory shall perform a new set of acceptance tests (as required by Section 321.10 representing the area for the set of tests in question). The referee tests will replace the original acceptance tests that were in question.

For permit work, the permittee, whose results necessitate referee testing, shall bear all expenses in the additional testing (i.e., secondary and the referee testing) if the original results are not substantiated by the referee testing procedure outlined in this section. Additionally, any testing performed that does not strictly adhere to the sampling and testing methodology and requirements in Section 321.10 shall be disregarded and not allowed in any acceptance determination. Disregarded tests will be re-performed at the expense of the permittee.

These tests may include asphalt binder content, aggregate gradation, Marshall or Gyratory unit weight, maximum theoretical unit weight, laboratory air voids and in-place air voids (compaction). All referee testing shall conform to Section 321.10. Samples for referee testing shall come from representative samples obtained from the completed pavement, as directed by the Engineer.

The number of samples taken will be the same as specified in Section 321.10. The independent laboratory shall compile the test results and transmit them to both the Engineer and the contractor. The independent laboratory shall include a report sealed and signed by an Engineer registered in the State of Arizona, who is experienced in asphalt concrete testing and mix design development. The signed report shall give an opinion that the material evaluated does or does not comply with project specifications, shall clearly describe any deficiencies, and the results will be binding between all parties.

321.12 MEASUREMENT:

Asphalt concrete pavement will be measured by the ton, or by the square yard, for the mixture actually used as allowed above, which shall include the required quantities of mineral aggregates, asphalt binder, and mineral admixture. 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.

Measurement for safety edge preparation only applies to overlays of existing pavements that require the construction of a safety edge when none exists. Safety edge preparation will be measured by the linear foot. Safety edge preparation will not be measured when a safety edge is part of new pavement construction, pavement widening, or when overlaying an existing pavement that contains a safety edge. The asphalt concrete pavement measurement shall include the tonnage used to construct safety edges or the square yard measurement for asphalt concrete pavement will be increased by the horizontal extension of the safety edge beyond the roadway pavement edge.

321.13 PAYMENT:

The asphalt concrete measured as provided above will be paid for at the contract price per ton or square yard, as adjusted per Section 321.10, which price shall be full compensation for the item complete, as herein described and specified.

Payment for tack coat will be by the ton diluted, based on the rate of application, as directed by the Engineer.

No payment will be made for any overrun in quantity of asphalt concrete in excess of 10 percent for newly constructed pavement having a total thickness equal to or greater than 2.5 inches. The overrun quantity is excess tonnage above the tonnage calculated based on actual field measurement of area covered, design thickness, and the mix design unit weight. The calculations for overrun will be by individual pay 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 price.

Removal of raised pavement markers, pavement repairs, and surface pavement replacements required prior to roadway overlay operations will be paid for by other pay items unless otherwise specified.

Except as otherwise specified, no separate payment will be made for work necessary to construct thickened edges, safety edges, or other miscellaneous items or surfaces of asphalt concrete.

Payment for safety edge preparation will be at the contract unit price for the quantities measured as described above.

321.14 ASPHALT CORE METHOD: Core Drilling of Hot Mix Asphalt (HMA) for Specimens of 4" or 6" diameter

321.14.1 Scope: This method is to establish a consistent method of the use of a diamond bit core to recover specimens of 4 or 6 inch diameter for laboratory analysis and testing. The method will require the use of: water, ice (bagged or other suitable type), dry ice, and a water-soap solution to be utilized when coring asphalt rubber concrete. Individuals doing the specimen recovery should be observing all safety regulations from the equipment manufacturer as well as the required job site safety requirements for actions, and required personal protective equipment.

For permit work, testing of cores obtained in a manner that does not strictly adhere to the methodology outlined in this section shall be disregarded and not considered in any acceptance determination. Retesting shall be at the expense of the permittee.

321.14.2 Core Drilling Device: The core drilling device will be powered by an electrical motor, or by an acceptable gasoline engine. Either device used shall be capable of applying enough effective rotational velocity to secure a drilled specimen. The specimen shall be cored perpendicularly to the surface of pavement, and that the sides of the core are cut in a manner to minimize sample distortion or damage. The machinery utilized for the procedure shall be on a mounted base, have a geared column and carriage that will permit the application of variable pressure to the core head and carriage throughout the entire drilling operation. The carriage and column apparatus shall be securely attached to the base of the apparatus; and the base will be secured with a mechanical fastener or held in place by the body weight of the operator. The core drilling apparatus shall be equipped with a water spindle to allow water to be introduced inside of the drill stem while operating. The cutting edge of the core drill bit shall be of hardened steel or other suitable material with embedded diamond chips in the cutting surface. The core barrel shall be of sufficient diameter to secure a specimen that is a minimum of four or six inches or whichever is prescribed for necessary testing. The core barrel shall not be missing more than one of the teeth used for cutting; if so, it shall be discarded and another barrel shall be used. The core barrel shall also be a minimum of two inches longer than the anticipated depth of pavement in accordance with project paving plans.

321.14.3 Accessory Equipment: A sufficient supply of ice and dry ice shall be provided to sufficiently cool the pavement prior to securing the samples from the designated areas in the pavement. The ice should also be used to adjust the temperature of the water used to cool the core bit. A water supply (usually a plastic 35 – 55 gallon drum) with sufficient hose to introduce the water into and through the spindle of the coring device by gravity feed. The drum should be white or light in color to minimize excessive thermal heating of the water (*for coring of asphalt rubber cores see Note 1*). At no time shall the water utilized in the coring operation exceed 65 degrees F during the coring operation. Ice shall be utilized to ensure the temperature control of the water being introduced during the cutting operation. An ice chest or other suitably insulated container that can maintain a temperature of less than 70 degrees F shall be used to secure the specimens during transport. The container will be equipped with flat shelving that will support the drilled cores throughout the entire specimen dimension during transport back to the testing facility.

Miscellaneous hand tools to remove the drilled specimen from the drill hole or the core barrel taking great care in not disturbing the specimen more than necessary (refer to fig. 1 in ASTM D5361).

321.14.4 Process: The pavement surface at the time of coring shall not exceed a temperature of 90 degrees F; the pavement shall be conditioned with ice or dry ice to ensure that this requirement is met. Immediately after it has been ensured that the pavement has dropped to the required temperature, core drilling shall begin. The operator will then apply an even and continuous pressure (Note 2) to penetrate through the full depth of the pavement. The operator will concurrently ensure that enough water is moving over the core surface as to adequately remove any and all cuttings that could damage the drilled core.

After the pavement thickness has been penetrated, the core shall be carefully removed from either the drill hole or the core barrel and be immediately transferred to an ice chest or other suitable container. Each individual core shall be placed on a shelf in the cooler with the exposed side of the specimen facing down, or the "top side" down. If the specimen is a two-lift core, the only acceptable means of separating lifts is with a power or other acceptable wet saw type of equipment (conforming to ASTM D5361); however, at no time shall cores be split using a mallet and screwdriver or metal straight edge when being tested for bulk density. Perpendicularity of the specimen shall be checked in the field after the specimen has been extracted from the surface. The core operator shall hold the core up to eye level and place the core top side down in a "speed square" or small carpenters square. The specimen placed in the square shall not depart from perpendicular to the axis more than 0.5º (approximately equivalent to 1/16 of an inch in 6 inches). If the specimen is outside of this distance from square, it shall be discarded in the field and another sample cored that falls within tolerance. The cores upon arriving at the laboratory for testing shall be carefully cleaned and measured for thickness in accordance with ASTM D3549. A speed square shall be used to measure perpendicularity as compared to a 90 degrees angle and shall not depart from perpendicular to the axis more than 0.5 degrees (approximately equivalent to 1/16 of an inch in 6 inches). All remaining testing shall be done within the parameters of the current project and/or agency required specification.

The core operator that obtained the cores is responsible for restoration of the core holes at the conclusion of the coring process. Immediately before restoration, standing water and errant debris shall be removed from the holes. Core holes shall be patched back with an agency-approved material. One typical material is hot mix asphalt conforming to Section 710, compacted in thin (1.5 inch) lifts with the temperature compaction range as specified on the mix design, or as established by the binder supplier. Another typical material is pre-packaged non-shrink grout conforming to ASTM C1107. If non-shrink grout is used, the individual restoring the core holes is responsible for protecting the finished work from tire traffic, etc. Other patch materials maybe used at the discretion of the Engineer.

- End of Section -

*Note 1 – It should be noted that when the material to be cored is a rubberized asphalt mixture a wetting agent such as liquid dish soap be added to the water barrel to hinder the material from sticking or allowing the binder to spread during coring.
*Note 2 – This refers to pressure exerted on the core barrel and machine during the coring process. Too much pressure can cause damage to the core barrel and the motor; and too little pressure can cause a glazing of the diamonds, reducing cutting efficiency and premature wear of the barrel.

SECTION 322

DECORATIVE ASPHALT

322.1 GENERAL REQUIREMENTS:

Decorative asphalt is asphalt stamping that creates an imprinted surface pattern and/or installs color coatings to the surface of a newly constructed asphalt pavement. Mock ups may be required at the owner's discretion to ensure Contractor familiarity with product and installation procedures. Acceptance of colors and application procedures should be accepted in writing from the agency/owner prior to commencement of work. Payment for mock ups, if required in the contract documents, will be considered incidental to the stamping or coating item.

The Contractor shall submit for review and approval all manufacturer product and technical data for materials proposed to be installed. The Contractor shall submit for review and approval a sample of the stamped asphalt material prior to installation. These submittals shall be submitted to the Engineer.

322.2 MATERIALS:

All products used in the surfacing system shall meet the minimum physical and performance properties in Table 322-1. The Contractor shall, upon request, submit a Certificate of Compliance to the Engineer indicating that the materials to be included in the work meet these specification requirements. The color used for painted asphalt shall be as per the contract documents or as approved by the Agency.

TABLE 322-1		
ASPHALT SURFACING SYSTEM PHYSICAL PROPERTIES		
CHARACTERISTIC	TEST SPECIFICATION	TEST RESULT – BASE
Solids by Volume (%)	ASTM D2697	68% Min
Solids by Weight (%)	ASTM D2369	78% Min
Density	ASTM D1475	13.7 lbs./gal Min
Dry-Time (To Recoat)	ASTM D5895	20 Min
Taber Wear Abrasion Dry H-10 Wheel	ASTM D4060 1 day cure	0.16 g/1000 cycles Max
Taber Wear Abrasion Wet H-10 Wheel	ASTM D4060 7 days cure	2.34 g/1000 cycles Max
QUV E Accel.	ASTM G154 Delta	0.53 Min
Hydrophobicity Water Absorption	ASTM D570	7.6% (9 Day Immersion) Max
Shore Hardness	ASTM D2240	67 Type D Min
Mandrel Blend	ASTM D522-93A	1/4" @ 21 Degree C Pass Min
Permeance	ASTM D1653	3.77 g/m2 /hr. (52 mils) Max
VOC	Per MSDS	25 g/l Max
Adhesion to Asphalt	ASTM D4541	Substrate Failure
Friction Wet	ASTM E303 British Pendulum Tester	WP * Coated - 62 Min WP * Uncoated - 59 Min AC ** Coated - 70 Min AC ** Uncoated - 61 Min
Cure Time	Measured @ 77 Degrees Fahrenheit	Dry to touch – 20 Min Light Foot/Vehicle Traffic – 2-4 Hrs. Full Cure – 5 to 7 days

WP*= Wheel Path (Test conducted on asphalt pavement in wheel path.)
AC**= Adjacent to curb (Test conducted on asphalt pavement adjacent to curb.)

322.3 INSTALLATION & SURFACE PATTERNING:

The patterning equipment shall be metal templates that shall correspond to the patterns shown in the project plans and specifications.

The Contractor shall obtain the Engineer's approval prior to beginning asphalt stamping.

When new asphalt is to be stamped, it shall have one overnight period to set prior to stamping for conventional mixes and ARAC mixes shall have 30 days to set prior to the stamping/coating process. Asphalt shall be fully compacted prior to positioning the patterning template and meet all the requirements set forth in Sections 321 or 325 as applicable.

For raised medians and other areas not subject to vehicular traffic, the surface course shall be at least 2-1/2" of 1/2" or 3/8" Marshall Low Traffic asphalt concrete mix in accordance with Section 710, or as approved by the Engineer.

The asphalt to be stamped shall be uniformly heated using infrared technology to a temperature that shall not exceed 280 degrees Fahrenheit. Templates shall be set in place using a plate compactor and fully embedded into the asphalt.

The template imprint depth shall be 3/8" over 95% of the patterned area. Template print depth shall be inspected prior to coating to ensure compliance. All hand tooling shall be complete, full depth, aligned vertically, and shall extend to the edge of the asphalt pavement, common edge, concrete curb, gutter, or other border. There shall be no over print or shadowing of patterns and no remnants of excess print on surrounding unintended areas. Should overprinting or other imperfections occur, these areas shall be repaired by using the same process outlined in this section to return the asphalt to a smooth condition to that of the unstamped area(s).

322.3.1 Surfacing System (Painted Asphalt & Clear Coat Sealant): The air temperature shall be at least 45 degrees F and rising before the application of surface system products begins. There shall also be no precipitation expected within 24 hours of the anticipated surfacing completion. The surface shall be free from laitance, grease, deleterious oils, or any other foreign matter prior to placing any pavement coating.

The surfacing system products shall be spray-applied. Where required to cover small areas, the surfacing system may be applied using brooms or brushes. When complete, the entire asphalt surface shall be uniformly covered with the surfacing product with no exposed asphalt present.

The Contractor shall use sufficient masking to ensure that the surface system products are applied only where specified. Masking shall be complete and no overspray, or other imperfections, onto surfaces not designated as coated surfaces shall be allowed.

The Contractor shall apply the surface system products per the manufacturer's recommendations. After the colorant has had sufficient time to set, a clear coat sealant, if required, shall be applied per the manufacturer's recommendations.

Total thickness of the surfacing product shall be per the manufacturer's recommendations or greater including the sealant.

After the surfacing system products have been applied, the treated asphalt shall not be exposed to vehicular traffic for eight (8) hours, or per the manufacturer's recommendations.

322.4 MEASUREMENT:

Approved and accepted decorative asphalt installations shall be measured by the square foot for asphalt surface patterning with color coating or for asphalt surface color coating without surface patterning. The measurement for asphalt stamping specialty design shall be the number of approved and accepted installations of each specialty design. Asphalt coloring shall be measured by the square foot.

322.5 PAYMENT:

Payment for specialty designs, for asphalt surface patterning with color coating, and for asphalt surface color coating without surface patterning shall be at the contract unit price and shall be full compensation for furnishing all labor, material, tools, equipment and incidentals, and doing all work involved in the installation of asphalt stamping complete in place, in compliance with the contract documents.

322.6 WARRANTY:

Asphalt color coating shall have a two-year warranty from flaking, premature wearing and like defects. Color changes shall not be part of the warranty.

Warranty repair shall be at the expense of the Contractor. Areas that require recoating shall receive a light scuffing to remove the clear coat sealant prior to reapplication of the color coating and sealant.

- End of Section-

SECTION 323

PLACEMENT OF PERVIOUS CONCRETE

323.1 DESCRIPTION:

Pervious concrete describes a near-zero-slump, open graded material with sufficient continuous voids to allow water to pass from the surface to underlying layers. It does not look or behave like typical asphalt or concrete. The finished surface is not tight and uniform, but is open and varied to allow permeability. Minor surface irregularities and minimal amounts of surface raveling, and color variations are normal. Pervious concrete is usually part of a water management system used to reduce runoff rates and volumes from on-grade surfaces such as patios, walkways, driveways, fire lanes, and parking spaces. Sections without sub-surface storage bed systems can achieve reductions in runoff rates and volumes by providing less surface runoff than conventional hardscape surfaces. Sections with sub-surface storage bed systems designed to meet specific groundwater recharge requirements will require additional engineering and supplemental specifications. The work covered by this specification is intended for light traffic areas and consists of furnishing all materials, labor and equipment for the placement of pervious concrete.

323.2 MATERIALS:

Materials utilized in pervious concrete shall conform to the requirements of Section 723.

323.3 GENERAL:

The Pervious Concrete Contractor shall be experienced in the installation of pervious concrete and shall employ no less than one National Ready Mixed Concrete Association (NRMCA) certified Pervious Concrete Craftsman who must be on site overseeing each placement crew during all pervious concrete placements or employ no less than three NRMCA Certified Pervious Concrete Installers on each pervious concrete placement crew during all pervious concrete placements. The minimum number of certified individuals (1 Craftsman or 3 Installers) is to be present at each pervious concrete placement, and a certified individual is to be in charge of the placement crew and the construction procedures.

Field test(s) of pervious concrete shall be performed by an individual certified as both an NRMCA Certified Pervious Concrete Technician or equivalent, and ACI Concrete Field Technician Grade 1 or equivalent as approved by the Engineer.

323.4 CONSTRUCTION OF TEST SECTION(S):

If required by the Engineer or contract documents, the Contractor shall construct a test section(s) using the same equipment, and placement crew as proposed to be used for the remainder of the pervious concrete work and may be placed non-contiguously. Test section(s) shall be a minimum of 225 square feet and shall include a construction joint and a control joint. Test section(s) may be placed at any of the final pervious concrete placement locations and may be incorporated into the work if approved by the Engineer.

323.4.1: Sample fresh pervious concrete in accordance with ASTM C172. The size of the sample shall be at least 1 ft^3. The temperature of the pervious concrete shall be tested in accordance with ASTM C1064 and shall be 95 degrees or less, unless a higher temperature is approved by the Engineer. Complete at least one density test on a sample of freshly mixed pervious concrete in accordance with ASTM C1688. The acceptable fresh density shall be within ± 5 lbs./ft^3 of the approved mix design density.

323.4.2: Remove cores not less than 7 days after placement in accordance with ASTM C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. Test thickness in accordance with ASTM C174 and test saturated density in accordance with ASTM C140, paragraphs 8.3 and 9.3.

Tolerance for thickness, and density, reported as the average of three cores of each test panel, shall be as follows:

A. The average compacted thickness shall not be greater than 1/2 in. less than the specified thickness, with no single core exceeding 1 in. less than the specified thickness; nor shall the average compacted thickness be 1-1/2 in. more than the specified thickness.
B. The acceptable hardened density shall be within ± 5 lbs./ft^3 of the approved mix design density.

When a test panel is outside any of the limits of A and B above, the test panel shall be rejected, removed, and replaced at the Contractor's expense, unless accepted by the Engineer. When the test panel complies with A and B, the panel may be left in place and included in the completed work.

323.5 PERVIOUS CONCRETE BASE PREPARATION:

The surface below pervious concrete shall be prepared in accordance with the contract documents or as directed by the Engineer. Remove any non-compliant or loose material from the prepared base surface before placing pervious concrete. Keep all traffic off the base during construction to the maximum extent practical. Regrade base material disturbed by concrete delivery vehicles or other construction traffic to the satisfaction of the Engineer, as needed.

323.6 PLACEMENT:

Pervious concrete shall be constructed a minimum of 6 inches in depth, unless otherwise specified in the plans or special provisions.

When hot weather is anticipated, recommended practices in ACI 305, Specification for Hot Weather Concreting, can provide good reference information to help the Contractor prepare and submit detailed procedures for the production, transportation, placement, protection, and curing of pervious concrete for approval by the Engineer. Evaporation retarders shall be available during placement and applied as needed in accordance with the manufacturer's recommendations to protect the pervious concrete from rapid evaporation. In cold weather, follow the requirements of Section 725.9(A)(2).

Pervious concrete shall be uniformly deposited over the entire formed area. A self-propelled roller screed shall be used for strike-off, spreading, and compaction. Hand-rodding or other placement methods may be used if approved by the Engineer. Adjacent to the edge of each form, hand tampers shall be used for compaction. Placement operations shall not result in the voids becoming sealed in order to maintain an adequate continuous voids structure for water passage through the pervious concrete. Surface depressions shall be corrected immediately after compaction by placing fresh pervious concrete in the depressions and compacting using a hand tamper or roller compactor. The final surface shall not deviate more than 3/8 inch from a 10 foot straightedge laid on the surface.

323.6.1 JOINTS:

Joints shall be constructed in accordance with an approved jointing plan. Contraction joints shall be constructed at regular intervals not to exceed two times the placement width or 15 feet on center, whichever is less. Joints shall be constructed to a depth of 1/4 of the thickness, or a minimum of 1-1/2 inches whichever is greater. Unless otherwise approved, contraction joints shall be constructed by one of the following methods:

A. Rolling with a small roller to which a beveled fin has been attached around the circumference immediately after compaction and prior to curing.

B. Saw cutting as soon as the pervious concrete can be saw cut without causing raveling along the joint edges. Only the area occupied by the concrete saw shall be uncovered and exposed with all other curing materials remaining in place. Immediately after sawing each joint, the exposed area shall be fogged with water and re-covered in accordance with Section 323.7.

Use isolation joints only where pavement abuts fixed objects, such as buildings, foundations, and manholes. Extend isolation joints through the full depth of the pavement. Fill the entire isolation joint with expansion joint material that complies with Section 729.

323.7 CURING:

The Contractor shall submit a curing plan to the Engineer for review and approval. Curing shall begin immediately or in any case within 20 minutes of finishing. The surface and edges shall be securely covered with polyethylene sheeting/film having a minimum thickness of 6 mils and meeting the requirements of Section 726.2(A). The cover shall be checked daily to verify that it has not been displaced or damaged, and that condensation is evident underneath the sheeting. Damaged sheeting shall

be repaired immediately. Displaced sheeting shall be replaced immediately. When there is no observable condensation, 1.5 gallons of water per square yard shall be applied to the surface. Curing methods shall remain in place for a minimum of 7 days or as directed by the Engineer. Pavement sections shall not be opened to light vehicular traffic until the concrete has cured for at least 14 days (28 days for heavy traffic), and until approved by the Engineer for opening to traffic.

323.8 QUALITY CONTROL FIELD TESTING:

Complete at least one density test on a sample of freshly mixed pervious concrete for each 5000 square feet or each day of concrete placement, whichever is less, in accordance with ASTM C1688. Sample fresh pervious concrete in accordance with ASTM C172. The size of the sample shall be at least 1 ft^3. The temperature of the pervious concrete shall be tested in accordance with ASTM C1064 and shall be 95 degrees or less, unless a higher temperature is approved by the Engineer. Discharge of the previous concrete shall be completed in accordance with Section 725.9 (A)(4).

Remove three cores from each lot of 5,000 square feet or each day's production, whichever is less, in accordance with ASTM C42 not less than 7 days after placement of the pervious concrete. Cores shall be a minimum nominal 4 in. diameter. Select three locations in accordance with ASTM D3665. Upon approval of the Engineer, small test sections may be cast for sample extraction along with each placement to avoid removing cores from in-place work. Measure the cores for thickness in accordance with ASTM C174. After thickness determination, trim and measure the cores for density in the saturated condition as described in Paragraph 8.3 and 9.3 of ASTM C140. Core holes in the in-place work shall be filled with pervious concrete or other acceptable material in a manner satisfactory to the Engineer.

323.9 TOLERANCES:

Mechanically sweep or vacuum pavement with clean equipment or flush with water before testing for compliance with tolerances.

Tolerance for hardened thickness, and density, reported as the average of three cores f each test panel shall be as follows:

A. Average hardened thickness from a lot shall not be more than 1/2 in. less than the specified thickness, with no single core exceeding 1 in. less than the specified thickness; nor shall the average hardened thickness be 1-1/2 in. more than the specified thickness.

B. Average hardened density from a lot shall be within ± 5 lbs./ft^3 of the average hardened density of the test section(s) from Section 323.4.

C. Unless otherwise specified in the Special Provisions, Pervious Concrete shall have a minimum infiltration rate of 50 inches per hour when tested in accordance with ASTM C1701.

323.10 ACCEPTANCE:

Pervious concrete does not look or behave like typical concrete or asphalt. The finished surface shall be open and varied to permit permeability. Minor surface irregularities and moderate amounts of surface raveling and color variations are normal and acceptable. Pervious concrete shall have no visible excess cement paste, tears, or gouges. Roller constructed joints shall have smooth, rounded, and uniformly compacted edges. Saw cut joints shall not contain cement paste or dust nor exhibit evidence of spalling.

Acceptance will be based on conformance to the specifications. When a lot is outside one of more of the tolerances in Section 323.9, the lot shall be subject to rejection, removal, and replacement at the Contractor's expense, unless accepted by the Engineer.

323.11 PAYMENT:

Payment for pervious concrete shall be made at the contract unit price per square foot for each thickness shown on the plans.

- End of Section -

SECTION 324

PORTLAND CEMENT CONCRETE PAVEMENT (PCCP)

324.1 DESCRIPTION:

This item shall consist of construction of a pavement composed of plain jointed Portland cement concrete on a prepared subgrade. The Contractor shall furnish all labor, materials and equipment necessary for the construction of the pavement in accordance with these specifications and in reasonably close conformity to the lines, grades, thicknesses and details indicated by the plans or as established by the Engineer. All tests shall be performed by a laboratory approved by the Engineer.

324.2 MATERIALS:

324.2.1 Portland Cement Concrete: Portland cement concrete shall conform to the applicable requirements of Section 725 and the additional requirements of this section.

Concrete shall comply with Table 725-1 for Class AA, 4000 psi unless otherwise specified by the Engineer.

The maximum concrete slump shall be as determined by the approved mix design in accordance with Section 725.9(A)(1).

324.2.2 Reinforcement: Tie bars shall be deformed billet steel reinforcing bars conforming to the requirements of ASTM A615, Grade 40.

Dowel or load transfer bars shall conform to the requirements of ASTM A615, Grade 40. An approved support system shall be used to hold bars in position.

324.2.3 Curing Materials: Materials for curing concrete shall conform to the requirements of Section 726.

324.2.4 Joint Materials: Joint sealant shall be poured type, conforming to the requirements of Section 729.2 or as approved by the Engineer. Preformed expansion joint filler shall conform to the requirements Section 729.1 or as approved by the Engineer.

324.3 CONSTRUCTION METHODS:

324.3.1 General: Pavement shall be constructed with mechanical equipment utilizing stationary side forms or by the use of slipform paving equipment without stationary side forms. Manual methods of placing and finishing concrete with stationary side forms may be permitted by the Engineer for areas inaccessible for mechanical equipment.

All curb and gutter shall have the same class of concrete as the adjacent PCCP. Gutter sections shall have the same thickness as the PCCP section. All curbs or combined curb and gutter joints shall align with roadway joints.

324.3.2 Equipment: Design, capacity, and mechanical condition of equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer. Equipment shall be at the jobsite sufficiently ahead of the start of concrete paving operations to permit thorough examination and approval by the Engineer prior to start of concrete paving.

Equipment used to place concrete may consist of one or more machines, shall be capable of uniformly distributing and consolidating the concrete as it is placed without segregation and shall be capable of producing concrete pavement, which will conform to the required cross-section with a minimum of hand work. The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to the concrete delivery rate.

Vibrators shall be used to consolidate concrete; the rate of vibration shall be not less than 3,500 cycles per minute for surface vibrators and not less than 8,000 cycles per minute for internal vibrators. Power to vibrators mounted on mechanical equipment shall be so connected that vibration ceases when forward or backward motion of the machine is stopped. Contractor shall furnish a tachometer or other suitable device for measuring and indicating the frequency of vibration.

Slipform pavers shall be equipped with high frequency internal vibrators mounted with axes either parallel or normal to pavement alignment for the full paving width. Vibrators mounted with axes parallel with pavement alignment shall be spaced at intervals not to exceed 24 inches, measured center-to-center. Vibrators mounted with axes normal to pavement alignment shall be spaced so that lateral clearance between individual vibrating units does not exceed 6 inches.

Slipform paving equipment which will be wholly or partially supported on subgrade shall be equipped with traveling side forms of sufficient dimensions, shape and strength to support the concrete at free edges laterally for a sufficient length of time during placement to produce pavement of the required cross-section, and shall be equipped and operate with automatic sensing and control devices such that the machine automatically senses deviations from the established guideline and performs the necessary corrective maneuvers to overcome variations from correct grade and alignment.

When concrete will be placed adjacent to existing pavement or curb and gutter, that part of the equipment supported on the existing pavement or curb and gutter shall be equipped with protective pads on crawler tracks or rubber-tired wheels with bearing surfaces offset a sufficient distance from the edge of the pavement or curb and gutter to avoid edge damage, or the surface of the existing pavement or curb and gutter shall be otherwise protected against such damage in a manner approved by the Engineer.

324.3.3 Subgrade and Base Preparation: Subgrade and base shall conform to the applicable compaction requirements of Section 601 and elevation tolerances specified for the material involved, shall be kept smooth and compacted, and shall be free of all loose and extraneous material when concrete is placed.

The surface of the subgrade shall be uniformly moist when concrete is placed. The surface of the subgrade shall be moistened immediately prior to placement of concrete, if necessary to produce a uniformly moist condition. Any excess water standing in pools or flowing on the surface shall be removed prior to placing concrete.

324.3.4 Stationary Side Forms and Setting of Forms: Side form sections shall be straight, free from warps, bends, indentations or other defects. Side forms shall be of metal, have a base width of at least four inches and a minimum depth equal to the thickness of the pavement. No section shall show a variation from a true plane greater than 1/8 inch in ten feet on the top of the form or more than 1/4 inch in ten feet on the inside face. Flexible or curved forms of proper radius shall be used for curves of 100 feet radius or less. Suitable materials other than metal may be used to form end closures or at other locations where use of metal forms is not practical. Forms shall be thoroughly cleaned and oiled each time they are used.

Forms shall be of such cross-section and strength and so secured and supported on the subgrade as to resist the pressure of the concrete when placed and the impact and vibration of any equipment they are to support without springing or settlement. The method of connection between sections shall be such that the joints shall not move in any direction.

Subgrade under forms shall be compacted and cut to grade so that the form when set will be uniformly supported for its entire length at the specified elevation. Forms shall be so supported and secured during the entire operation of placing and finishing that they will not deviate vertically at any point more than 1/8 inch from the proper elevation. Forms shall be set to the required lines and grades well in advance and for a distance sufficient to prevent delay in placing concrete, and shall be approved by the Engineer prior to placing concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

Side forms shall remain in place until the day after placing concrete, and in all cases until the edge of the pavement no longer requires the protection of the forms. Forms shall be carefully removed in such a manner as to avoid damage to the pavement. Use of pry bars between the pavement and the forms will not be permitted.

324.3.5 Placing, Spreading and Compacting: Construction equipment shall not operate on the subgrade in the paving lane when conditions of the job will permit operation from outside the lane. When job conditions make it necessary to operate equipment on the subgrade in the paving lane, suitable runways or other precautions shall be taken to prevent rutting or displacement of subgrade material. The grade shall be checked and corrected immediately ahead of concrete placement and all disturbed grade shall be properly recompacted. Except when otherwise approved by the Engineer, concrete shall be deposited on the subgrade and spread full width using mechanical methods that result in minimal handling and segregation.

Necessary hand spreading shall be done with shovels, not rakes. Placement shall be continuous between transverse joints without the use of intermediate bulkheads.

The Contractor shall make adequate advance arrangements for preventing delay in delivery and placing of concrete. An interval of more than 15 minutes between placing of any two consecutive batches shall constitute cause for stopping operations, and Contractor shall remove all concrete placed beyond the last scheduled joint or install a joint of the type and at the location as directed by the Engineer.

Concrete shall be deposited as near to expansion and construction joints as possible without disturbing them but shall not be dumped onto a joint assembly. Concrete shall be thoroughly consolidated against and along the faces of all forms, adjacent pavement or curb and gutter, and on both sides of all joint assemblies. Vibrators shall not be permitted to come in contact with joint assemblies, the grade, or side forms, and shall not be operated longer than 15 seconds in any one location.

Manual methods of placing, spreading, and compacting may be used in the construction of pavement lanes of irregular width or widths less than 10 feet, and sections of intersections or other locations with complex variable surface configurations when permitted by the Engineer. Workmen shall not be allowed to walk in the freshly placed concrete.

324.3.6 Shaping and Initial Finishing: Concrete shall be struck off, consolidated, and float-finished with a slipform paver, mechanical finishing machine, vibrating screed, or by hand finishing methods when approved by the Engineer so that the complete pavement will conform to the thickness and cross-section requirements of the plans and specifications. When the pavement being constructed is contiguous to existing parallel concrete pavement or curb and gutter, the elevation of the new pavement surface shall conform as closely as possible to the elevation of the existing pavement or gutter surface in a manner that will prevent ponding. The difference in elevation shall not exceed 1/4 inch.

Water shall not be applied to the pavement surface during screeding and finishing operations in excess of the amount lost by evaporation. Adding water to the surface of the concrete to assist in finishing operations shall not be permitted. When applications of water to the surface are required to prevent rapid evaporation of water from the surface during finishing operations, it shall be applied as a fog spray and with approved spray equipment.

(A) Slipform Supported on Subgrade Method: When concrete pavement will be placed with slipform paving equipment which will be supported and operate on the subgrade, the subgrade and slipform paver track area shall be brought to proper grade and cross-section by means of a properly designed and operated machine. The equipment shall spread, consolidate, screed and float-finish the concrete in one complete pass of the machine. The machine shall be operated with as nearly a continuous forward movement as possible, and all paving operations shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. Sliding side forms shall be rigidly held together to prevent spreading. Any edge slump of the pavement, exclusive of edge rounding, in excess of 1/4 inch shall be corrected.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation shall not exceed one inch from the alignment established by the Engineer.

While concrete is being spread, compacted and shaped, vibrating units shall be operated within fresh concrete so that the longitudinal axis, at the center of each unit, is not more than 6 inches above the top of the subgrade. Amplitude of vibration shall be sufficient to be perceptible on the surface of concrete along the entire length of vibrating units and for a distance of at least one foot.

(B) Mechanical Equipment Supported on Fixed Form Method: When concrete is spread without the use of internal vibration, the finishing machine shall be equipped with vibrating equipment that will internally vibrate the concrete for the full paving width and with not less than two oscillating or reciprocating screeds. Concrete shall be struck off and consolidated so that the surface will conform to the finished grade and cross-section shown on the project plans and with sufficient material on the surface for floating operations.

After the concrete has been struck off and consolidated, it shall be floated with a longitudinal float of a type approved by the Engineer.

A slipform paver or a single machine, which will effectively spread, consolidate, screed, and float in one operation may

be used in lieu of separate finishing and floating equipment.

(C) Manual Methods with Fixed Forms: Concrete shall be deposited, spread and struck off to such an elevation that, when properly consolidated, the surface will conform to the required lines and grades. Concrete shall be consolidated by internal vibration as it is struck off with a screed. A slight excess of concrete shall be kept in front of the screed at all times during the strike-off operation.

After consolidation and screeding, concrete shall be tamped to the proper surface elevation and cross-section using either a heavy plank with a length in excess of the width of pavement being placed by one foot or more, or with a mechanical vibrating unit spanning the full width between forms. The tamping plank, if used, shall be stiffened as necessary to prevent sag and shall have the lower tamping edge shod with metal. The tamping plank shall be moved forward with a combined vertical tamping and longitudinal screeding motion so that the concrete will be thoroughly consolidated and the surface screeded to the required elevation. A small surplus of concrete shall be kept in front of the tamper or vibrating unit. Tamping or vibrating shall continue until the specified cross-section is obtained and the mortar flushed slightly to the surface. On grades in excess of 5 percent a second strike board shall follow from 25 to 50 feet behind the tamper or vibrating unit and shall be used in the same manner to remove waves caused by the flow of concrete behind the first strike board.

Methods other than the tamping plank may be utilized for screeding when approved by the Engineer.

Pavement shall be finished smooth and true to grade with suitable manually operated floats or powered finishing equipment.

324.3.7 Final Finishing: After the pavement has been float-finished, it shall be scraped with a 10-foot long straightedge equipped with a handle to permit operations from the edge of the pavement, and excess water and laitance shall be removed from the surface. The straightedge shall be operated parallel to the centerline of the pavement and shall be moved forward one-half length after each pass. Irregularities shall be corrected by adding or removing concrete, and disturbed places shall be again straight-edged.

Long-handled floats shall be used only in areas not accessible to finishing equipment and in emergencies, and use of such floats shall be confined to a minimum.

The addition of water to the surface of the concrete to assist in finishing operations shall not be permitted unless approved by the Engineer. When the evaporation rate on the concrete surface exceeds the rate of bleeding of the concrete, measures shall be taken to prevent the rapid evaporation of water from the surface during finishing operations. When allowed by the Engineer, the addition of water to the surface may be permitted when applied as a fog spray with approved spray equipment immediately after screeding and/or between finishing operations. A commercial evaporation reducer that forms a monomolecular film may also be sprayed onto the concrete surface in accordance with the Manufacturer's recommendations. When either of these methods is approved and used, it does not take the place of proper curing methods per Section 324.3.8.

Pavement edges and joints shall be edged in accordance with details shown on the project plans or as directed by the Engineer.

In advance of curing operations, pavement shall be textured. Texturing shall be performed with an artificial turf drag with a board added to assure the weight needed to obtain an approved surface. Artificial turf shall be a molded composite structure with polyethylene face, nylon and polyester backing, a pile height of 0.85 inches, and total weight of 75 oz./sq. yd. The surface obtained during initial surface texturing shall be subject to approval by the Engineer. The texturing approved on the initial construction shall not be changed without the Engineer's approval. Each time the construction is stopped or causes the texturing to stop, the artificial turf must be shaken clean before continuing.

324.3.8 Curing: Curing shall begin immediately following surface texturing and edging. Before concrete placement begins, Contractor shall have at hand and ready to install the materials and equipment needed for adequate curing.

After finishing operations have been completed, the newly placed concrete shall be cured by moist curing methods, by application of a white pigmented liquid membrane compound conforming to the requirements of Section 726, or by a combination of these methods. All surfaces not covered by reasonably waterproof forms shall be kept damp by applying water with a nozzle that so atomizes the flow of water that a fog mist and not a spray is formed until the surface is covered with liquid

membrane compound, the surface has hardened sufficiently to permit sprinkling of the surface, or moist curing by covering with wet burlap or other approved materials can be initiated. Moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow and erode the surface. Moist curing shall be continued until liquid membrane curing compound or other type of curing membrane is applied.

Membrane curing compound shall be applied to all pavement by automatic mechanical method from a construction bridge.

The edges of concrete slabs exposed by the removal of forms shall be protected immediately to provide these exposed surfaces with continuous curing treatment equal to the method selected for curing the pavement surface.

The membrane method of curing may be applied behind the final finishing operation after all free water has disappeared from the surface. Complete and uniform coverage at the rate of one gallon per 100 square feet, or as otherwise recommended by the manufacturer, shall be required. Compound shall be kept agitated to prevent pigment from settling.

324.3.9 Joints: Joints shall be provided in the pavement of the type, dimensions and at the locations as indicated in the plans or as specified herein. Joints in concrete pavement will be designated as transverse expansion joints, longitudinal or transverse construction joints, longitudinal or transverse weakened plane joints, or isolation joints. The faces of all joints shall be perpendicular to the pavement surface. Joints shall be constructed in accordance with the details shown or referenced in the plans and in accordance with the following provisions.

At all times prior to acceptance of the construction, joints shall be maintained clean and free of soil, gravel, and other foreign material except approved types of joint filler materials.

(A) Longitudinal Joints: Longitudinal joints shall be weakened plane or construction joints. Longitudinal weakened plane joints shall be constructed by sawing or by insertion of a parting strip in the plastic concrete to be left in place. Longitudinal construction joints shall be constructed with tie bars or keyways as indicated in the plans.

(B) Transverse Joints: Transverse joints shall be weakened plane, construction or expansion joints. All transverse weakened plane joints will be constructed by sawing and in accordance with the details shown in the project plans. Transverse construction joints shall be constructed in accordance with the details shown or referenced in the project plans. Transverse expansion joints shall be constructed in accordance with the details shown or referenced in the project plans.

Dowel bars when required shall be supported with an approved support system.

(C) Joint Location: Longitudinal and transverse joints shall be constructed at locations as indicated in the project plans.

Isolation joints shall be provided around manholes, catch basins, or other elements, which extend into or project through the pavement and act as point of restraint to horizontal or vertical movement of the pavement. Isolation joints shall be located in accordance with Detail 224 or as directed by the Engineer.

324.3.9.1 Construction of Joints:

(A) Sawed Joints: Sawed joints shall be constructed by cutting a groove in the pavement using a single or multiple-blade power saw. The groove shall be cut to the dimensions shown on the project plans. Suitable guidelines or devices shall be used to ensure joints are cut true to the lines as shown on the project plans.

If joints are sawed in stages, the initial saw cut shall be of the minimum width specified and sawed to the required depth. The depth of the initial saw cut in the construction of weakened plane joints shall be a minimum of 1/4 of slab thickness.

Sawing of weakened plane joints shall be done before uncontrolled cracking takes place, and after the concrete has hardened to the extent that tearing or raveling of the edges of the saw cut is not excessive. The exact time for all sawing shall be determined by the Contractor when not otherwise specified.

Any procedure for sawing joints that result in premature, uncontrolled cracking shall be revised immediately. The Contractor shall be responsible for replacing or repairing areas containing uncontrolled cracking and for repairing spalled or chipped concrete along the edges of sawed joints to the satisfaction of the Engineer.

After saw cutting of the joint and just prior to sealing the joint, the internal joint surfaces shall be cleaned of all dirt, curing compound residue, laitance and other foreign materials. The internal joint surface shall be defined as the sawed portion of the joint and the resultant crack for the full depth of the pavement.

Sealing of sawed joints where required shall be completed prior to the opening of the pavement to traffic unless otherwise approved by the Engineer. When delayed sealing of sawed joints is permitted, saw cuts and formed recess to be filled with sealant shall be protected to ensure thorough curing of the concrete along the edges of the joint recesses and to prevent entry of foreign materials into the joint. At the Contractor's option, inert compressible joint filler material such as plastic backer rod or upholstery cord may be inserted into joints immediately after sawing or forming of the joint recess to provide curing protection and prevent entry of foreign material. If absorptive filler material is used, it shall be thoroughly moistened either before or immediately after installation in the sawed groove. When filler material is rope, or similar material which does not fill the entire depth of sawed groove, it shall be depressed not less than 1/2 inch below the pavement surface before the pavement is opened to traffic.

(B) Expansion and Construction Joints: Longitudinal and transverse expansion and construction joints shall be as required by the project plans.

(C) Isolation Joints: Isolation joints unless otherwise detailed in construction documents shall be 1/2 inch wide expansion joints in accordance with Detail 224 or as directed by the Engineer.

(D) Sealing of Joints: Sealant shall be applied in accordance with the sealant manufacturer's recommendations. A primer shall be furnished and applied after the joint has been cleaned and prepared to receive sealant when indicated in the manufacturer's recommendations.

Prior to the application of the sealant, an approved type of inert, compressible joint filler material such as plastic backer rod or upholstery cord, or an approved type of bond breaker, shall be inserted along the joint in accordance with the details shown on the project plans. The joint shall then be filled with sealant to a level not less than 1/8 inch or more than 1/4 inch below the elevation of the pavement surface adjacent to the joint edge.

The equipment used to apply sealant shall be as recommended by the sealant manufacturer. Sealant shall not be spilled on the surface of the concrete pavement, and Contractor shall remove any sealant inadvertently spilled on the pavement surface.

(E) Repair of Cracks, Spalls, Raveling and Tearing: Contractor shall be responsible for replacing or repairing all areas of pavement containing uncontrolled cracking, surface spalls, or other types of surface. Repairs when authorized shall be made and completed by methods acceptable to the Engineer.

324.4 TESTS OF FINISHED PAVEMENT:

324.4.1 Smoothness: The pavement surface including pavement in intersections will be tested with a ten-foot straight-edge placed parallel to the centerline of the pavement in each lane. Ordinates measured from the face of the straight-edge to pavement surface shall at no place exceed one-quarter inch. Areas that do not meet the required surface accuracy as determined by straight-edge testing shall be marked, and Contractor shall at his own expense and as required by the Engineer either:

(1) Grind down areas higher than 1/4 inch but not more than 1/2 inch above the correct surface.

(2) Correct areas lower than 1/4 inch but not lower than 1/2 inch below the correct surface by grinding down the adjacent areas.

(3) Remove and replace pavement when the deviation exceeds 1/2 inch from the correct surface. Area replaced shall be of a length, width and depth as required to allow formation of a new slab of the required quality. The area replaced shall be compatible with the joint layout shown on the project plans as determined by the Engineer.

After grinding, the finished surface of the ground area shall be provided with a uniform texture acceptable to the Engineer. The method of texturing shall be approved by the Engineer.

324.4.2 Pavement Thickness: Concrete pavement shall be constructed in accordance with the thickness requirements of the plans and specifications. Tolerances for base and subgrade construction and other provisions of these specifications, which may affect thickness, shall not be construed to modify such thickness requirements.

Pavement thickness testing shall begin after achieving pavement smoothness compliance. For the purpose of determining acceptability for thickness, cores shall be drilled by the Contractor at the locations specified by the Engineer. Cores shall have a minimum diameter of four inches. Length of cores will be determined in accordance with the requirements of AASHTO T-148.

In calculating average length, cores that have a length in excess of the thickness specified by more than 0.25 of an inch, will be deemed to have a length of the specified thickness plus 0.25 of an inch. Field length measurements will be acceptable in lieu of average length measurement in accordance with the requirements of AASHTO T-148, provided the original core in any secondary unit meets or exceeds the specified thickness. Measurements in accordance with the requirements of AASHTO T-148 will be required on any questionable thickness measurements and on the three cores used to determine the average length for payment, regardless of length.

A primary unit of pavement shall be the area of pavement placed in each day's paving operation. Each intersection or special section shall be considered as a primary unit. A secondary unit of pavement shall consist of 1,000 linear feet, or fraction thereof, of each traffic lane. Each 1,300 square yards of pavement in intersections, etc., shall be considered a secondary unit regardless of when the concrete was placed.

One core shall be drilled in each secondary unit. If the length of that core is not deficient by more than 0.25 of an inch, that secondary unit will be measured for payment at 100 percent. If the length of that core is deficient by more than 0.25 of an inch but less than 1.0 inch, two additional cores shall be drilled within that secondary unit and the length of the three cores averaged. If the average length is not deficient by more than 0.25 of an inch, that secondary unit will be measured for payment at 100 percent. If the average length of the three cores is deficient by more than 0.25 of an inch, that secondary unit will be measured for payment in accordance with the requirements of Table 324-1.

If the core in the secondary unit is deficient by more than 1.00 inch, that core will not be used in determining the average thickness of that secondary unit. Additional cores shall be drilled at intervals not to exceed ten feet in each direction from the deficient core, parallel to the main-line centerline, until one core is obtained in each direction that is not deficient by more than 1.00 inch. The pavement between these two cores will be evaluated separately from the balance of the pavement in that secondary unit. The limits for evaluation shall be between the longitudinal weakened plane or construction joint on each side of the core and between the next transverse weakened plane, construction, or expansion joint beyond each of the last two cores. Unless the Engineer allows the pavement to remain, it shall be removed and replaced with pavement of the specified thickness and no payment will be made for the removed pavement.

If the pavement in the deficient area is removed, either by the order of the Engineer or at the option of the Contractor, it shall be removed between the limits of the evaluation. After the pavement has been replaced, one core shall be drilled at random in that secondary unit after deducting the area of the replaced pavement and one core shall be drilled in the new pavement. Pavement represented by the core drilled in the secondary unit, less the replaced pavement, will be measured for payment as hereinbefore specified. The core drilled in the replaced pavement shall be not less than the specified thickness; otherwise, that pavement will not be measured or paid for.

At all locations where cores have been drilled, the resulting holes shall be filled with concrete in a manner satisfactory to the Engineer.

324.5 PROTECTION OF PAVEMENT:

The Contractor shall be responsible for taking adequate steps to protect concrete placed during rain, or hot or cold weather as defined in ACI Standards. Any concrete damaged by rain or extreme temperatures shall be removed and replaced at the Contractor's expense.

When ordered by the Engineer, pavement crossings shall be constructed for the convenience of public traffic. Where motor vehicles are encountered, a temporary bridge to span the newly placed concrete will be provided.

No traffic or Contractor's equipment, except as hereinafter provided, will be permitted on the pavement until the concrete has developed a compressive strength of 3500 psi.

Equipment for sawing joints will be permitted on the pavement when, in the Contractor's judgment, the concrete has developed sufficient strength to support the equipment without damage to the concrete. In case of visible cracking or other damage to the pavement, operation of the equipment on the pavement shall be immediately discontinued.

Any damage to the pavement resulting from early use of pavement by the Contractor's equipment shall be repaired by the Contractor at his expense.

324.6 METHOD OF MEASUREMENT:

Portland Cement Concrete Pavement will be measured by the square yard. Any opening in excess of one square yard will not be measured for payment.

324.7 BASIS OF PAYMENT:

The accepted quantities of Portland Cement Concrete Pavement, measured as provided for herein, will be paid for at the contract unit price complete in place, except that where the average length of cores indicates pavement deficient in thickness by more than 0.25 of an inch but not more than 1.00 inch, payment will be made as specified in Table 324-1. Payment will be made to the nearest cent.

No additional payment will be allowed for pavement constructed in excess of the thickness specified on the project plans.

TABLE 324-1	
PAVEMENT THICKNESS PAYMENT REDUCTION (PCCP)	
Core Thickness, Less Than Specified Thickness, Inches	Percent of Contract Unit Price Allowed
0.00 to 0.25	100
0.26 to 0.35	93
0.36 to 0.45	85
0.46 to 0.55	75
0.56 to 0.75	63
0.76 to 1.00	50

- End of Section -

SECTION 325

PLACEMENT AND CONSTRUCTION OF ASPHALT-RUBBER ASPHALT CONCRETE

325.1 DESCRIPTION:

Asphalt-rubber asphalt concrete (ARAC) consists of supplying, placing and compaction of plant-mixed, gap-graded ARAC over asphalt surfaces. The thickness of the finished ARAC overlay shall be within the range of one to two inches as shown on the plans or as specified in the special provisions.

325.2 MATERIALS:

ARAC shall consist of a mixture of aggregate, mineral admixture and asphalt-rubber binder (ARB) as specified in Section 717.

325.2.1 Mixing of Asphalt-Rubber Binder: Mixing of asphalt-rubber binder (ARB) may take place in a dedicated blending and storage unit connected to the hot plant or at the asphalt binder supplier's facility. In either case, the temperature of the asphalt cement shall be between 375° F and 425° F prior to the addition of crumb rubber. No agglomerations of crumb rubber particles in excess of 2 inches in the least dimension shall be allowed in the mixing chamber. The crumb rubber and asphalt cement shall be accurately proportioned in accordance with the ARB design as identified in 717.2.14 and thoroughly mixed prior to the beginning of the one-hour reaction period. Reaction time may be decreased to 45-minutes if documentation is provided that the physical properties of the mix design requirements are consistently met using a 45-minute reaction period. The Contractor or supplier shall document that the proportions are accurate and that the crumb rubber has been uniformly incorporated into the mixture. Additionally, the Contractor or supplier shall demonstrate that the crumb rubber particles have been thoroughly mixed into the base asphalt cement. The occurrence of crumb rubber floating on the surface or agglomerations of crumb rubber particles shall be evidence of insufficient mixing. The temperature of the ARB immediately after mixing shall be between 350° F and 400° F. Reaction time shall start after all of the material for the batch has been mixed and the minimum reaction temperature of 350° F has been achieved.

Prior to use, the viscosity of the ARB shall be tested by the use of a rotational viscometer, which is to be furnished by the Contractor or supplier. The Contractor or supplier shall provide a qualified person to perform the testing.

325.2.2 Handling of ARB: Once the ARB has been mixed, it shall be kept thoroughly agitated during periods transport and use to prevent settling of the crumb rubber particles. During the production of ARAC the temperature of the ARB shall be maintained between 325° F (163°C) and 400° F (204°C). However, in no case shall the ARB be held for more than 10 hours at these temperatures. It may be allowed to cool to a temperature of 250° F (121°C) or lower and held at that temperature for not more than four days. The process of cooling and reheating shall not be allowed more than one time for a batch of ARB.

For each load or batch of ARB, the Contractor or supplier shall provide the Engineer with the following documentation:

(A) The source, grade, amount and temperature of the asphalt cement prior to the addition of crumb rubber.

(B) The source, type and amount of crumb rubber and the rubber content expressed as percent by the weight of total ARB.

(C) Times and dates of the crumb rubber additions, resultant viscosity test, and the elapsed reaction time at which the viscosity test was taken.

(D) A record of the temperature, with time and date reference for each load or batch. The record shall begin at the time of the addition of crumb rubber and continue until the load or batch is completely used. Readings and recordings shall be made at every temperature change in excess of 20° F, and as needed to document other events, which are significant to batch use and quality.

325.3 WEATHER AND MOISTURE CONDITIONS:

ARAC shall be placed only when the surface is dry, and when the atmospheric temperature in the shade is 55° F or higher. No ARAC shall be placed when the weather is foggy or rainy. ARAC shall be placed only when the Engineer determines that weather conditions are suitable.

325.4 APPLICATION OF TACK COAT:

A tack coat shall be applied to all existing and to each new course of ARAC prior to the placing of a succeeding lift of ARAC. The tack coat may be deleted when a succeeding layer of ARAC is being applied over a freshly laid course that has been subjected to very little traffic when approved by the Engineer.

The application of the tack coat shall comply with Section 329. The grade of emulsified asphalt shall be SS-1h or CSS-1h as specified in Section 713.

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.

The surface to be covered may require repair or patching as directed by the Engineer. This shall be addressed in the project specifications prior to the bidding of the project.

325.5 MIX PRODUCTION:

All materials shall be proportioned by weight in a hot mix asphalt plant in the proportions required by the mix design to provide a homogeneous and workable mass. Each hot mix asphalt plant shall be inspected in accordance with the provisions contained in the 'Hot Mix Asphalt Production Facilities' by the Arizona Rock Products Association and shall have a current inspection certificate. All measuring devices shall be calibrated at least annually by a technician licensed by the Arizona Bureau of Weights & Measures. Mixing plants shall conform to the requirements of AASHTO M-156, except as modified herein.

In drum mix plants, the mineral admixture shall be added and thoroughly mixed with the mineral aggregate by means of a mechanical mixing device prior to the mineral aggregate and mineral admixture entering the dryer. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process.

For drum-mix plants, the mineral admixture shall be weighed across a weigh belt, or other approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer that is in good working condition. The rate of the aggregate feed shall not exceed the mixing device's capacity in ton per hour. The mixer shall be constructed to minimize the loss of mineral admixture and shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected. The mixing device shall be capable of effective mixing in the full range of the ARAC production rates.

The hot plant and equipment shall be constructed and operated to prevent loss of mineral admixture through the dust collection system of the plant.

A positive signal system shall be provided and utilized during production whereby the mixing shall automatically be stopped if the mineral admixture is not introduced into the mineral aggregate. The plant will not be permitted to operate unless the signal system is in good working condition.

The introduction of ARB shall be controlled by an automated system fully integrated with the controls for the mineral aggregate and mineral admixture. The production of the plant shall be controlled by the rate required to obtain a uniform mixture of all components. Drying and heating shall be accomplished in such a manner as to preclude the aggregate or mineral admixture from becoming coated with un-spent fuel. The completed ARAC may be held in storage for up to 12 hours in insulated or heated silos, providing the minimum temperature noted herein for placement and compaction is met behind the placement device. If the Engineer determines that there is an excessive amount of heat, heat loss, drain down, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

The temperature of the ARAC, with unmodified binders, upon discharge from the mixer shall not exceed 350° F. The discharge temperature may be increased, when approved by the Engineer. If the ARAC is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the ARAC will be minimized.

325.6 TRANSPORTATION:

Petroleum distillates or other substances that will have a detrimental effect on the asphalt concrete shall not be used as a release agent.

The beds of all transportation units shall be clean and smooth to allow the free flow of material into the paving machine's hopper.

Tarpaulins shall be furnished on all trucks and used when weather condition warrant, or if directed by the Engineer.

325.7 PLACEMENT:

325.7.1 Surface Preparation:

The provisions for preparation of pavement surfaces in Section 321.8.6 (Asphalt Concrete Overlay) shall apply to ARAC overlays. Placement compaction and surface smoothness shall be as specified in this section.

After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat as specified in Section 325.4.

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

325.7.2 Placing and Construction Methods:

All courses of ARAC shall be placed and finished by means of a self-propelled paving machine equipped with an automatically actuated control system, except under certain conditions or at locations where the Engineer deems the use of a self-propelled paving machine impracticable. Safety edge construction, when required, shall comply with Section 321.8.9.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternatively when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with one of the following devices:

(A) Ski or non-contact device of not less than 30 feet in length, supported throughout its entire length
(B) Taut stringline or wire set to grade
(C) Short ski or sonar sensing units from curb control
(D) Joint matching shoe

Failure of the control system to function properly shall be cause for the suspension of asphalt concrete production. In order to achieve a continuous operation, the speed of the paving machine shall be coordinated with the hot mix plant and transport units.

The ARAC shall be dumped from the hauling vehicles directly into the paving machine, unless otherwise approved by the Engineer.

Care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machine by the truck.

If ARAC is dumped upon the surface being paved and subsequently loaded in the paving machine, the loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the ARAC shall be picked up and loaded into the paving machine. If ARAC is placed in a windrow during paving, the windrow shall not exceed a distance greater than 150 feet in front of the paving machine.

Self-propelled paving machines shall spread the mixture without segregation or tearing, true to line, grade and crown as indicated on the project plans. Pavers shall be equipped with hoppers and augers that will distribute the mixture uniformly in front of an adjustable floating screed. The raising of the hopper wings shall be minimized and the paving machine shall not be operated when in an empty condition.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective, without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required. In the case of the screed, auger extensions and vibrators shall be installed wherever the screed is extended more than one (1) foot beyond the end of the base auger or auger extension. However, when placing material against an extremely uneven curb or edge over a short distance, the Engineer may waive the auger extensions and vibrators.

325.7.3 Compaction: It is the contractor's responsibility to perform any desired Quality Control monitoring and/or testing during compaction operations to achieve the required compaction. The temperature of the ARAC immediately behind the laydown machine shall be at least 275° F. A probe type electronic thermometer with a current calibration sticker attached will be used to measure the temperature of the asphalt concrete mixture. When measuring the temperature of the mat, the probe shall be inserted at mid-depth and as horizontal as possible to the mat. When the pavement lift is less than 1.5-inches, the temperature of the material shall be measured in the truck by inserting a calibrated probe type electronic thermometer, or other approved measuring device, to a point at least 6" below the surface of material.

Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. Pneumatic tired compactors shall not be used.

The Engineer will determine the acceptability of the pavement compaction in accordance with Section 325.9. At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers to provide a uniform and smooth layer over the entire area compacted in this manner.

325.7.4 Lime Water: An application of lime water shall be applied by the Contractor to the compacted ARAC surface after final compaction, prior to opening the roadway to traffic, or when requested by the Engineer to cool the pavement to prevent tracking and pick-up. The lime water solution shall be applied at the rate of approximately ½ gallon/square yard. The lime shall be mixed using a minimum of one (1) 50-pound bag per 3,000 gallons of water.

325.7.5 Adjustments: After installation of an overlay course all necessary frame and cover adjustments for manholes, valve boxes, survey monuments, sewer clean-outs, etc., shall be completed by the Contractor within the given segments being surfaced.

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

325.8 QUALITY CONTROL:

It is the contractor's responsibility to perform Quality Control monitoring and/or testing during ARAC production to achieve the required compaction and the required mix properties. The Engineer may obtain samples of any portion of any material at any point of the operations for his own use. In addition, the Engineer may order that the use of any drying, proportioning or mixing equipment or the handling of any material be discontinued which, in his/her opinion, fails to produce a satisfactory mixture.

The ARAC produced s hall conform to the requirements of the production tolerances established in Section 325.9. When the ARAC does not conform to the production tolerances, it shall be reported to the Engineer, and corrective quality control measures shall be implemented, or production shall cease immediately at no additional cost to the contracting Agency or Engineer.

325.9 ACCEPTANCE:

325.9.1 Acceptance Criteria: The ARAC will be divided into lots for the purpose of acceptance. A lot shall be one day's production. Each lot shall be divided into sublots of 500 tons or fraction thereof. Tests used to determine acceptance will be performed by a laboratory accredited by the AASHTO Accreditation Program (AAP), for the tests being performed. The contracting agency shall provide an appropriately accredited laboratory or laboratories to perform the acceptance testing. The acceptance laboratory will take representative samples of the ARAC from each sublot to allow for determination of gradation, binder content, and air voids. Each sublot will be accepted based on the test data from the sample(s) from that sublot. All acceptance samples shall be taken using random locations or times designated by the Engineer in accordance with ASTM D3665. The laboratory shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications).

325.9.2 Gradation and Binder Content: Acceptance testing for gradation and binder content will be performed in one of the following ways; A) Plant-based testing of the mineral aggregate and binder content using cold feed samples and a nuclear asphalt content gauge or B) End-product testing of the ARAC using an ignition furnace with the gradation being performed on the resulting aggregate. The specifics of these methods are detailed in the following subsections.

During production, the allowable deviations from the mix design gradation targets are listed in Table 325-1 below. The allowable production tolerances may fall outside of the mix design gradation bands.

TABLE 325-1

GRADATION ACCEPTANCE LIMITS FOR ASPHALT-RUBBER MIXES

Sieve Size	1" & 1 ½" Lift Thickness	2" Lift Thickness
1 inch	100%	100%
3/4 inch	100%	92-100%
1/2 inch	92-100%	±6%
3/8 inch	±6%	±6%
No. 4	±6%	±6%
No. 8	±6%	±6%
No. 30	±4%	±4%
No. 200	±2%	±2%

325.9.2.1 Plant-Based Sampling and Testing:

325.9.2.1.1 Mineral Aggregate Gradation: The acceptance laboratory will take a sample of the mineral aggregate in accordance with the requirements of Arizona Test Method 105 on a random basis for each sublot. For batch plants, the sample shall be taken from the hot bins. For plants other than batch plants, the sample shall be taken from the cold feed belt. Samples will be taken by means of a sampling device, which is capable of obtaining representative samples. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of ARAC is less than 500 tons, at least one sample will be taken.

Samples will be tested for conformance with the mix design gradation, with or without mineral admixture as appropriate, in accordance with the requirements of Arizona Test Method 201. If the results from a single acceptance sample fall outside of the acceptance limits in Table 325-1 a second sample shall be taken and if the second acceptance sample is also outside of the acceptance limits in Table 325-1 the Contractor shall cease production of asphalt concrete. Production shall not begin again until calibration test results verify that adjustments made to materials or proportions yield a gradation that falls within acceptance limits in Table 325-1.

325.9.2.1.2 Binder Content: During production of ARAC, the contractor shall maintain at the plant site a nuclear asphalt content gauge calibrated and operated in accordance with Arizona Test Method 421. At the discretion of the Engineer, the Owner may choose to prepare the calibration samples for use by the contractor. Under the observation of the Engineer, the contractor shall determine the ARB content by means of the nuclear asphalt content gauge a minimum of four times per full

shift. The Engineer shall determine the times that the samples are taken. The contractor's technicians performing the testing, including the calibration of the nuclear gauge, shall meet the technician requirements given in the Arizona Department of Transportation (ADOT) System for the Evaluation of Testing Laboratories. The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, AZ 85009.

Production of ARAC shall cease immediately and the plant and/or the nuclear asphalt content gauges re-calibrated if any single test result varies by an amount greater than ± 0.60%, or the average of three consecutive test results varies by an amount greater than ± 0.40%, from the mix design target. Material that has already been produced may be used on the project if the single test value representative of that material varies by an amount from ± 0.61% to ± 0.75%, inclusive, from the mix design target. Material that has already been produced may not be used on the project if the single test value representative of that material varies by an amount greater than ± 0.75% from the mix design target unless, by retesting, the material is found to be acceptable.

When there is cause to question the ARB content being obtained via nuclear asphalt content gauge, or if approved by the Engineer, the ARB content may be determined using inventory data provided by the supplier as detailed in the following paragraphs. This will only apply for plants providing ARAC exclusively for the subject project, or if an asphalt cement tank is dedicated for the shift of ARAC production.

The determination of the actual ARB content by inventory methods may include weighing of asphalt cement deliveries, invoice quantities, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to ARAC production. At any time during ARAC production, the Engineer may require that a new calibration of the mass-flow meter be performed.

If there is a difference of greater than 0.2% ARB between the ARB content measured by nuclear asphalt content gauge testing and the actual ARB content as determined by inventory, the contractor may request that the ARB content be determined by inventory. The contractor must make such a request in writing within two working days after receiving the test results for the first day of ARAC production.

325.9.2.2 End Product Sampling and Testing:

325.9.2.2.1 Mineral Aggregate Gradation and Binder Content: The acceptance laboratory will take a sample of the asphalt concrete in accordance with the requirements of Section 2 or 4 of Arizona Test Methods 104 or AASHTO T-168 from each sublot. The minimum weight of the sample shall be 45 pounds. Asphalt binder content and gradation shall be determined in accordance with AASHTO T-308 using the ignition furnace for each sublot. The acceptance laboratory is responsible for obtaining the necessary materials and performing an ignition furnace calibration as outlined in AASHTO T-308 for each asphalt concrete mixture utilized on the project. The correction factor used for each test shall be clearly indicated on the report. Reports that do not include the correction factor, performed as stated in the previous sentences, shall be considered invalid and not allowed to be used for acceptance.

During production, the allowable deviations from the mix design gradation targets are listed in Table 325-1 above. The allowable production tolerances may fall outside of the mix design gradation bands.

If the results from a single acceptance sample fall outside of the acceptance limits in Table 325-1 a second sample shall be taken and if the second acceptance sample is also outside of the acceptance limits in Table 325-1 the Contractor shall cease production of asphalt concrete. Production shall not begin again until calibration test results verify that adjustments made to materials or proportions yield a gradation that falls within acceptance limits in Table 325-1.

If the asphalt binder content is within ± 0.60% of the mix design target value, the asphalt concrete will be paid for at the contract unit price. If the asphalt binder content deviates by more than ± 0.60% from the mix design target value, the deficient area will be evaluated within the sublot by coring at maximum intervals of 100 feet from the deficient sample. The asphalt content of the original deficient sample will be averaged with the asphalt binder content of the cores taken for re-evaluation to determine compliance with the acceptance requirements. If the resulting average of the asphalt binder content deviates by more than ± 0.60% from the mix design target value, then Table 325-2 shall apply to the sublot. Additional cores may be required to define the limits of the deficient area, and shall not be used for re-evaluating acceptance.

TABLE 325-2	
ARB CONTENT ACCEPTANCE AND PENALTIES	
Deviation from that permitted	($ per ton of asphalt concrete)
Over 0.2% above that permitted	Removal* or EA
Over 0.1% to 0.2% above that permitted	$6.00
Over 0.0% to0.1% above that permitted	$2.00
Within permitted range	Full Payment
Over 0.0% to0.1% below that permitted	$2.00
Over 0.1% to 0.2% below that permitted	$6.00
Over 0.2% below that permitted	Removal* or EA

NOTES: *The Contractor shall remove and replace the entire sublot that is deficient.
EA = Engineering Analysis per Section 325.9.6

325.9.3 Marshall Air Voids: For purposes of determining Marshall air voids, the acceptance laboratory will designate one sample of the ARAC in accordance with the requirements of Section 2(h) of Arizona Test Methods 104 or AASHTO T-168 for each day's production or as directed by the Engineer's. The minimum weight of the sample shall be 45 pounds. The bulk density shall be tested in accordance with AASHTO T-245. The maximum theoretical density shall be tested in accordance with the requirements of AASHTO T-209, including fan drying per AASHTO T-209 Section 11. Effective voids determined on the laboratory compacted specimens will be determined in accordance with the requirements of AASHTO T-269. Should the testing for effective air voids not meet the "Full Payment" or "No Corrective Action" requirements of Table 325-3, additional testing for laboratory air voids on additional samples will be performed as necessary to determine the extent of the deficiency.

TABLE 325-3		
LABORATORY VOIDS ACCEPTANCE AND PENALTIES		
Marshall Air Voids (Measured at 75 blows) Deviation from Mix Design Target	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
± 0% to 2.0%	Full Payment	No corrective action
± 2.1% to 2.9%	$1.00	EA (see 325.9.5)
± 3.0% to 4.0%	$2.50	EA (see 325.9.5)
± Greater than 4.0%	Removal* or EA per 325.10.4	Removal* or EA per 325.9.5

325.9.4: Requests for Referee Testing as described in 325.10 will only be considered based on quality control test results performed by a laboratory accredited by the AASHTO Accreditation Program (AAP) for the tests being performed or a laboratory listed in the current ADOT Directory of Approved Materials Testing Laboratories for the set of tests in question. The laboratory shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications).

325.9.5 Density: The temperature of ARAC just prior to compaction shall be at least 275° F. The Engineer may change the rolling procedure if in the Engineer's judgment the change is necessary to prevent picking up of the ARAC.

325.9.5.1 Equipment: Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. The compactors shall weigh not less than eight tons. Compactors shall not be used in the vibratory mode for courses of one inch or less in nominal thickness. The wheels of compactors shall be wetted with water, or if necessary soapy water, or a product approved by the Engineer to prevent the ARAC from sticking to the steel wheels during rolling.

325.9.5.2 Compaction Procedures:

325.9.5.2.1 Pavement Lift Thickness 1½ Inches or Less: Achieving the required compaction is the responsibility of the contractor. A minimum of three static steel-wheel compactors shall be provided; however, sufficient compactors must be provided so that the drums of the compactors when staggered will cover the entire width of the paving machine on the initial forward pass while a static compactor remains to complete final rolling. The roller(s) for final compaction shall follow as closely behind the initial breakdown as practical, such that a uniformly smooth surface is achieved. As many passes as are possible shall be made with the compactors before the temperature of the ARAC falls below 220° F.

At the Engineer's discretion, cores may be taken and used to evaluate thickness.

325.9.5.2.2 Pavement Lift Thickness Greater than 1½ Inches: Achieving the required compaction is the responsibility of the contractor. The number and types of rollers is the contractor's responsibility and shall be sufficient to meet these requirements. Initial breakdown rollers shall follow as closely behind the paving machine as practical. The roller(s) for final compaction shall follow as closely behind the initial breakdown as practical, such that a uniformly smooth surface is achieved.

Compaction will be determined using a correlated nuclear density gauge and will be monitored for acceptability continuously during construction. The density of the compacted mixture shall not be less than 95% of the laboratory unit weight composed of the same mixture compacted by the 75 blow method of AASHTO T-245 at the job mix design specified compaction temperature. The outside one foot of each pass of the pavement course or any unconfined edge will be excluded from testing. The Engineer may exclude areas from the compaction lot that are not accessible by normal compaction equipment.

Nuclear Density Gauge Correlation - During placement of the test strip or on the first day of paving, the pavement surface shall be tested with a nuclear density gauge at a minimum of four locations. These same locations shall then be cored, using a 4-inch diameter core barrel, and tested for bulk density (AASHTO T-166A, or T-275) and a correlation value developed between the nuclear density gauge and the asphalt cores.

At the Engineer's discretion, cores may be taken and used to evaluate density and/or thickness.

325.9.5.3 Compacting Miscellaneous Items and Surfaces: ARAC used in the construction of miscellaneous items and surfaces shall be compacted using compactors, hot-hand tampers, smoothing irons, mechanical vibrating hand tampers, or with other devices to the extent considered necessary by the Engineer.

325.9.6 Engineering Analysis (EA): Within 10 working days after receiving notice that a lot or sublot of ARAC is deficient and is found to fall within the "Removal or EA" band per Table(s) 325-2 or 325-3, the contractor may submit a written proposal (Engineering Analysis) to accept the material in place at the applicable penalties along with possible remediation(s) listed in the "Removal or EA" category. An Engineering Analysis can also be proposed for non-removal categories of "Corrective actions" when the contracting agency is not the owner (i.e. permits).

The Engineering Analysis shall contain an analysis of the anticipated performance of the ARAC if left in place. The Engineering Analysis shall also detail the effect of any proposed corrective action to the material(s) in place as it relates to the in-place material's performance. The Engineering Analysis shall be performed by a professional engineer experienced in asphalt concrete testing and mix designs. If the lot or sublot is submitted for referee testing by the contractor, the ten working days allowed to prepare an Engineering Analysis will begin upon notification of referee test results.

When an Engineering Analysis recommends that a specific lot or sublot should not be removed, the Engineering Analysis will recommend that the following penalties (Table 325-4) be paid when the contracting agency is the owner, for the specific criteria being reviewed by the EA.

TABLE 325-4		
ENGINEERING ANALYSIS PENALTIES for REMOVAL* LOTS/SUBLOTS LEFT IN-PLACE		
Acceptance Criteria	**Acceptance Limits**	**Penalty When Contracting Agency is the Owner ($/Ton)**
Laboratory Air Voids (Measured at 75 blows)	Deviation from Target Greater Than ± 4.0%	$3.75

Within 15 working days, the Engineer will determine whether or not to accept the Contractor's proposed Engineering Analysis.

325.10 REFEREE:

In the event the contractor elects to question the acceptance test results for laboratory air voids, the Contractor may make a written request for additional testing of the affected material. Any request for referee testing must describe the contractor's reasons for questioning the validity of the original acceptance results and must clearly describe which set of acceptance tests are in question. The Contractor will engage an independent laboratory (at the Contractor's own expense) who is accredited by AAP in all of the acceptance test methods. The independent laboratory shall be acceptable to the Engineer and shall perform a new set of acceptance tests as required by Section 325.9.2.3 representing the area or set of tests in question. The results of these determinations will be binding on both the contractor and the agency.

These tests will include Marshall unit weight, maximum theoretical unit weight, binder, and laboratory air voids. Samples for referee testing shall come from representative samples obtained from the completed pavement, as directed by the Engineer. All referee testing shall conform to Section 325.9.

The number of samples taken will be the same as specified in Section 325.9.2.3. The independent laboratory shall compile the test results and transmit them to both the Engineer and the contractor. The independent laboratory shall include a report signed by an Engineer registered in the State of Arizona, who is experienced in asphalt concrete testing and mix design development. The signed report shall give an opinion that the material evaluated either does or does not comply with project specifications, shall clearly describe any deficiencies, and the results will be binding between all parties.

325.11 MEASUREMENT:

ARAC shall be measured by the ton, for the mixture actually used, which shall include the required quantities of mineral aggregates, filler material, asphalt-rubber binder and admixture.

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

Except as otherwise specified, no separate measurement will be made for work required for the construction of safety edges or for the grading and compaction for shoulder adjustment to match the new pavement surface elevation. The cost of this work shall be included in the price paid for ARAC or other related pay items. Engineer requested imported material for shoulder adjustment is not included in the price paid for the ARAC.

Measurement for safety edge preparation only applies to overlays of existing pavements that require the construction of a safety edge when none exists. Safety edge preparation will be measured by the linear foot. Safety edge preparation will not be measured when a safety edge is part of new pavement construction, pavement widening, or when overlaying an existing pavement that contains a safety edge.

325.12 PAYMENT:

Payment for asphalt milling will be as specified in Section 317.

Removal of raised pavement markers, pavement repairs, and surface pavement replacements required prior to roadway overlay operations, will be paid for by other pay items unless otherwise specified.
Payment for safety edge preparation will be at the contract unit price for the quantities measured as described above.

Payment for tack coat will be by the ton diluted, based on the rate of application, as directed by the Engineer.

Payment for ARAC will be at the contract unit price, complete in place.

Application of lime water as approved by the Engineer will be paid at the contract unit price.

Payment for frame and cover adjustments will be at the contract unit prices specified in the proposal.

- End of Section -

SECTION 326

PLACEMENT AND CONSTRUCTION OF POLYMER MODIFIED ASPHALT CONCRETE

326.1 DESCRIPTION:

This section is to provide specifications for furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture and asphalt binder to form a pavement course for placement upon a previously prepared base or sub base.

326.2 MATERIALS AND MANUFACTURE:

The materials shall conform to Section 719 for the type specified. The specific required mix type shall be called out in the contract documents or as directed by the Engineer.

326.3 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 degrees F. (50 degrees F for Asphalt Concrete lift less than 2 inch thick) or greater. No asphalt concrete shall be placed when the weather is foggy or rainy, or when the base or sub base on which the material is to be placed is unstable. Asphalt concrete shall be placed only when the Engineer determines that weather conditions are suitable.

326.4 APPLICATION OF TACK COAT:

A tack coat shall be applied to all existing and to each new course of asphalt concrete prior to the placing of a succeeding lift of asphalt concrete. If approved by the Engineer, 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.

The application of the tack coat shall comply with Section 329. The grade of emulsified asphalt shall be SS-1h or CSS-1h as specified in Section 713.

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.

The surface to be covered may require repair or patching as directed by the Engineer. This shall be addressed in the project specifications prior to the bidding of the project.

326.5 MIX DESIGN:

The mix design shall be submitted to the Engineer at least five working days prior to the start of asphalt concrete production. Mix designs provided by the agency may be utilized on projects at the Engineer's discretion. The Engineer will review and approve the mix design to assure it contains all of the required information as outlined in Section 719.3.1. The target values for gradations, binder contents, and air voids will be established as the accepted Job Mix Formula (JMF) based upon the mix design. Mix designs not containing all of the information will be returned within five working days of receipt of all mix design information, for action and resubmission by the contractor.

Once the mix design has been approved by the agency and the mixing plant selected, the Contractor and/or his supplier shall not change plants nor utilize additional mixing plants without prior approval of the Engineer.

If the contractor elects to change its source of material, the contractor shall furnish the Engineer with a new mix design, which meets the requirements of Section 719, as amended by the Project Specifications.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing, acknowledged by the Engineer prior to the start of production of a lot, and will remain in effect until such time as any additional changes are implemented. The self-directed target changes must meet the contract requirements for mix design criteria and gradation limits.

TABLE 326-1 ALLOWABLE SELF-DIRECTED TARGET CHANGES	
MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (Sieve Size)	
3/8 inch	± 4% from mix design target value
No 8	± 4% from mix design target value
No 40	± 2% from mix design target value
No 200	+0.5% from mix design target value
Binder Content	± 0.2% from mix design target value
Effective Air Voids	None

The contractor may propose target changes, other than self-directed changes, to the approved mix design for the approval of the Engineer. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and gradation limits. The target changes will not be retroactive for the purpose of acceptance.

326.6 MIX PRODUCTION:

All materials shall be proportioned by weight in a hot mix asphalt plant in the proportions required by the mix design to provide a homogeneous and workable mass. Each hot mix asphalt plant shall be inspected in accordance with the provisions contained in the 'Hot Mix Asphalt Production Facilities' by the Arizona Rock Products Association and shall have a current inspection certificate. All measuring devices shall be calibrated at least annually by a technician licensed by the Arizona Bureau of Weights & Measures. Mixing plants shall conform to the requirements of AASHTO M-156, except as modified herein.

In drum mix plants, the mineral admixture shall be added and thoroughly mixed with the mineral aggregate by means of a mechanical mixing device prior to the mineral aggregate and mineral admixture entering the dryer. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process.

For drum-mix plants, the mineral admixture shall be weighed across a weight belt, or other approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer that is in good working condition. The rate of the aggregate feed shall not exceed the mixing device's capacity in ton per hour. The mixer shall be constructed to minimize the loss of mineral admixture and shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected. The mixing device shall be capable of effective mixing in the full range of the asphalt concrete production rates.

The hot plant and equipment shall be constructed and operated to prevent loss of mineral admixture through the dust collection system of the plant.

A positive signal system shall be provided and used during production whereby the mixing shall automatically be stopped if the mineral admixture is not introduced into the mineral aggregate. The plant will not be permitted to operate unless the signal system is in good working condition.

The introduction of bituminous material shall be controlled by an automated system fully integrated with the controls or the mineral aggregate and mineral admixture. The production of the plant shall be controlled by the rate required to obtain a uniform mixture of all components. Drying and heating shall be accomplished in such a manner as to preclude the mineral admixture from becoming coated with un-spent fuel. The completed asphalt concrete may be held in storage for up to 12 hours in insulated or heated silos, providing the minimum temperature noted herein for placement and compaction is met behind the placement device. If the Engineer determines that there is an excessive amount of heat, heat loss, drain down, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

The temperature of the asphalt concrete upon discharge from the mixer shall not exceed 335 degrees F. The discharge temperature may be increased to 350 degrees F if the binder supplier affirms that no binder degradation will occur from such an increase, and when approved by the Engineer. If the asphalt concrete is discharged from the mixer into a hopper, the hopper

shall be constructed so that segregation of the asphalt concrete will be minimized.

326.7 TRANSPORTATION:

Petroleum distillates or other substances that will have a detrimental effect on the asphalt concrete shall not be used as a release agent.

The beds of all transportation units shall be clean and smooth to allow the free flow of material into the paving machine's hopper.

Tarpaulins shall be furnished on all trucks and used when weather condition warrant, or if directed by the Engineer.

326.8 PLACEMENT:

Placement of asphalt concrete pavement shall not commence until authorized by the Engineer. The Engineer's authorization to allow commencement of asphalt concrete paving will generally require all newly constructed valley gutters, curbing, and curb and gutters which new pavement is to be placed against to be in-place and in an acceptable condition. While it is preferred to have all newly constructed concrete items against which new pavement is to be placed be in an acceptable condition, the Engineer may allow paving to commence based on weather, the amount of defective concrete, or other considerations.

326.8.1 Placing: All courses of asphalt concrete shall be placed and finished by means of a self-propelled paving machine equipped with an automatically actuated control system, except under certain conditions or at locations where the Engineer deems the use of a self-propelled paving machine impracticable.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternatively when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with one of the following devices:

(a) Ski or non-contact device of not less than 30 feet in length, supported throughout its entire length
(b) Taut stringline or wire set to grade
(c) Short ski or sonar sensing units from curb control
(d) Joint matching shoe

Failure of the control system to function properly shall be cause for the suspension of asphalt concrete production. In order to achieve a continuous operation, the speed of the paving machine shall be coordinated with the hot mix plant and transport units.

If the asphalt concrete is dumped from the hauling vehicles directly into the paving machine, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machine by the truck.

If asphalt concrete is dumped upon the surface being paved and subsequently loaded in the paving machine, the loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphalt concrete shall be picked up and loaded into the paving machine.

Self-propelled paving machines shall spread the mixture without segregation or tearing, true to line, grade and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers that will distribute the mixture uniformly in front of an adjustable floating screed. The raising of the hopper wings must be minimized and the paving machine will not be operated when in an empty condition.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective, without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required. In the case of the screed, auger extensions and vibrators shall be installed wherever the screed is extended more than one (1) foot

beyond the end of the base auger or auger extension. However, when placing material against an extremely uneven curb or edge over a short distance, the Engineer may waive the auger extensions and vibrators.

At any place not accessible to the roller, the mixture shall be thoroughly compacted with tampers to provide a uniform and smooth layer over the entire area compacted in this manner.

326.8.2 Joints: Transverse joints, before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphalt concrete shall be trimmed to a vertical face for its full depth exposing a fresh face. The fresh face shall be tack coated prior to placement of the new asphalt concrete. After placement and finishing the new asphalt concrete, both sides of the joint shall be dense and the joint shall be smooth and tight. The surface in the area of the joint shall not deviate more than 1/4 inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, parallel to the centerline.

Longitudinal joints of each asphalt course shall be staggered a minimum of 6 inches with relation to the longitudinal joint of the immediate underlying course's cold longitudinal construction joint.

Longitudinal joints with existing or cold (more than 32 hours old) asphalt concrete shall require the existing pavement to be trimmed to a vertical face for its full depth exposing a fresh face. The fresh face shall be tacked prior to placement of the adjacent course. Longitudinal joints with an existing asphalt pavement that is less than 32 hours old that has had its edge protected from damage may have adjacent new asphalt concrete placed after applying the required tack coat. After placement and finishing of longitudinal joints, both sides of the joint shall be dense and the joint shall be smooth and tight. The surface in the area of the joint shall not deviate more than 1/4 inch from a 12-foot straightedge, when tested with the straightedge placed across the joint, in any direction.

326.8.3 Asphalt 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. If a leveling course is being applied on an asphalt surface, a tack coat shall be applied. The compaction requirements contained in Section 326.10 do not apply to leveling courses.

326.8.4 Compaction; Asphalt Base Course and Surface Course: It is the contractor's responsibility to perform Quality Control monitoring and/or testing during compaction operations to achieve the required density. The temperature of the asphalt concrete immediately behind the laydown machine shall be at least 265 degrees F. A probe type electronic thermometer with a current calibration sticker attached will be used to measure the temperature of the asphalt concrete mixture. When measuring the temperature of the mat, the probe shall be inserted at mid-depth and as horizontal as possible to the mat. The contractor is responsible to achieve the required compaction.

Asphalt compaction equipment shall be of sufficient size and weight to accomplish the required compaction. All compaction equipment shall be operated and maintained in accordance with the manufacturer's recommendations and the project requirements. During the rolling operation, the speed of the roller shall not exceed three miles per hour, unless otherwise approved by the Engineer.

Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

The Engineer will determine the acceptability of the pavement compaction in accordance with Section 326.10.

326.8.5 Smoothness: 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 1/4 inch from the lower edge of a 12-foot straightedge when the straightedge is placed parallel to the centerline of the roadway.

326.8.6 Polymer Modified Asphalt Concrete Overlay: Polymer modified asphalt concrete overlay consists of the placing and compacting plant mix polymer modified asphalt concrete over existing pavement. The mix design and thickness of the overlay shall be as shown on the plans or as specified in the special provisions.

Except when the existing asphalt surface is to be preheated and remixed, pavement surfaces shall be prepared as follows:

(a) Areas designated for pavement repair by the contract documents (which may include severely raveled areas, severely cracked areas, over-asphalted areas, and other defects) shall be cut out and replaced. Pavement repairs shall be completed and approved before placing the overlay.

(b) Before placing the overlay, raised pavement markers shall be removed, and milling shall be completed. Milling shall be as shown on the plans or specified in the special provisions and shall be in accordance with Section 317.

(c) After pavement repairs and milling have been completed, the entire surface shall be cleaned with a power broom.

(d) After surfaces have been prepared to the satisfaction of the Engineer, they shall receive a tack coat per Section 326.4. Traffic will not be permitted to travel over surfaces, which have received a tack coat, except when tack coat is applied to milled surfaces in compliance with Section 317.2 for dust control purposes. When the overlay is to extend onto a concrete surface, the concrete surface shall be thoroughly cleaned of loose dust and cement particles and shall be tack coated.

The overlay shall be placed as specified in Section 326.8.1 and compacted as specified in Section 326.8.4. The surface smoothness shall meet the tolerances specified in Section 326.8.5.

Frames and covers of manholes, survey monuments, valve boxes, clean-outs and other existing structures shall be adjusted in accordance with Section 345 to set flush with the finished surface of the new pavement. During adjustment, if pavement or base materials are removed or disturbed, they shall be replaced with approved materials installed in a manner acceptable to the Engineer.

On roads without curb and gutter, the existing unpaved shoulder elevation shall be adjusted by the Contractor to match the elevation at the edge of the new overlay and slope away from the new pavement surface at a rate that the existing quantity of shoulder material will allow. Shoulder material shall be compacted to a minimum of 95% of maximum density, determined in accordance with Section 301.3. Shoulder adjustment to match the new pavement surface elevation shall not be measured. The cost of shoulder adjustment shall be included in the price paid for the asphalt concrete overlay or other related pay items. When the Engineer determines an insufficient amount of material is available for shoulder adjustment, the Engineer may require the Contractor to provide additional material. Acceptable material for shoulders includes the existing shoulder material, millings, untreated base materials, or a granular material approved by the Engineer. Engineer requested imported material for shoulder adjustment is not included in the price paid for the asphalt concrete overlay.

326.8.7 Pavement Fabric Interlayer: Pavement fabric interlayer shall be used only when specified on the plans or in the specifications.

Pavement fabric interlayer shall be in accordance with Table 796-1 and be the class designated on the plans or in the specifications.

Asphalt binder coat used to bond the fabric to the pavement shall be paving asphalt PG 70-10 asphalt cement conforming to the requirements of Section 711. The application and distributing equipment for the asphalt binder shall conform to the requirements of Section 330. The asphalt binder coat shall be uniformly spray applied to the prepared pavement surface at the rate of 0.20 gallons per square yard for Class B fabric or at the rate of 0.25 gallons per square yard for Class A fabric. Some underlying surfaces may require a higher or lower application rate. A test strip may be necessary to determine the proper application rate. The width of liquid asphalt cement application shall be the fabric width, plus six inches.

Neither the asphalt binder coat or fabric interlayer shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. The asphalt binder and fabric interlayer shall only be placed when the pavement is dry, the ambient air temperature is 50 degrees F and rising, and pavement temperature is 40 degrees F and rising.

Equipment for placing the fabric shall be mechanized and capable of handling full rolls of fabric. The equipment shall be able to lay the fabric smoothly to maximize pavement contact and remove air bubbles. Stiff bristle brooms shall be used to smooth the fabric. The equipment used to place the fabric shall be in good working order and is subject to approval by the Engineer.

Pavement fabric interlayer shall not be placed if the in-place binder is hotter than 325 degrees F or has cooled to 180 degrees F or below (as determined by non-contact thermometer).

Pavement fabric interlayer shall be placed onto the asphaltic binder with the heat-bonded side up with a minimum amount of wrinkling or folding. Remaining wrinkles or folds 1-inch and larger shall be removed or slit and shingle-lapped in the direction of paving. Burning or torching of wrinkles is not allowed. Fabric shall overlap three to six inches to insure full closure of the joint. Transverse joints shall be shingle-lapped in the direction of paving to prevent edge pickup by the paver. A second application of hand-placed asphalt binder may be required at laps and repairs as determined by the Engineer to ensure proper binding of the narrow double fabric layer. All areas where fabric has been placed shall be paved with asphaltic concrete during the same work shift. Placement of the asphaltic concrete shall closely follow fabric lay down. The temperature of the asphaltic concrete immediately behind the laydown machine shall not exceed 335 degrees F, unless the binder supplier has affirmed a higher temperature range in writing.

In the event that the asphalt binder coat bleeds through the fabric causing construction problems before the overlay is placed, the affected areas shall be sanded with a sand blotter in compliance with Section 333. Excess sand shall be removed before beginning the paving operation. In the event of rainfall prior to the placement of the asphaltic concrete, the fabric shall be allowed to dry before the asphalt concrete is placed.

Turning of the paving machine or of other vehicles on the fabric shall be gradual and kept to a minimum to avoid damage to the fabric. Should equipment tires stick to the fabric during pavement operations, small quantities of paving asphalt concrete shall be broadcast on the fabric to prevent pick-up. Decrease of binder rate in order to minimize pick-up on tires is not allowed.

326.8.8 Thickened Edge: Shall be constructed in accordance with Section 321.8.8

326.8.9 Safety Edge: Shall be constructed in accordance with Section 321.8.9

326.8.10 Protection for Asphalt Base Course: Arterial roadway traffic shall not be allowed on a new asphalt base course that is less than five inches (5”) in thickness without the written consent of the Engineer.

326.9 QUALITY CONTROL:

It is the contractor’s responsibility to perform Quality Control monitoring and/or testing during asphalt concrete production to achieve the required compaction and to perform Quality Control monitoring and/or testing during asphalt concrete production to achieve the required mix properties. The Engineer may obtain samples of any portion of any material at any point of the operations for his own use. Also, the Engineer may order the use of any drying, proportioning and mixing equipment or the handling of any material discontinued which, in his/her opinion, fails to produce a satisfactory mixture.

The asphalt concrete produced shall conform to the requirements of the production tolerances established in Section 326.10. When the asphalt concrete does not conform to the production tolerances, it shall be reported to the Engineer, and corrective quality control measures shall be implemented, or production shall cease immediately at no additional cost to the contracting Agency.

Requests for referee testing as described in Section 326.11 will only be considered based on quality control test results performed by a laboratory accredited by the AASHTO Accreditation Program (AAP) for the tests being performed or a laboratory listed in the current ADOT Directory of Approved Materials Testing Laboratories for the set of tests in question. The laboratory shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications).

326.10 ACCEPTANCE:

326.10.1 Acceptance Criteria: Asphalt concrete will be divided into lots for the purpose of acceptance. A lot shall be one day’s production. Each lot shall be divided into sublots of 500 ton or fraction thereof. Tests used to determine acceptance will be performed by a laboratory accredited by the AASHTO Accreditation Program (AAP) for the tests being performed. The contracting agency shall provide an appropriately accredited laboratory or laboratories to perform the acceptance testing. Laboratories shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications).

The acceptance laboratory will take representative samples of the asphalt concrete from each sublot to allow for testing of gradation, binder content, air voids, pavement thickness, and compaction of base and surface courses. Acceptance of each sublot will be based on the test data from the sample(s) from that sublot. All acceptance samples shall be taken using random locations or times designated by the Engineer in accordance with ASTM D3665.

326.10.2 Gradation, Binder Content and Air Voids: The acceptance laboratory will take a sample of the asphalt concrete in accordance with the requirements of Section 2 or 4 of Arizona Test Methods 104 or AASHTO T-168 from each sublot. The minimum weight of the sample shall be 45 pounds. Asphalt binder content and gradation shall be determined in accordance with AASHTO T-308 using the ignition furnace for each sublot. The acceptance laboratory is responsible for obtaining the necessary materials and performing an ignition furnace calibration as outlined in AASHTO T-308 for each asphalt concrete mixture utilized on the project. The correction factor used for each test shall be clearly indicated on the report. Reports that do not include the correction factor, performed as stated in the previous sentences, shall be considered invalid and not allowed to be used for acceptance. The bulk density for Marshall Mix designs shall be tested in accordance with AASHTO T-245. The bulk density for Gyratory mix designs shall be determined in accordance with AASHTO T-312. The maximum theoretical density shall be determined in accordance with the requirements of AASHTO T-209 including fan drying per AASHTO T-209 Section 15. Effective voids of the laboratory compacted specimens will be determined at a minimum of once per lot in accordance with the requirements of AASHTO T-269. Should the testing for effective air voids not meet the "Full Payment" or "No Corrective Action" requirements of Table 326-5, additional testing for laboratory air voids on the remaining sublots will be performed as necessary to determine the extent of the deficiency. Acceptance testing results will be furnished to the contractor and the supplier within five working days of receipt of samples by the acceptance laboratory.

During production, the allowable deviations from the mix design gradation targets are listed in the tables below. The allowable production tolerances may fall outside of the mix design gradation bands.

TABLE 326-3	
GRADATION ACCEPTANCE LIMITS FOR PMAC	
Sieve Size	
1 inch	---
3/4 inch	---
1/2 inch	±7%
3/8 inch	±6%
No. 8	±6%
No. 40	±4%
No. 200	±2%

If the results from a single acceptance sample fall outside of the acceptance limits in Table 326-3 as applicable, a second sample shall be taken and if the second acceptance sample is also outside of the acceptance limits the Contractor shall cease production of asphalt concrete. Production shall not begin again until calibration test results verify that adjustments made to materials or proportions yield a gradation that falls within acceptance limits in Table 326-3 or as applicable.

If the asphalt binder content is within ± 0.50% of the mix design target value, the asphalt concrete will be paid for at the contract unit price. If the asphalt binder content deviates by more than ± 0.50% from the mix design target value, the deficient area will be evaluated within the sublot by coring one additional location at a maximum interval of 100 feet on each side of the deficient sample. The asphalt content of the original deficient sample will be averaged with the asphalt binder content of the two additional cores to determine compliance with the acceptance requirements. If the resulting average of the asphalt binder content deviates by more than ± 0.50% from the mix design target value, then Table 326-4 shall apply to the sublot. If approved by the Engineer, the Contractor may obtain additional cores to assist in formulation of an Engineering Analysis, but the additional cores shall not be used for re-evaluating acceptance.

TABLE 326-4		
ASPHALT BINDER CONTENT ACCEPTANCE AND PENALTIES		
Deviation from that permitted	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Over 0.2% above that permitted	Removal* or EA	Removal* or EA
Over 0.1% to 0.2% above that permitted	$6.00	EA
Over 0.0% to0.1% above that permitted	$2.00	EA
Within permitted range	Full Payment	No Corrective Action
Over 0.0% to0.1% below that permitted	$2.00	EA
Over 0.1% to 0.2% below that permitted	$6.00	EA
Over 0.2% below that permitted	Removal* or EA	Removal* or EA

NOTES: *The Contractor shall remove and replace the entire sublot that is deficient.
EA = Engineering Analysis per Section 326.10.6

If the laboratory air voids fall within a range of -1.5% and +2% of the design target, the asphalt concrete will be paid for at the contract unit price. If the laboratory air voids are outside of this range, the deficient area will be evaluated within the sublot by coring one additional location at a maximum interval of 100 feet on each side of the deficient sample. The laboratory air voids of the original deficient sample will be averaged with the laboratory air voids obtained from each of the two additional cores to determine compliance with the acceptance requirements. If the resulting average of the laboratory air voids is outside the indicated range, then Table 326-5 shall apply to the sublot. If approved by the Engineer, the Contractor may obtain additional cores to assist in formulation of an Engineering Analysis, but the additional cores shall not be used for re-evaluating acceptance.

TABLE 326-5		
LABORATORY VOIDS ACCEPTANCE AND PENALTIES		
Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	When the contracting agency is the owner: Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner (i.e. permits): Corrective Action
Greater than -2.7% from Target	Removal* or EA	Removal* or EA
-2.7% to -2.1% from Target	$5.00	EA
-2.0% to -1.6% from Target	$2.00	EA
-1.5% to +2% from Target	Full Payment	No Corrective Action
+2.1 to +2.9% from Target	$2.00	EA
+3.0% to +4.0% from Target	$5.00	EA
Greater than 4.0% from Target	Removal* or EA	Removal* or EA

NOTES: *The Contractor shall remove and replace the entire sublot that is deficient.
EA = Engineering Analysis per Section 326.10.6

If an agency or Engineer is purchasing asphalt concrete directly from a commercial material supplier, the agency or Engineer will use Section 326.10, and specifically Table 326-3 as applicable, 326-4 and 326-5 from Section 326.10, when determining the acceptance of the asphalt concrete with the material supplier.

326.10.3 Surface Testing: If directed by the Engineer surface drainage test shall be performed. The completed surfacing shall be thoroughly compacted, smooth, true to grade and cross-section, and free from ruts, humps, depressions or irregularities. An acceptable surface shall not vary more than 1/4 inch from the lower edge of a 12-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.

All streets shall be water tested for drainage in the presence of the Engineer or designated representative before final acceptance. Any areas not draining properly shall be corrected to the Engineer's satisfaction at the Contractor's expense. Water for this testing shall be provided and paid for by the Contractor.

When deviations in excess of the above tolerance are found, humps or depressions shall be corrected to meet the specified tolerance. The defective pavement shall be cut out along neat straight lines or for multiple course pavements the surface course may be milled out, and the removed pavement 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.

When pavement is cut out along neat straight lines, full depth longitudinal joints shall not be located within a lane wheel path or within forty-eight inches (48") of an asphalt pavement edge. Longitudinal joints shall comply with the restrictions for Type A Trench Repairs in Section 336.3.

326.10.4 Asphalt Pavement Thickness: Asphalt pavement thickness will be determined from cores secured from each lift of each sublot. Such cores will be taken and measured by the Asphalt Concrete Coring Method. This method is found in Section 321.14. Each core location will be patched by the party responsible for the testing.

Acceptance or assessment of penalties for asphalt pavement thickness will be based on the combined total thickness of all asphalt concrete layers omitting all layers of asphalt-rubber asphalt concrete. If the final total pavement thickness exclusive of all ARAC layers is deficient from the target thickness by 0.25 inches or less, it will be paid for at the contract unit price.

If the thickness deficiency of the pavement core exceeds 0.25 inch, the thickness deficiency shall be evaluated by coring at a maximum interval of 100 feet on each side of the deficient core. The thickness of the original deficient core will be averaged with the thicknesses of the cores taken from each side of it to determine compliance with the acceptance requirements.

If the pavement thickness deficiency is greater than 0.25 inches and the contracting agency is not the owner (i.e. permits) the following will apply:

(1) If the pavement thickness deviates from the target thickness by more than 0.25 inch but not more than 0.50 inch, corrective action will be required. This corrective action shall consist of application of a Type II slurry seal coat in accordance to Section 715. The Contractor may present an Engineering Analysis outlining other proposed remedial measures for the consideration by the Engineer. The Engineer will review the Engineering Analysis and decide within 30 working days whether to accept the proposed remedial measures.

(2) If the pavement thickness deviates from the target thickness by more than 0.50 inch, corrective action will be required. The deficient area shall be overlaid with no less than a 1 inch thick lift, for the full width of the pavement to meet or exceed the designed thickness, with appropriate end and edge milling, with a mixture approved by the Engineer. The Contractor may present an Engineering Analysis outlining other proposed remedial measures for the Engineer's consideration. The Engineer will review the Engineering Analysis and decide within ten working days whether to accept the proposed remedial measures. If the Engineer chooses to reject the Engineering Analysis, the indicated overlay shall be constructed by the Contractor at no additional cost to the Owner.

If the contracting agency is the owner and the pavement thickness deficiency is greater than 0.25 inches but less than 0.50 inches, Table 326-6 will apply. If the pavement thickness deficiency is greater than 0.5 inches, the deficient area shall be overlaid with no less than a 1-inch thick lift for the full width of the pavement to meet or exceed the designed thickness using an asphalt mixture approved by the Engineer. The Contractor shall provide appropriate end and edge milling. The overlay and milling shall be accomplished by the Contractor at no additional cost to the contracting agency.

TABLE 326-6 ASPHALT PAVEMENT THICKNESS PAYMENT REDUCTION For Thickness Deficiency of More Than 0.25 inches and less than 0.50 inches	
Total Specified Asphalt Pavement Thickness exclusive of ARAC (if any)	**Reduction in Payment Applied to asphalt concrete Except ARAC layers (if any)**
Less than 1.5 inches	50%
1.50 inches to 1.99 inches	33%
2.00 inches to 2.49 inches	25%
2.50 inches to 2.99 inches	20%
3.00 inches and greater	17%

326.10.5 Density:

326.10.5.1 Pavement 1-1/2 Inches or Less in Nominal Thickness:

Compaction shall consist of a "Rolling Method Procedure" using an established sequence of coverage with specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as shown in Table 326-7.

TABLE 326-7 ROLLING SEQUENCE FOR LIFT THICKNESS 1½" OR LESS				
Rolling Sequence	**Type of Compactor**		**No. of Coverages**	
	Option No. 1	**Option No. 2**	**Option No. 1**	**Option No. 2**
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2- 4*
Finish	Static Steel	Static Steel	1-3	1-3
* Based on the roller pattern which exhibits the best performance.				

The Contractor shall select the option for compaction and, when pneumatic-tired compactors are used will designate the tire pressure. Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F. Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

326.10.5.2 Pavement Greater than 1-1/2 Inches in Nominal Thickness:

Achieving the required compaction is the responsibility of the contractor. The number and types of rollers is the contractor's responsibility and shall be sufficient to meet these requirements.

In-place air voids shall be determined in accordance with AASHTO T-269 utilizing cores taken from the finished pavement. The maximum theoretical density used in the determination of in-place air voids will be the average value from the acceptance samples determined for the lot as outlined in 326.10.1.

The Engineer will designate one random test location for each sublot and the acceptance laboratory will obtain one core from that location. Regardless of sublot quantities or boundaries, a minimum of one core will be obtained per residential street and a minimum of one core per travel lane for collector and arterial streets. The outside one foot of each pass of the pavement course or any unconfined edge will be excluded from testing. The Engineer may exclude areas from the compaction lot that are not accessible by normal compaction equipment. All coring shall be in accordance with Section 321.14.

The Contractor shall provide the traffic control to facilitate any coring operations necessary for compaction acceptance.

Cores will be taken per the Asphalt Concrete Coring Method. This method can be found in Section 321.14. Acceptance testing results will be furnished to the contractor within five working days of receipt of samples by the acceptance laboratory.

If the pavement density has in-place voids of between 4.0% and 8.0%, the asphalt concrete will be paid for at the contract unit price. If the acceptance core for a sublot indicates that the pavement density has in-place voids of less than 4.0% or greater than 8.0%, the deficient area will be evaluated by coring two additional locations at maximum intervals of 100 feet from the deficient core. The in-place voids of the original deficient core will be averaged with the in-place voids of the cores taken from 100 feet on each side of it to determine compliance with the acceptance requirements. If the resulting average of the in-place voids is outside the indicated range, then Table 326-8 shall apply to the sublot. If approved by the Engineer, the Contractor may obtain additional cores to assist in formulation of an Engineering Analysis, but the additional cores shall not be used for re-evaluating acceptance. All coring shall be in accordance with Section 321.14.

TABLE 326-8		
PAVEMENT DENSITY PENALTIES		
Limits of In-place Air Voids for design lift thicknesses 1.5 inches and greater	When the contracting agency is the owner Payment Reduction ($ per ton of asphalt concrete)	When the contracting agency is not the owner i.e. permits Corrective Action
Below 3.0%	Removal* or EA	Removal* or EA
3.0% to below 4.0%	$10.00	EA
4.0% to 8.0%	Full Payment	No Corrective Action
Greater than 8.0% to 9.0%	$6.00	EA
Greater than 9.0% to 10.0%	$10.00	EA and Type II Surry Seal
Greater than 10.0%	Removal* or EA	Removal* or EA

NOTES: *The Contractor shall remove and replace the entire sublot that is deficient.
EA = Engineering Analysis per Section 326.10.6

326.10.6 Engineering Analysis (EA): Within 10 working days after receiving notice that a lot or sublot of asphalt concrete is deficient and is found to fall within the "Removal or EA" band per Table(s) 326-4, 326-5, and/or 326-8 the contractor may submit a written proposal (Engineering Analysis) to accept the material in place at the applicable penalties along with possible remediation(s) listed in the "Removal or EA" category. Engineering Analysis can also be proposed for non-removal categories of "Corrective Actions" when the contracting agency is not the owner (i.e. permits).

The Engineering Analysis shall contain an analysis of the anticipated performance of the asphalt concrete if left in place. The Engineering Analysis shall also detail the effect of any proposed corrective action to the material(s) in place as it relates to the in-place material's performance. The Engineering Analysis shall be performed by a professional engineer experienced in asphalt concrete testing and mix designs.

If a lot or sublot is accepted for referee testing and the referee test results still show a deficiency, the contractor shall have ten working days to submit an Engineering Analysis beginning upon notification of referee test results.

When an Engineering Analysis recommends that a specific lot or sublot should not be removed, the Engineering Analysis will recommend that the following penalties (Table 326-9) be paid when the contracting agency is the owner, for the specific criteria being reviewed by the EA.

TABLE 326-9		
ENGINEERING ANALYSIS PENALTIES for REMOVAL* LOTS/SUBLOTS LEFT IN-PLACE		
Acceptance Criteria	**Acceptance Limits**	**Penalty When Contracting Agency is the Owner ($/Ton)**
Asphalt Binder Content	Over 0.2% points from that Permitted	$9.00
Laboratory Air Voids (Measured at N_{des} or 75 blows as applicable)	Less than 1.5% or Greater Than 8.0%	$7.50
Limits of In-place Air Voids	Less than 2.7% or Greater than 4.0% from Target	$15.00

Within 15 working days, the Engineer will determine whether or not to accept the contractor's proposed Engineering Analysis.

326.11 REFEREE:

If the Contractor has reason to question the validity of any of the acceptance test results, the Contractor may request that the Engineer consider referee test for final acceptance. Any request for referee testing must describe the contractor's reasons for questioning the validity of the original acceptance test results and must clearly describe which set of acceptance tests are in question. The Engineer may either accept or reject the request for referee testing. When referee testing is accepted the Contractor (at the Contractors own expense) will engage an independent laboratory accredited by the AAP or a laboratory listed in the current ADOT Directory of Approved Materials Testing Laboratories as appropriate the acceptance tests that are being questioned. The independent referee laboratory shall use properly certified technicians in accordance with ASTM D3666, Section 7 (Personnel Qualifications). For the set of test results in question, the referee laboratory shall perform a new set of acceptance tests (as required by Section 326.10 representing the area for the set of tests in question). The referee tests will replace the original acceptance tests that were in question.

These tests may include asphalt binder content, aggregate gradation, Marshall or Gyratory unit weight, maximum theoretical unit weight, laboratory air voids and in-place air voids (compaction). All referee testing shall conform to Section 326.10. Samples for referee testing shall come from representative samples obtained from the completed pavement, as directed by the Engineer.

The number of samples taken will be the same as specified in Section 326.10. The independent laboratory shall compile the test results and transmit them to both the Engineer and the contractor. The independent laboratory shall include a report sealed and signed by an Engineer registered in the State of Arizona, who is experienced in asphalt concrete testing and mix design development. The signed report shall give an opinion that the material evaluated does or does not comply with project specifications, shall clearly describe any deficiencies, and the results will be binding between all parties.

326.12 MEASUREMENT:

Asphalt concrete pavement will be measured by the ton, or by the square yard, for the mixture actually used as allowed above, which shall include the required quantities of mineral aggregates, asphalt binder, and mineral admixture. 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.

Measurement for safety edge preparation only applies to overlays of existing pavements that require the construction of a safety edge when none exists. Safety edge preparation will be measured by the linear foot. Safety edge preparation will not be measured when a safety edge is part of new pavement construction, pavement widening, or when overlaying an existing pavement that contains a safety edge. The asphalt concrete pavement measurement shall include the tonnage used to construct safety edges or the square yard measurement for asphalt concrete pavement will be increased by the horizontal extension of the safety edge beyond the roadway pavement edge.

326.13 PAYMENT:

The asphalt concrete measured as provided above will be paid for at the contract price per ton or square yard, as adjusted per Section 326.10, which price shall be full compensation for the item complete, as herein described and specified.

Payment for tack coat will be by the ton diluted, based on the rate of application, as directed by the Engineer.

No payment will be made for any overrun in quantity of asphalt concrete in excess of 10 percent for newly constructed pavement having a total thickness equal to or greater than 2.5 inches. The overrun quantity is excess tonnage above the tonnage calculated based on actual field measurement of area covered, design thickness, and the mix design unit weight. The calculations for overrun will be by individual pay 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 price.

Removal of raised pavement markers, pavement repairs, and surface pavement replacements required prior to roadway overlay operations will be paid for by other pay items unless otherwise specified. Except as otherwise specified, no separate payment will be made for work necessary to construct thickened edges, safety edges, or other miscellaneous items or surfaces of asphalt concrete.

Payment for safety edge preparation will be at the contract unit price for the quantities measured as described above.

-End of Section-

SECTION 327

HOT IN-PLACE RECYCLING

327.1 DESCRIPTION:

This work shall consist of rehabilitating the surface layer of existing asphalt concrete pavement. Rehabilitation shall be accomplished with specially designed equipment in a simultaneous multistep process of heating, scarifying, applying an asphalt recycling agent and thoroughly remixing and reshaping the old asphalt concrete surface to an average depth of 1", and then placing an overlay of new hot mix asphalt concrete in compliance with the lines, grades, thickness and typical cross-sections shown on the plans (typically 1" to 2"). NOTE: This work shall be performed with a single machine that heats, scarifies, recycles and spreads new asphalt concrete hot mix, all in one continuous pass. Additional preheaters may be utilized to achieve specified depth and temperature.

327.2 MATERIALS:

Asphalt Recycling Agent used to restore the existing pavement shall be approved by the Engineer prior to use. A manufacturer's certification shall be submitted for each load of recycling agent delivered to the project.

Hot Mix Asphalt Concrete (HMAC) shall meet the requirements of Section 710 or Section 717.

327.3 EQUIPMENT:

The Contractor shall specify, in the bid proposal, the type of equipment intended for use. The equipment shall be on the project in operating condition a minimum of 2 days before beginning operations to allow evaluation by the Engineer. The Engineer reserves the right to reject equipment deemed not suitable for the intended purpose, at no additional cost to the Agency.

The recycling equipment shall meet the following minimum requirements:

Repaver: The equipment for this work shall be a self-contained, self-propelled, automated unit capable of heating, scarifying (or milling), mixing, redistributing and leveling the existing asphalt concrete pavement to the specified depth, all in a single pass.

It shall have a means of automatically applying an asphalt recycling agent at a uniform rate as shown on the plans, special provisions, or as requested by the Engineer. It shall be capable of applying a new HMAC layer over the hot, partially compacted recycled mixture.

Heating Unit: This unit shall be hooded to prevent damage to adjacent property, including trees and shrubs. It shall be capable of heating the pavement surface to a temperature high enough (375° - 400° F.) to allow scarification to the required depth without breaking aggregate particles or charring the pavement surface.

Scarifying or Milling Units: The scarifiers or rotary millers shall be able to penetrate the pavement surface to a depth shown, up to a maximum of one inch in one pass. Scarifiers or millers shall be equipped with separate, automatic height adjustments, which allow clearance over manholes and other obstructions.

Recycling Agent Applicator: This system shall automatically add recycling agent to the scarified material at a uniform rate as shown on the plans, special provisions or as requested by the Engineer. The application rate shall be synchronized with the machine's forward speed to maintain a tolerance, within 5% of the specified rate.

Conveying System: Shall consist of a receiving hopper and conveying system to collect and transport new hot mix asphalt concrete material to the finishing unit.

Recycling Unit: A system that mixes, distributes and levels the scarified material over the width processed to produce a uniform cross-section of recycled material.

Finishing Unit: This unit shall have automatic screed controls to produce a surface conforming to that shown on the plans.

The unit shall be capable of producing a uniform slope, grade and texture.

327.4 CONSTRUCTION METHODS:

The contractor shall be responsible to clean 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.

The heating shall be sufficient to soften the pavement to the extent that it can be scarified or milled to the depth specified. Due to the varying properties of the existing asphalt pavement, depth of the scarification material may be varied, if requested by the Engineer. Heating shall be done in a manner that will assure uniform softening and will not char the asphalt.

The Contractor shall be responsible for protecting the area adjacent to the work from heat damage. If damage occurs, the Contractor shall replace all damaged areas, landscape, curb, parked vehicles, etc. at no cost to the Agency.

To provide a welded longitudinal joint, the standing edge of the adjoining asphalt pavement shall be fully heated to a width at least 2 inches beyond the width to be scarified and recycled.

Immediately following heating, the pavement surface shall be scarified (or milled) to the specified depth. The scarified material shall have a temperature between 225° F and 265° F unless otherwise requested by the Engineer. The material shall be leveled, mixed and treated with a recycling agent. The application rate shall be as shown on the plans, special provisions or as requested by the Engineer. Application rate for the recycling agent may be adjusted as necessary to maintain a uniform mixture.

The reclaimed material shall be gathered by a leveling device and spread to a uniform depth over the width being processed. After it is placed and while it still has a residual temperature of at least 190° F, a layer of new HMAC conforming to the job mix formula shall be placed over it. The application rate of new material shall be sufficient to provide the required pavement thickness.

Construction, compaction and smoothness of the surface shall be in accordance with Section 321 except as modified in this Section.

327.5 WEATHER CONDITIONS:

This work shall not be done when it is raining or if 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 reaches 55° F. and falling.

327.6 AIR QUALITY:

The equipment and process shall meet all Arizona Department of Environmental Quality (ADEQ) and County air quality regulations and the Contractor shall have the appropriate ADEQ air quality control permit prior to the issuance of the notice to proceed.

327.7 MEASUREMENT:

Pavement Recycling will be measured by the square yard completed and accepted. Recycling Agent will measure by the gallon of actual material used in place. Hot Mix Asphalt Concrete (HMAC) will be measured by the ton in place.

327.8 PAYMENT:

The accepted quantities of pavement recycling will be paid at the contract unit price per square yard. Payment shall include cleaning the existing pavement surface and heating, scarifying, redistributing, leveling and compacting HMAC pavement. Asphalt Recycling Agent will be paid for by the gallon used in place. Hot Mix Asphalt concrete (HMAC) will be paid for by the ton in place.

- End of Section -

SECTION 329

TACK COAT

329.1 DESCRIPTION:

Tack coat for bituminous paved surfaces shall consist of the application of emulsified asphalt as specified in Section 713.

329.2 PREPARATION OF SURFACE:

Surfaces to be treated shall be cleaned of all loose material as specified in Section 330.

329.3 APPLICATION:

Tack coat shall be diluted in the proportion of 50 percent water and 50 percent emulsion and applied at the rate of 0.05 to 0.10 gallons per square yard. Application shall be made in advance of subsequent construction as ordered by the Engineer.

329.4 EQUIPMENT:

Tack coat shall be applied by distributor trucks designed, equipped, maintained and operated in accordance with Section 330. Hand spray by means of hose or bar through a gear pump or air tank shall be acceptable for resurface work, corners or tacking of vertical edges. Care shall be taken to provide uniform coverage. Equipment that performs unsatisfactory shall be removed from the job.

329.5 PROTECTION FOR ADJACENT PROPERTY:

According to Section 333.

329.6 MEASUREMENT:

Bituminous emulsion that is diluted prior to application will be measured by the ton of diluted material. Any conversion from volumetric quantities shall be in accordance with Section 713.

329.7 PAYMENT:

Payment for the emulsified bituminous tack coat will be by the ton, diluted.

- End of Section -

SECTION 330

ASPHALT CHIP SEAL

330.1 DESCRIPTION:

This work shall consist of the application of a bituminous material followed by the application of a cover material.

330.2 MATERIALS:

330.2.1 Asphalt: The type of grade of the bituminous material will be specified in the contract documents.

Paving grade asphalt shall meet the requirements to Section 711.

Liquid Grade asphalt shall meet the requirements of Section 712.

Emulsified asphalt shall meet the requirements of Section 713.

330.2.2 Aggregate: The cover material (chips) shall meet the requirements of Section 716. Gradation of the chips shall be as specified in Table 716-1 or Table 716-2.

330.3 TIME OF APPLICATION AND WEATHER CONDITIONS:

Chip seal shall not be applied for at least 7 days after completion of new bituminous paving.

The chip seal shall be placed only when the roadway surface is dry and there is no imminent threat of rain. The ambient temperature must be at least 60°F. and rising.

Caution should be exercised in the placement of asphalt chip seal between the dates of Oct. 1 and April 1.

330.4 CONSTRUCTION METHODS:

330.4.1 Preparation of surfaces: Immediately before applying the bituminous material, the area to be surfaced shall be cleaned of dirt and other objectionable material. In urban areas, the surface shall be cleaned with a self-propelled pickup sweeper. In rural areas, power brooms may be used. When necessary, cleaning shall be supplemented by hand brooms.

The bituminous material shall not be applied until an inspection of the surface has been made by the Engineer and he has determined that it is suitable.

For chip seals using paving grade asphalt as the binder, a bituminous tack coat shall be applied prior to sealing. The tack coat shall comply with Section 329. The exact rate shall be determined by the Engineer.

330.4.2 Application of Bituminous Material: The bituminous material shall be applied as soon as possible after preparation of surfaces. At the time of application, temperatures of the asphalt shall be within the ranges specified in Table 330-1 and Table 330-2 or in Sections 711, 712 and 713 for each specified asphalt type. The Engineer may require a specific temperature within the ranges.

The quantity of liquid or emulsified asphalts will be between the range of 0.20 and 0.40 gals./sq. yd. The quantity of paving grade asphalt will be between the range of 0.17 and 0.31 gals./sq. yd. The exact rate of application will be determined by the Engineer.

The bituminous material shall be placed using a distributor as specified in Section 330. Application methods shall insure that a uniform distribution is obtained over the area to be sealed.

The chips shall be spread before the bituminous material sets. The maximum distance that the bituminous material is applied in advance of the chips will be determined by the Engineer.

TABLE 330-1		
APPLICATION TEMPERATURES OF LIQUID ASPHALTS		
All types of Liquid Asphalt	Distributor Application Temperature, Degree F.	
	Min.	Max.
70	105	175
250	140	225
800	175	255
3000	215	290

TABLE 330-2		
APPLICATION TEMPERATURE OF EMULSIFIED ASPHALTS		
Grade of Emulsified Asphalts	Distributor Application Temperature, Degree F.	
	Min.	Max.
RS-1, CRS-1, CRS-1h	75	140
RS-2, CRS-2, CRS-2h	125	185
SS-1, CSS-1	75	130
SS-1h, CSS-1h	75	130

The surfaces of structures, trees and shrubbery adjacent to the areas being seal coated shall be protected in such manner as to prevent their being spattered with bituminous material or marred. The Contractor shall be responsible for all damage to such structures or landscaping.

330.4.3 Application of Cover Material: Immediately following the application of the bituminous material, the chips shall be spread with a self-propelled mechanical spreader. The chip spreading equipment shall be capable of applying a uniform application of cover material. The self-propelled requirement may be waived for projects under 10,000 sq. yds.

At the time of application, precoated aggregate shall be within the temperature range of 250 degrees F. and 350 degrees F. measured at a point 6 to 12 inches below the top of the load.

At the time of application, uncoated chips shall not contain moisture in excess of a saturated, surface dry condition when liquid or paving grade asphalt are used as the seal coat binder.

At the time of application, chips shall be surface wet but free from running water when emulsified asphalt is used as the seal coat binder.

The precise application rate for cover material will be determined by the Engineer within the ranges of 15 to 25 pounds per square yard for the 1/4 in. size and 20 to 30 pounds per square yard for the 3/8 in. size.

When so directed by the Engineer and within 48 hours after application of the precoated chips, all chipped surfaces on major streets shall receive a flush coat in accordance to Section 333. The exact rate of application shall be as directed by the Engineer.

330.4.4 Rolling: Immediately following the application of the cover material, the surface shall be rolled with self-propelled pneumatic-tired rollers. Three coverages shall be made with a pneumatic roller. Each roller shall carry a minimum of 2,000 pounds on each wheel and a minimum of 60 psi in each tire. The roller shall not travel in excess of 12 miles per hour. A minimum of three (3) self-propelled pneumatic rollers shall be required for projects over 10,000 sq. yds. On projects under 10,000 sq. yds. one roller may be used provided it performs the same number of coverages.

330.4.5 Joints: All joints shall be constructed as approved by the Engineer such that there will be a uniform application of cover material and bituminous material.

330.4.6 Surplus Aggregate Removal: Surplus aggregate shall be removed from the surface using methods specified in Subsection 330.4.1 and stockpiled in the location indicated on the plans or as directed by the Engineer. In no event shall surplus aggregate be left on the pavement for more than one day (24 hours).

330.4.7 Distributing Equipment: Distributor trucks shall be of the pressure type with insulated tanks. Gravity distributors will not be permitted.

Spray bars and extensions shall be of the full circulating type. The spray bar shall be adjustable to permit varying height above the surface to be treated.

The nozzle spacings, center to center, shall not exceed 6 inches. The valves shall be operated so that one or all valves may be quickly opened or closed in one operation. The valves, which control the flow from the 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, rapid determination and control of the amount of bituminous material being applied. The distributor shall be equipped with a tachometer of the auxiliary wheel type registering speed in feet per minute. The distributor shall also be equipped with pressure gauges and an accurate thermometer for determination of the temperature of bituminous material. The spreading equipment shall be designed so that uniform application of a bituminous material can be applied in controlled amounts ranging from 0.05 to 2.0 gallons per square yard. Transverse variation rate shall not exceed ten (10) percent of the specified application rate. The distributor shall be equipped with a hose and nozzle attachment to be used for spotting skipped areas and areas inaccessible to the distributor. Distributor and booster tanks shall be maintained as to prevent dripping of bituminous material from any part of the equipment.

Equipment that fails to perform satisfactorily shall be removed from the job.

330.5 TRAFFIC:

Traffic will not be permitted on the surface until the cover aggregate has set. Traffic control shall be in accordance with Section 401 as supplemented by the Contracting Agency.

When using paving grade or liquid grade asphalt chip seal, the speed limit must be maintained at 25 mph for all equipment and traffic until the cover material is swept.

When using emulsified asphalt chip seals, only emergency or local access traffic will be allowed until the seal coat has had time to set.

330.6 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 the next day.

330.7 PAYMENT:

Quantities of materials for this work will be paid for at the contract unit price.

(A) Asphalt Cement, Liquid Asphalt, Emulsion, Diluted Emulsion	Ton
(B) Chips	Ton

There will be no payment for materials not placed in accordance with this specification.

- End of Section -

SECTION 331

PLACEMENT AND CONSTRUCTION OF ASPHALT EMULSION MICRO-SURFACING TREATMENTS

331.1 GENERAL:

The work covered by this specification consists of furnishing all labor, equipment, and materials for the application of a "quick traffic solid/polymer micro-surface."

This specification covers the equipment and construction procedures for rut filling and/or resurfacing of existing paved surfaces. The micro-surface shall be a mixture of cationic polymer modified asphalt emulsion, mineral aggregates, mineral filler, water and other additives properly proportioned, mixed and spread on the pavement surface.

331.2 MATERIALS:

The Contractor shall supply all materials necessary for the performance of the work in accordance with the specifications. The asphalt emulsion, aggregate, and mineral filler shall be as specified in Section 714. Materials shall be approved by the Engineer prior to the start of construction. When requested by the Engineer, Certificates of Compliance shall be provided for each delivery of emulsion.

The micro-surface mixture shall conform to the requirements of the contract documents. The mixture shall attain an initial set in not less than three (3) minutes and not more than one (1) hour. In cases where the surface is not critical to be open to traffic, a longer set time may be allowed, however not to exceed twelve (12) hours. The setting time may be adjusted by the addition or removal of approved mineral fillers or chemical agents. The mixture shall be one of three (3) types whose combined aggregates conform to the requirements of Table 714-1. The mixture shall not segregate during or after laydown. The mixture shall produce a skid-resistant surface.

The Contractor shall be responsible for the safety of all materials of which he has taken delivery until they are in place on the road, and shall take all necessary precautions to avoid loss by fire or theft, or damage by water, and shall bear the cost of replacing any such material that is lost, spilled, destroyed or damaged after delivery.

331.2.1 Material Control:

331.2.1.1 Calibration: Each mixing unit to be used in the performance of the work shall be calibrated prior to construction. Calibration data, if done within the calendar year and using the same material, may be used, providing the verification of the aggregate feed correlates to the existing calibration data. The documentation shall include an individual calibration of each material at various settings that can be related to the machine metering devices, and shall be kept on the machine at all times. Individual volume or weight controls for proportioning each material to be added to the mix shall be provided, and shall be accessible to the Engineer. Any component replacement affecting material proportioning requires that the machine be recalibrated. No machine shall be allowed to work on the project until the calibration has been completed and/or accepted by the Engineer.

331.3 PROPORTIONING:

The micro-surface shall be proportioned in accordance with the mix design. Calibrated sign flowmeters shall be provided to measure both the addition of water and additives to the pugmill. Emulsion and cement flow shall be tied directly to aggregate flow. All additive flows shall be calibrated.

Mineral filler shall be used in accordance to the job mix formula to adequately control the mixture. The expected mineral filler range shall be between 0.1% and 2.0% by weight of aggregate.

331.3.1 Performance: The micro-surface mixture shall be proportioned per the mix design to ensure:

(A) Trafficability - the material will permit controlled traffic without damage to the surface within thirty (30) minutes and uncontrolled traffic without damage within three (3) hours minimum.

(B) Prevent development of bleeding, raveling, separation or other distress for seven (7) days after placing the micro-surface.

331.4 SAMPLING AND TESTING:

331.4.1 Material Sampling: A representative sample of the mineral aggregate shall be obtained by Arizona Test Method 105. The mineral aggregate shall be sampled from the stockpile at the contractor's yard or staging area.

A representative sample of the asphalt emulsion shall be obtained according to Arizona Test Method 104. The asphalt emulsion mixture shall be sampled from the storage tank at the Contractor's yard or staging area.

A representative sample of the micro-surfacing mixture shall be taken directly from the non-absorbent protective material used to protect a manhole cover. Sampling locations shall be at the discretion of the Engineer. Once cured and prior to the introduction of traffic, care shall be taken by the Contractor to carefully remove the protective material and to include all material within the sampling area. The Contractor shall provide the sample to the Engineer's representative. The sample shall be transported and stored in such a way as to prevent contamination.

Where sampling from a manhole cover is not feasible, the Engineer shall select a 2 ft. x 2 ft. sampling area prior to mixture placement. This sampling area shall be determined at the discretion of the Engineer. A non-absorbent protective material shall be placed and secured in the same manner as manhole covers. The contractor shall replace the removed sampling area with micro-surfacing mixture to match the placement area.

331.4.2 Quality Control: To account for aggregate bulking, it is the responsibility of the contractor to check stockpile moisture content and to set the machine accordingly.

The aggregate gradation production tolerances specified in Table 714-1 shall be maintained at all times. The gradation of the aggregate stockpile shall not vary by more than the production tolerance from the job mix formula gradation, while also remaining within the specification gradation band. The percentage of aggregate passing any two successive sieves shall not change from one end of the specified range to the other end.

331.4.3 Quality Assurance: Samples for quality assurance shall be taken throughout the project and tested per ASTM D2172 for testing by an AASHTO re:source accredited laboratory as required by the Engineer. The contractor shall be notified immediately if any test fails to meet the specifications. Materials with test results not meeting these specifications shall be corrected. Testing shall be at the expense of the Agency. The material shall meet the requirements specified in Section 714 for the following:

Micro-Surfacing Mixture:
(A) Residual Asphalt Content

Polymer Solid or Latex Modified Emulsions:
(B) Softening Point
(C) Elastic Recovery
(D) Penetration
(E) Ductility
(F) Residue by Evaporation

Aggregate:
(G) Aggregate Gradation
(H) Sand Equivalent

Data obtained from the proportioning devices on the micro-surfacing machine shall be used to determine individual material quantities and application rate.

331.4.4 Mixture Tolerances: Tolerances for the micro-surfacing mixture are as follows:

(A) After the residual asphalt content is determined, a variation ±1% by weight of dry aggregate shall be permitted.
(B) The rate of application shall not vary more than ± 2 lbs./yd² (± 1.1 kg/m²) when the surface texture does not vary significantly.

331.4.5 Inspection: The Contractor shall visually inspect the area(s) prior to placement and identify existing pavement conditions such as excessive rutting, shoving, heaving or any other conditions that will be detrimental to the performance of the micro-surfacing. The Contractor shall provide a report of existing pavement condition to the Engineer. Additional pavement remediation measures will be done at the direction of the Engineer.

A post-placement inspection of the project shall be made 7 to 14 calendar days following placement of the micro-surfacing. Areas exhibiting a non-conformity shall be identified by the Engineer.

331.4.6 Non-Conformity: If any two successive tests on the stockpile aggregate and/or the emulsion fail, the job shall be stopped. If any two successive tests on the mix from the same machine fail, the use of the machine shall be suspended. It shall be the responsibility of the contractor, at their expense, to prove to the Engineer that the problems have been corrected. Any failing laboratory test result shall be retested for validity on the original sample by the Agency. If both samples fail to meet the requirements, the Engineer shall consider the corresponding placement area(s) for corrective action. Corrective action may include patching, seal coating, resurfacing with additional micro-surfacing, extended warranty, removal and replacement of the micro-surfacing, or other remedies considered by the Engineer. The Engineer may consider the material acceptable if the failing area(s) exhibits no signs of distress within thirty (30) days of placement.

Areas that exhibit excessive raveling, bleeding, streaking, lumping, roughness, or unacceptable lines, regardless of the laboratory test results, shall be corrected to the satisfaction of the Engineer, at the expense of the contractor.

Areas that exhibit excessive flushing or other preventable non-conformities, not identified prior to placement of micro-surfacing by the Contractor, shall be corrected to the satisfaction of the Engineer at no additional cost.

331.5 EQUIPMENT:

331.5.1 General: All equipment, tools and machines used in the performance of this work shall be maintained in satisfactory working condition at all times to ensure a high-quality product.

331.5.2 Mixing Equipment: The mixing machine shall be a self-propelled continuous machine or truck mounted mixing machine which shall be able to accurately deliver and proportion the aggregate, mineral filler, water, additive, and polymer solid or latex modified asphalt emulsion to a revolving multi-blade mixer capable of minimum speeds of 200 RPM and discharge the product on a continual flow basis.

The machine shall have sufficient storage capacity for aggregate, polymer solid or latex modified asphalt emulsion, mineral filler, water, and additive to maintain an adequate supply to the proportioning controls.

The mixing machine shall be capable of producing evenly controlled low rates of speed throughout the operation to ensure the micro-surfacing mixture is spread evenly.

331.5.3 Aggregate Feed: The aggregate feed to the mixer shall be equipped with a revolution counter or similar device so the amount of aggregate used may be determined at any time.

331.5.4 Emulsion Pump: The emulsion pump shall be the positive displacement type with a jacketed housing for uniform heating. A revolution counter or similar device shall be fitted so that the amount of emulsion used may be determined at any time.

331.5.5 Fines Feeder: An approved fines feeder is required that shall provide a uniform, positive, accurately metered range specified in Section 714. The fines feeder shall have a counter so the amount of mineral filler can be determined at any time.

331.5.6 Liquid Additive: The mixing machine shall be equipped with a liquid additive system that provides a pre-determined amount of additive to the mixing chamber. This additive system must be equipped with a counter that can determine the amount used at any time.

331.5.7 Water System: The mixing machine shall be equipped with a water system that provides a pre-determined amount of water to the mixing chamber. This water system must be equipped with a counter that can determine the amount used at any time.

331.5.8 Operator Controls: Controls shall allow the operator to sequence and proportion the material per the mix design.

331.5.9 Spray Bars: The mixing machine shall be equipped with a water pressure system that provides a water spray immediately ahead of and outside the spreader box.

331.5.10 Micro-Surface Spreading Equipment: The paving mixture shall be spread uniformly by means of mechanical type laydown box attached to the mixer, equipped with agitation, to spread the materials throughout the box without any dead zones. The paddles shall be designed and operated so all the fresh mix shall be agitated. Flexible seals, front and rear, shall be in contact with the road surface to prevent loss of mixture from the box. The spreader box shall be equipped with devices for controlling the thickness of the spread mixture.

The spreading equipment shall be maintained free from build-up of the mixture on the paddles or side walls. Skips, lumps, or tears shall not be allowed in the finished product.

331. 5.12 Cleaning Equipment: Power brooms, pick-up brooms, water flushing equipment, and hand brooms shall be suitable for cleaning of the existing surface.

331.5.13 Auxiliary Equipment: Suitable surface preparation equipment, traffic control equipment, hand tools, and other support and safety equipment necessary to perform the work shall be provided by the Contractor.

331.6 PREPARATION OF THE SURFACE:

Immediately before applying the micro-surface, the area to be surfaced shall be cleaned of dirt, loose material, and other objectionable materials, including thermoplastic and raised pavement markers. Where existing thermoplastic marking thickness is significant, markings shall only be partially removed and roughened to create a flat surface with the surrounding pavement. In urban areas, the surface shall be cleaned with a self-propelled pick-up sweeper. In rural areas, power brooms may be used. When necessary, cleaning shall be supplemented by hand brooms. Water flushing shall not be permitted in areas where cracks are present in the pavement surface.

Areas exhibiting considerable irregularities like heaving at joints, whether along the edge of pavement or in travel lanes, and rutting should be addressed prior to application. Rut fill, scratch course or micro-milling of the surface, especially at intersections where rutting is present, should be completed to reduce the likelihood of flushing or shoving of the applied micro-surface.

The micro-surface shall not be applied until an inspection of the surface has been made by the Engineer and determined that it is suitable for placement.

331.6.1 Tack Coat: When specified, a tack coat shall be applied in accordance with Section 329 using the same type and grade of asphalt emulsion as specified for the micro-surfacing.

331.6.2 Cracks: When specified, cracks shall be sealed in accordance with the requirements of Section 337.

331.7 APPLICATION:

331.7.1 General: The micro-surface shall be of the desired consistency when deposited in the spreader box and nothing more shall be added to it. The mixing time shall be sufficient to produce a complete and uniform coating of the aggregate and the mixture shall be chuted into the moving spreader box at a sufficient rate to maintain an ample supply across the full width of the strike-off squeegee at all times.

331.7.2 Weather: Micro-surfacing shall not be placed if either the pavement or air temperature is below 50° F and falling, but may be applied if both the air and pavement temperature are at least 45° F and rising. No micro-surfacing shall be applied when there is the possibility of freezing temperatures at the project location within 24 hours after application. The mixture shall not be applied during unsuitable weather.

331.7.3 Protection of Existing Surfaces: The Contractor shall take all necessary precautions to prevent micro-surface or other material used from entering or adhering to steel gratings, valve boxes, manhole covers, bridge or culvert decks, and any other road fixtures. The Contractor shall clean off any such material and leave any steel grating, manholes, etc. in a satisfactory condition, within 24 hours of placement.

331.7.4 Fogging Pavement: The surface shall be pre-wetted by fogging ahead of the spreader box. The rate should be adjusted as dictated by the pavement temperature, surface texture, humidity, and dryness of existing pavement. The fogging shall be accomplished in such a manner that the entire surface is damp with no apparent flowing water or puddles.

331.7.5 Mix Stability: The mix shall possess sufficient stability so that premature breaking of material in the spreader box does not occur. If breaking, hardening, segregation, balling or lumping occurs during the mixing process, the batch will be discarded. The mixture shall be homogeneous during mixing and spreading; it shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate.

331.7.6 Application Rate: The application rates, pounds per square yard of mix specified, are average rates; the surface texture variation throughout the work shall dictate the actual spreading rates. The strike-off squeegee shall be adjusted to provide a micro-surface thickness, which shall completely fill the surface voids and provide an additional thickness not exceeding one and one-half times the largest top-size stone. The requirement of 1-1/2 stone depth does not apply to rut filling operations as these depths vary greatly according to the surface irregularities.

	Type I	**Type II**	**Type III**
Application Rate: Pounds of Aggregate per Square Yard (approx.)	10-15	18-24	24-35

331.7.7 Joints: No excessive build-up or unsightly appearance shall be permitted on longitudinal or transverse joints. A maximum of 4.0 inches overlap shall be permitted on longitudinal joints. The Contractor shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the work. Half passes and odd width passes shall be used in minimal amounts. If half passes are used, they cannot be the last pass on any area. Care shall be taken to ensure straight lines along curbs and shoulders. No runoff shall be permitted on these areas. Construction joints shall be neat in appearance and shall be tapered or feathered to conform to the existing surface. All excess material shall be removed from the surface upon completion of each run.

331.7.8 Scratch or Leveling Course: When project plans require, micro-surfacing material may be used to fill irregularities such as ruts, utility cuts, depressions in the existing surface, etc. Irregularities of 0.5 inches or greater in depth, should be filled independently with a scratch or leveling course. Irregularities that are more than 1.0 inches in depth may require multiple applications to restore the cross-section. When irregularities are less than 0.5 inches a full width scratch course may be applied with the spreader box using a metal or stiff rubber strike-off.

Apply at a sufficient rate to level the pavement surface. The scratch or leveling course may, or may not, meet the suggested application rate specified in Subsection 331.7.6. All scratch and leveling material should cure for at least twenty-four (24) hours before additional material is placed. The scratch and leveling course will be measured and paid as specified in Subsection 331.8.

331.7.8 Handwork: Approved squeegees and lutes shall be used to spread the mixture in areas inaccessible to the spreader box and in other areas where hand spreading may be required. If necessary, the area to be hand worked shall be lightly dampened prior to mix placement. As much as possible, handwork shall exhibit the same finish as that applied by the spreader box.

Care shall be taken to prevent segregation of the mixture due to excessive hand work. Excessive handwork may result in increased raveling of the cured micro-surface.

Large areas requiring handwork should be applied in small sections, allowing sufficient time to place and finish the material without causing segregation or sizeable areas to break.

331.7.9 Protection of the Micro-surface: Adequate means shall be provided by the Contractor to protect the uncured product. Any damage done to the product shall be repaired at the Contractor's expense.

331.7.10 Damage to the Micro-surface: The Contractor's responsibility to replace micro-surface damaged by unexpected rain after spreading shall be limited to the period within four (4) hours of placement of the micro-surface.

331.7.11 Power Broom Sweeping: Within 7 to 14 days following the placement, the entire surface area shall be swept with a power broom to remove any loose material.

331.7.12 Trial Applications: At the discretion of the Engineer, the Contractor shall place a test strip of 1,000 square yards in the area designated by the Engineer for all projects 35,000 square yards and larger. The test section shall be placed using the same equipment and methods as shall be used on the job. The micro-surfacing mixture placed in a test strip shall conform to the design mix with minor variations to obtain set time, pavement bond and a skid resistant texture. If the materials do not meet the requirements for fluidity, non-segregation, or surface texture, adjustments shall be made to the mixture within the allowable production tolerances. Work shall not proceed until approval of mixture and acceptance of a test strip by the Engineer.

331.8 MEASUREMENT:

Quantities and materials for this work shall 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 if specified	Ton (Diluted)
(B) Emulsified asphalt for micro-surfacing	Ton (Undiluted)
(C) Aggregate for micro-surfacing	Ton (Surface Dry)

Micro-milling, edge-milling, removal of thermoplastic markings, crack sealing, and pavement replacement completed as part of surface preparation will be measured and paid as a separate bid item.

331.9 PAYMENT:

The micro-surfacing shall be paid for by the weight of the aggregate and weight of emulsified asphalt, as shown on certified weight tickets from the supplies delivered to the project, less weigh backs and waste material. If crack seal is required, it will be specified and paid for as a separate item. The price shall be full compensation for furnishing, mixing and applying all materials; and for all labor, equipment, tools, design tests, all other surface preparation not excluded in Subsection 331.8 and incidentals necessary to complete the job as specified herein.

- End of Section -

SECTION 332

PLACEMENT AND CONSTRUCTION OF ASPHALT EMULSION SLURRY SEAL TREATMENTS

332.1 GENERAL:

The work covered by this specification consists of furnishing all labor, equipment, and materials necessary to perform all operations required for the application of an asphalt emulsion slurry surface.

This specification covers the equipment and construction procedures resurfacing of existing paved surfaces. The slurry seal shall be a mixture of asphalt emulsion, mineral aggregates, mineral filler, water and other additives properly proportioned, mixed and spread on the pavement surface.

332.2 MATERIALS:

The Contractor shall supply all materials necessary for the performance of the work in accordance with the specifications. The asphalt emulsion material, mineral aggregate and mineral filler shall be as specified in Section 715. Materials shall be approved by the Engineer prior to the start of construction. When requested by the Engineer, Certificates of Compliance shall be provided for each delivery of emulsion.

The slurry seal mixture shall conform to the requirements of the contract documents. The mixture shall attain an initial set in not less than three (3) minutes and not more than one (1) hour. In cases where the surface is not critical to be open to traffic, a longer set time may be allowed, however not to exceed 12 hours. The setting time may be adjusted by the addition or removal of approved mineral fillers or chemical agents. The mixture shall be one of three (3) types whose combined aggregates conform to the requirements of Table 715-1. The mixture shall not segregate during or after laydown. The mixture shall produce a skid-resistant surface.

The Contractor shall be responsible for the safety of all materials of which he has taken delivery until they are in place on the road, and shall take all necessary precautions to avoid loss by fire or theft, or damage by water, and shall bear the cost of replacing any such material that is lost, spilled, destroyed or damaged after delivery.

332.2.1 Material Control:

332.2.1.1 Calibration: Each mixing unit to be used in the performance of the work shall be calibrated prior to construction. Calibration data, if done within the calendar year and using the same material, may be used, providing the verification of the aggregate feed correlates to the existing calibration data. The documentation shall include an individual calibration of each material at various settings that can be related to the machine metering devices, and shall be kept on the machine at all times. Individual volume or weight controls for proportioning each material to be added to the mix shall be provided, and shall be accessible to the Engineer. Any component replacement affecting material proportioning requires that the machine be recalibrated. No machine will be allowed to work on the project until the calibration has been completed and/or accepted by the Engineer.

332.3 PROPORTIONING:

The slurry seal shall be proportioned in accordance with the job mix formula. Calibrated flowmeters shall be provided to measure both the addition of water and additives to the pugmill. Emulsion and cement flow shall be tied directly to aggregate flow. All additive flows shall be calibrated.

Mineral filler shall be used as needed to adequately control the mixture. The expected mineral filler range shall be between 0.0% and 2.0% by weight of aggregate.

332.3.1 Performance: The slurry seal mixture shall be proportioned per the job mix formula to ensure:

(A) Trafficability - the material will permit controlled traffic without damage to the surface within one (1) hour minimum and uncontrolled traffic without damage within three (3) hours minimum.

(B) Prevent development of bleeding, raveling, separation or other distress for seven (7) days after placing the slurry seal.

332.4 SAMPLING AND TESTING:

332.4.1 Material Sampling: A representative sample of the mineral aggregate shall be obtained by Arizona Test Method 105. The mineral aggregate shall be sampled from the stockpile at the contractor's yard or staging area.

A representative sample of the asphalt emulsion shall be obtained according to Arizona Test Method 104. The asphalt emulsion mixture shall be sampled from the storage tank at the contractor's yard or staging area.

A representative sample of the slurry seal mixture shall be taken directly from the non-absorbent protective material used to protect a manhole cover. Sampling locations shall be at the discretion of the Engineer. Once cured and prior to the introduction of traffic, care shall be taken by the Contractor to carefully remove the protective material and to include all material within the sampling area. The Contractor shall provide the sample to the Engineer's representative. The sample shall be transported and stored in such a way as to prevent contamination.

Where sampling from a manhole cover is not feasible, the Engineer shall select a 2 ft. x 2 ft. sampling area prior to mixture placement. This sampling area shall be determined at the discretion of the Engineer. A non-absorbent protective material shall be placed and secured in the same manner as manhole covers. The contractor shall replace the removed sampling area with slurry seal mixture to match the placement area.

332.4.2 Quality Control: To account for aggregate bulking, it is the responsibility of the contractor to check stockpile moisture content and to set the machine accordingly.

The aggregate gradation production tolerances specified in Table 715-1 shall be maintained at all times. The gradation of the aggregate stockpile shall not vary by more than the production tolerance from the job mix formula gradation, while also remaining within the specification gradation band. The percentage of aggregate passing any two successive sieves shall not change from one end of the specified range to the other end.

332.4.3 Quality Assurance: Samples for quality assurance will be taken throughout the project per ASTM D2172 for testing by an AASHTO re:source accredited laboratory as required by the Engineer. The contractor shall be notified immediately if any test fails to meet the specifications. Materials with test results not meeting these specifications shall be corrected. Testing shall be at the expense of the Agency. The material shall meet the requirements specified in Section 715 for the following:

Micro-Surfacing Mixture:
(A) Residual Asphalt Content

Polymer Solid or Latex Modified Emulsions:
(B) Softening Point
(C) Elastic Recovery
(D) Penetration
(E) Ductility
(F) Residue by Evaporation

Non-Modified Emulsions:
(G) Residue by Distillation
(H) Penetration
(I) Ductility

Aggregate:
(J) Aggregate Gradation
(K) Sand Equivalent

Data obtained from the proportioning devices on the slurry seal machine shall be used to determine individual material quantities and application rate.

332.4.4 Mixture Tolerances: Tolerances for the slurry seal mixture are as follows:

(A) After the residual asphalt content is determined, a variation ±1% by weight of dry aggregate will be permitted.
(B) The rate of application shall not vary more than ± 2 lbs./yd² (± 1.1 kg/m²) when the surface texture does not vary significantly.

332.4.5 Inspection: The Contractor shall visually inspect the area(s) prior to placement and identify existing pavement conditions such as excessive rutting, shoving, heaving or any other conditions that will be detrimental to the performance of the slurry seal. The Contractor shall provide a report of existing pavement condition to the Engineer. Additional pavement remediation measures will be done at the direction of the Engineer.

A post-placement inspection of the project shall be made 7 to 14 calendar days following placement of the slurry seal. Areas exhibiting a non-conformity shall be identified by the Engineer.

332.4.6 Non-Conformity: If any two successive tests on the stockpile aggregate and/or the emulsion fail, the job shall be stopped. If any two successive tests on the mix from the same machine fail, the use of the machine shall be suspended. It shall be the responsibility of the contractor, at their expense, to prove to the Engineer that the problems have been corrected. Any failing laboratory test result shall be retested for validity on the original sample by the Agency. If both samples fail to meet the requirements, the Engineer shall consider the corresponding placement area(s) for corrective action. Corrective action may include patching, seal coating, resurfacing with additional micro-surfacing, extended warranty, removal and replacement of the micro-surfacing, or other remedies considered by the Engineer. The Engineer may consider the material acceptable if the failing area(s) exhibits no signs of distress within thirty (30) days of placement.

Areas that exhibit excessive raveling, bleeding, streaking, lumping, roughness, or unacceptable lines, regardless of the laboratory test results, shall be corrected to the satisfaction of the Engineer, at the expense of the contractor.

Areas that exhibit excessive flushing or other preventable non-conformities, not identified prior to placement of slurry seal by the Contractor, shall be corrected to the satisfaction of the Engineer at no additional cost.

332.5 EQUIPMENT:

332.5.1 General: All equipment, tools and machines used in the performance of this work shall be maintained in satisfactory working condition at all times to ensure a high-quality product.

332.5.2 Mixing Equipment: The mixing machine shall be a self-propelled continuous machine or truck mounted mixing machine which shall be able to accurately deliver and proportion the aggregate, mineral filler, water, additive, and polymer solid or latex modified asphalt emulsion to a revolving multi-blade mixer capable of minimum speeds of 200 RPM and discharge the product on a continual flow basis.

The machine shall have sufficient storage capacity for aggregate, polymer solid or latex modified asphalt emulsion, mineral filler, water, and additive to maintain an adequate supply to the proportioning controls.

The mixing machine shall be capable of producing evenly controlled low rates of speed throughout the operation to ensure the slurry seal mixture is spread evenly.

332.5.3 Aggregate Feed: The aggregate feed to the mixer shall be equipped with a revolution counter or similar device so the amount of aggregate used may be determined at any time.

332.5.4 Emulsion Pump: The emulsion pump shall be the positive displacement type with a jacketed housing for uniform heating. A revolution counter or similar device shall be fitted so that the amount of emulsion used may be determined at any time.

332.5.5 Fines Feeder: An approved fines feeder is required that shall provide a uniform, positive, accurately metered range specified in Section 715. The fines feeder shall have a counter so the amount of mineral filler can be determined at any time.

332.5.6 Liquid Additive: The mixing machine shall be equipped with a liquid additive system that provides a pre-determined amount of additive to the mixing chamber. This additive system must be equipped with a counter that can determine the amount used at any time.

332.5.7 Water System: The mixing machine shall be equipped with a water system that provides a pre-determined amount of water to the mixing chamber. This water system must be equipped with a counter that can determine the amount used at any time.

332.5.8 Operator Controls: Controls will allow the operator to sequence and proportion the material per the mix design.

332.5.9 Spray Bars: The mixing machine shall be equipped with a water pressure system that provides a water spray immediately ahead of and outside the spreader box.

332.5.10 Slurry Spreading Equipment: Attached to the mixer machine shall be a mechanical type squeegee spreader 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 to assure uniform spread. There shall be a steering device and a flexible strike-off.

The box shall be kept clean. Build-up of asphalt and aggregate on the box shall not be permitted. Skips, lumps, or tears shall not be allowed in the finished product.

332.5.11 Rollers: The rollers shall be a five (5) ton steel drum or nine (9) ton rubber tire rollers.

332.5.12 Cleaning Equipment: Power brooms, pick-up brooms, air compressors, water flushing equipment, and hand brooms shall be suitable for cleaning of the existing surface.

332.5.13 Auxiliary Equipment: Suitable surface preparation equipment, traffic control equipment, hand tools, and other support and safety equipment necessary to perform the work shall be provided by the Contractor.

332.6 PREPARATION OF THE SURFACE:

Immediately before applying the slurry seal, the area to be surfaced shall be cleaned of dirt, loose material, and other objectionable materials, including thermoplastic and raised pavement markers. Where existing thermoplastic marking thickness is significant, markings shall only be partially removed and roughened to create a flat surface with the surrounding pavement. In urban areas, the surface shall be cleaned with a self-propelled pick-up sweeper. In rural areas, power brooms may be used. When necessary, cleaning shall be supplemented by hand brooms. Water flushing will not be permitted in areas where cracks are present in the pavement surface.

Areas exhibiting considerable irregularities like heaving at joints, whether along the edge of pavement or in travel lanes, and rutting should be addressed prior to application. Micro-milling of the surface, especially at intersections where rutting is present, should be completed to reduce the likelihood of flushing or shoving of the applied slurry seal.

The slurry seal shall not be applied until an inspection of the surface has been made by the Engineer and determined that it is suitable for placement.

332.6.2 Tack Coat: When specified, a tack coat shall be applied in accordance with Section 329 using the same type and grade of asphalt emulsion as specified for the slurry seal.

332.6.3 Cracks: When specified, cracks shall be sealed in accordance with the requirements of Section 337.

332.7 APPLICATION:

332.7.1 General: The slurry seal shall be of the desired consistency when deposited in the spreader box and nothing more shall be added to it. The mixing time shall be sufficient to produce a complete and uniform coating of the aggregate and the mixture shall be chuted into the moving spreader box at a sufficient rate to maintain an ample supply across the full width of the strike-off squeegee at all times.

332.7.2 Weather: Slurry seal shall not be placed if either the pavement or air temperature is below 50° F and falling, but may be applied if both the air and pavement temperature are at least 45° F and rising. No slurry seal shall be applied when there is the possibility of freezing temperatures at the project location within 24 hours after application. The mixture shall not be applied during unsuitable weather.

332.7.3 Protection of Existing Surfaces: The Contractor shall take all necessary precautions to prevent slurry seal or other material used from entering or adhering to gratings, hydrants, valve boxes, manhole covers, bridge or culvert decks, and any other road fixtures. The Contractor shall clean off any such material and leave any grating, manholes, etc. in a satisfactory condition, within 24 hours of placement.

332.7.4 Fogging Pavement: The surface shall be pre-wetted by fogging ahead of the spreader box. The rate should be adjusted as dictated by the pavement temperature, surface texture, humidity, and dryness of existing pavement. The fogging shall be accomplished in such a manner that the entire surface is damp with no apparent flowing water or puddles.

332.7.5 Mix Stability: The mix shall possess sufficient stability so that premature breaking of material in the spreader box does not occur. If breaking, hardening, segregation, balling or lumping occurs during the mixing process, the batch will be discarded. The mixture shall be homogeneous during mixing and spreading; it shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate.

332.7.6 Application Rate: The application rates, pounds per square yard of mix specified, are average rates; the surface texture variation throughout the work will dictate the actual spreading rates. The strike-off squeegee shall be adjusted to provide a slurry seal thickness, which will completely fill the surface voids and provide an additional thickness not exceeding one stone thick based on the largest size stone of the gradation.

	Type I	Type II	Type III
Application Rate: Pounds of Aggregate per Square Yard (approx.)	8-10	12-18	18-25

332.7.7 Joints: No excessive build-up or unsightly appearance shall be permitted on longitudinal or transverse joints. A maximum of 4.0 inches overlap will be permitted on longitudinal joints. The Contractor shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the work. Half passes and odd width passes will be used in minimal amounts. If half passes are used, they cannot be the last pass on any area. Care shall be taken to ensure straight lines along curbs and shoulders. No runoff will be permitted on these areas. Construction joints shall be neat in appearance and shall be tapered or feathered to conform to the existing surface. All excess material shall be removed from the surface upon completion of each run.

332.7.8 Handwork: Approved squeegees and lutes shall be used to spread the mixture in areas inaccessible to the spreader box and in other areas where hand spreading may be required. If necessary, the area to be hand worked shall be lightly dampened prior to mix placement. As much as possible, handwork shall exhibit the same finish as that applied by the spreader box.

Care shall be taken to prevent segregation of the mixture due to excessive hand work. Excessive handwork may result in raveling of the cured slurry seal surface.

Large areas requiring handwork should be applied in small sections, allowing sufficient time to place and finish the material without causing segregation or sizeable areas to break.

332.7.9 Protection of the Slurry Seal Surface: Adequate means shall be provided by the Contractor to protect the uncured product. Any damage done to the product shall be repaired at the Contractor's expense.

332.7.10 Damage to the Slurry Seal: The Contractor's responsibility to replace slurry seal damaged by unexpected rain after spreading shall be limited to the period within four (4) hours of placement of the slurry seal.

332.7.11 Rolling: As soon as the asphalt slurry has been set sufficiently to prevent any material from being picked up.

332.7.12 Power Broom Sweeping: Within 7 to 14 days following the placement, the entire surface area shall be swept with a power broom to remove any loose material.

332.7.13 Trial Applications: At the discretion of the Engineer, the Contractor shall place a test strip of 1,000 square yards in the area designated by the Engineer for all projects 35,000 square yards and larger. The test section shall be placed using the same equipment and methods as will be used on the job. The slurry seal mixture placed in a test strip shall conform to the design mix with minor variations to obtain set time, pavement bond and a skid resistant texture. If the materials do not meet the requirements for fluidity, non-segregation, or surface texture, adjustments shall be made to the mixture within the allowable production tolerances. Work shall not proceed until approval of mixture and acceptance of a test strip by the Engineer.

332.8 MEASUREMENT:

Quantities and 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 if specified	Ton (Diluted)
(B) Emulsified asphalt for slurry	Ton (Undiluted)
(C) Aggregate for slurry	Ton (Surface Dry)

Micro-milling, edge-milling, removal of thermoplastic markings, crack sealing, and pavement replacement completed as part of surface preparation will be measured and paid as a separate bid item.

332.9 PAYMENT:

The slurry seal shall be paid for by the weight of the aggregate and weight of emulsified asphalt, as shown on certified weight tickets from the supplies delivered to the project, less weigh backs and waste material. If crack seal is required, it will be specified and paid for as a separate item. The price shall be full compensation for furnishing, mixing and applying all materials; and for all labor, equipment, tools, design tests, all other surface preparation not excluded in Subsection 332.8 and incidentals necessary to complete the job as specified herein.

- End of Section -

SECTION 333

FOG SEAL COATS

333.1 DESCRIPTION:

Fog seal coats on bituminous paved surfaces shall consist of the application of emulsified asphalt and a sand blotter when necessary.

333.2 TIME OF APPLICATION AND WEATHER CONDITIONS:

Fog seal coats on new pavements shall be applied within 24 hours. This time restriction may be extended by the Engineer.

Emulsified asphalt shall not be applied when the surface is wet or when there is a threat of rain. The ambient temperature shall be at least 50 degrees F. and rising and the application shall cease when the temperature is 55 degrees F. and falling.

333.3 MATERIALS:

333.3.1 Emulsified Asphalt: Unless otherwise specified in the special provisions, emulsified asphalt may be a grade SS-1h, CSS-1h, or CQSH, as specified in Section 713. The emulsified asphalt shall be diluted in proportions of 50% water and 50% emulsified asphalt.

333.3.2 Sand Blotter: The sand shall be as specified in Section 701.3 and shall be graded in accordance with Table 333-1.

TABLE 333-1	
SAND BLOTTER GRADATION	
Sieve Size	**Percentage Passing (by weight)**
3/8 inch	100%
No. 4	90-100%
No. 200	0-12%

333.4 TESTS, TEST REPORTS AND CERTIFICATIONS:

Asphalt emulsion shall meet requirements of Section 713.

Test reports and certifications 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, or pick-up brooms supplemented by hand brooms if necessary. The fog seal 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.

333.6 APPLICATION OF ASPHALT EMULSION:

The diluted material shall be well mixed before application. 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 330.

333.7 SAND BLOTTER:

A sand blotter shall be applied as directed by the Engineer where there is an excess of asphalt emulsion. 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 FOR ADJACENT PROPERTY:

Care shall be taken to prevent the spraying of asphalt emulsion on adjacent pavements, including that portion of the pavement being used for traffic, on structures, guardrails, guideposts, markers, trees, shrubs, and property of all kinds.

333.9 PROTECTION OF TREATED SURFACE:

The treated surface shall be protected by barricades until the asphalt emulsion will not be picked up by traffic.

333.10 PAYMENT:

Payment for asphalt emulsion in place will be by the ton, diluted.

Payment for furnishing and applying sand blotter in place will be paid for by the ton.

- End of Section -

SECTION 334

PRESERVATIVE SEAL FOR ASPHALT CONCRETE

334.1 DESCRIPTION:

The asphalt concrete preservative seal shall be composed of an emulsified asphalt or asphalt rejuvenate, or an asphalt sealant to preserve the asphalt concrete pavement.

Preservative seals are applicable for asphalt pavements as directed on the plans, special provisions, or the Engineer.

334.2 MATERIALS:

The preservative seal shall be one of the following materials as specified by the Engineer:

Type	Description	Material Conformance
1	Rejuvenating emulsion	Section 718.1
2	Petroleum hydrocarbon emulsion	Section 718.1
3	Acrylic polymer emulsion	Section 718.1
4	Polymer modified rejuvenating emulsion (PMRE)	Section 718.1
Other	Diluted asphalt emulsion, CSS-1 or SS-1h	Section 713
Asphalt Surface Sealer	"Filled" asphalt surface sealer	Section 718.3

334.3 CONSTRUCTION METHOD:

The material shall be approved by the Engineer in accordance to this specification. The application rates, dilution and curing shall be directed by the Engineer in accordance with this specification.

The contractor shall be responsible to clean the pavement to be treated free of trash, debris, earth or other deleterious substances present in sufficient quality to not interfere with the work to be performed.

The application rate will be based upon a typical surface condition test site with application rate trials to determine the needed rate. All application rates specified in Section 718 shall be a diluted 50-50 emulsified asphalt and water, except as recommended by the manufacturer for Type 2 and Asphalt Surface Sealer. Any over applied seal will be sanded as directed by the Engineer. Application equipment shall be in accordance with Section 330.

Before opening a treated area to traffic, the surface shall be checked for slipperiness and/or tackiness. If the treated portion of the roadway must be opened to traffic prior to the disappearance of slipperiness and/or tackiness, the surface shall be sanded with a minimum of 1 ½ pounds per square yard or as directed by the Engineer. Sand Blotter shall comply with Section 333.

334.4 MEASUREMENT:

Preservative seal for asphalt concrete will be measured by the gallon or ton applied.

334.5 PAYMENT:

Payment will be made on the basis of the unit price bid in the proposal. Payment shall be full compensation for preservative seal complete and in place.

- End of Section -

SECTION 335

PLACEMENT AND CONSTRUCTION OF HOT ASPHALT-RUBBER SEAL

335.1 DESCRIPTION:

This work shall consist of applying an application of asphalt-rubber binder, a combined mixture of hot paving grade asphalt and crumb rubber modifier. It shall be immediately covered with a cover material.

The work involves furnishing and placing all materials on existing pavement surfaces in accordance with this specification.

335.2 MATERIALS:

The asphalt-rubber binder shall comply with Section 717. Sand Blotter shall comply with Section 333. Cover material shall be precoated and comply with Section 716. Fog seal coats shall comply with Section 333.

335.2.1 Certification and Quality Assurance: Prior to application, the Contractor shall submit certification of compliance to the Engineer at least 7 days prior to application for all materials to be used in the work. For example: Asphalt-rubber binder designs (Section 717), cover material test results (Section 716), sand blotter material (Section 333), fog seal coats (Section 333), and any additional materials used on the project.

335.3 EQUIPMENT:

335.3.1 General: The method and equipment for combining the crumb rubber modifier and hot paving grade asphalt shall be so designed and accessible that the Engineer can readily determine the percentage by weight of each of two materials being incorporated into the mixture.

All equipment shall meet requirements of Section 330 with the following modifications:

(A) Pneumatic-tired rollers: At least three pneumatic-tired rollers shall be used. Each roller shall carry a minimum of 5,000 pounds on each wheel and a minimum of 90 psi in each tire. Rollers shall not travel in excess of 12 mph.

(B) Distributor: The distributor must be equipped with a mechanical mixing device.

335.3.2 Mechanical Pre-Blender: Crumb rubber modifier and the hot paving grade asphalt for the asphalt-rubber binder may be pre-blended prior to introduction of the blend into the distributor.

The mechanical pre-blender shall be equipped with an asphalt totalizing meter in gallons and a flow rate meter in gallons per minute.

335.4 MIXING:

Mixing shall be done in accordance with Section 717. Application shall proceed immediately upon the asphalt-rubber binder requirements being met.

335.5 CONSTRUCTION:

Prior to placing the hot asphalt-rubber binder, soil and other objectionable materials shall be removed from the pavement surface.

The application rate of the hot asphalt-rubber binder shall be 0.55 to 0.70 gallons per square yard or as directed by the Engineer based on field conditions. Material shall be applied at temperatures of 350 degrees F. to 400 degrees F. The application of the cover material shall follow as close as possible behind the distributor truck.

The cover material shall be preheated immediately prior to application and precoated as specified in Section 716 - PRECOATED. The temperature of the precoated chips shall be in accordance with Section 330.

Hot asphalt-rubber binder with hot precoated cover aggregate shall be placed only when the ambient temperature is at least 60 degrees F. and rising, on a dry surface and there is no imminent threat of rain.

The rate of application of the cover material shall be from 18 to 25 pounds per square yard for the Low Volume Chip or 28 to 35 pounds per square yard for the High Volume Chip, or as directed by the Engineer.

The rolling of the cover material shall proceed immediately after application in order to insure maximum embedment of the aggregate. Sufficient rollers shall be used for the initial rolling to cover the width of the aggregate spread with one pass. The first pass shall be made immediately behind the aggregate spreader. If the spreading is stopped for an extended period, the spreader shall be moved ahead or off to the side so that all cover material may be immediately rolled. Three (3) complete passes with rollers shall be made with all rolling completed within one (1) hour after the application of the cover material.

The Contractor shall sweep all joint edges clean of overlapping cover material prior to the adjacent application of asphalt-rubber binder. Transverse joints shall be made by placing building paper over the ends of the previous applications. The joining application shall start on the building paper. Once the application process has progressed beyond the paper, the paper shall be removed and disposed of to the satisfaction of the Engineer. All reasonable precautions shall be taken to avoid skips and overlaps at joints and to protect the surfaces of adjacent structures, trees and shrubs, etc., from being spattered or marred. Correction of any such defects will be required at no additional cost to the Contracting Agency.

Traffic will not be permitted on the surface until after sweeping operations have finished and the cover aggregate has set. Traffic control shall be in accordance with Section 401 as supplemented by the Contracting Agency.

At signalized intersections, an application of 2 to 5 pounds of sand blotter per square yard shall be applied through the intersection and for a distance of 200 feet each way from the near curb returns after rolling and before opening a lane to traffic. Sand Blotter shall meet requirements of Section 333.

After sweeping and prior to striping, a fog seal coat shall be applied to the asphalt-rubber seal consisting of 0.05 to 0.10 gallons per square yard according to Section 333. The application of the fog seal coat may be delayed to facilitate curing or to avoid placement under unfavorable high temperature conditions.

Note: The fog seal coat shall not be applied to the area 200 feet either side of and through signalized intersections.

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 for the next day.

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 used on the project.

(A) Cover Material (Precoated)	Ton
(B) Asphalt Rubber Binder	Ton
(C) Emulsified Asphalt (Fog Seal)	Ton (diluted)
(D) Sand Blotter	Ton (surface dry)

335.7 PAYMENT:

Payment will be full compensation for furnishing and placing all materials specified and used, with no allowance for waste,

and shall include labor, equipment, tools, and incidentals necessary to complete the work as prescribed in the specifications 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.

- End of Section-

SECTION 336

PAVEMENT MATCHING AND SURFACING REPLACEMENT

336.1 DESCRIPTION:

This specification identifies requirements for removing and replacing or widening pavement and replacing other surfacings within public rights-of-way.

Asphalt concrete roadway trench repairs shall be constructed in accordance with Type A, B, or T-Top trench repair of Detail 200-1 and as indicated on the plans or in the special provisions.

Trench repairs for unpaved alleys, roadways, and designated future roadway prism shall be constructed in accordance with Type E trench repair of Detail 200-1.

Trenching into Portland cement concrete pavement, sidewalk, or other concrete flatwork shall require complete joint-to-joint replacement of damaged panels unless an alternative repair is required by contract documents or is authorized in writing by the Engineer.

Surface replacement in the right-of-way not in paved roadways shall be constructed in accordance with Type D trench repair of Detail 200-1 and as indicated on the plans or in the special provisions.

Temporary pavement replacement shall be constructed as required herein.

Asphalt pavements to be matched by construction of new pavements adjacent to or at the ends of a project shall be milled or saw cut in accordance with these specifications and where shown on the plans.

Pavement and surfacing replacement within ADOT 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 device specifically designed for this purpose.

Existing asphalt 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 have tack coat applied to the vertical edges immediately prior to constructing the new abutting asphalt concrete pavement. No extra payment shall be provided for these items and all costs incurred in performing this work shall be incidental to the pavement widening or extension.

The location of longitudinal match points shall depend on the type of asphalt joint being constructed (full depth or offset) and the location of the pavement lane striping to be in place at completion of construction. Full depth longitudinal joints shall be located within one foot of a post construction lane line stripe or within the center two feet of a post construction travel lane. The location restriction for full depth longitudinal joints does not apply to multi-layer pavements when a vertically offset joint with the existing pavement is constructed. An acceptable offset joint shall have at least a six-inch horizontal offset with the nearest joint in the underlying asphalt layer. An offset joint may be obtained by edge milling to a depth that meets the minimum lift thickness identified in Section 710 for the asphalt surface course to be placed.

The exact point of matching, termination, and overlay may be adjusted in the field by the Engineer or designated representative.

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.

In lieu of cutting 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.

When installations are within the street pavement and essentially parallel to the centerline of the street, the Contractor, with approval of the Engineer, may elect to bore or tunnel all or a portion of the installation. In such installations, the seal coat requirements, as discussed in Section 336.2.4, will be modified as follows:

(A) If the pavement cuts (bore pits, recovery pits, etc.) are 300 feet or more apart, the bore or tunneled distance will not be considered as part of the open trench and the seal coat will not be required.

(B) If the pavement cuts (bore pits, recovery pits, etc.) are less than 300 feet apart, the distance between the cuts will be considered the same as a trench cut and the distance will be added to any trench cut distances.

Pavement removal limits when replacing existing curb or gutter shall be as follows. For curb or gutter replacement adjacent to a designated bike lane or paved shoulder area wider than three feet, the asphalt pavement removal and replacement shall extend to within 6 inches of the travel lane edge stripe. For curb or gutter replacement when no travel lane edge stripe exists, the asphalt pavement match point shall extend two feet or less from the pavement edge into the vehicle travel lane.

Asphalt pavement damaged by the Contractor during trenching or other activities shall be removed after adjacent aggregate base has been placed and compacted and prior to placement of the adjacent permanent pavement. The replacement of the damage asphalt pavement shall occur at the same time as the permanent pavement replacement is constructed.

336.2.3 Temporary Pavement Replacement: Temporary pavement replacement, as required in Section 601, may be with cold-mix asphalt concrete, with a minimum thickness of 2 inches, using aggregate grading in accordance with Marshall mix design of Section 710. Permanent pavement replacement shall replace temporary repairs within 5 working days after completion of temporary work.

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 flush with the adjacent pavement.

336.2.4 Permanent Pavement Replacement and Adjustments:

336.2.4.1 Permanent Asphalt Pavement Replacement: All asphalt pavement replacement shall match gradation and thickness of the existing pavement. Immediately preceding the placement of permanent pavement the density of the base material shall comply with requirements of Table 601-2. Asphalt concrete pavement shall be compacted to the same density specified in Section 321. The compacted thickness of all courses shall conform to the recommended thicknesses of Table 710-1.

Unless otherwise noted, asphalt concrete pavement replacement shall comply with the following:

(A) Single course pavement replacement shall consist of a 1/2” or 3/4” mix in accordance with Section 710.

(B) The base course(s) of a multi-course pavement replacement shall consist of a 3/4" mix in accordance with Section 710.
(C) The surface course of a multi-course pavement replacement shall consist of a 3/8" or 1/2" mix in accordance with Section 710 to match the existing surface.

(D) Where the base course is to be placed with non-compactive equipment, it shall be immediately rolled with a pneumatic-tired roller.

(E) Pavement replacement over trenches where the pavement replacement width is 6 feet or more, all courses shall be placed with self-propelled spreading and compacting equipment. When the pavement replacement width is from 6 to 8 feet, self-propelled spreading and compacting equipment shall not be wider than 8 feet.

(F) Placement of the surface course is to be by means that will result in a surface flush with the existing pavement. The pavement replacement surface shall not vary more than 1/4 inch from the lower edge of a straightedge placed across the replacement pavement surface between edges of the existing matched surfaces. When the pavement replacement includes replacement of the roadway crown, the surface smoothness shall comply with requirements of Section 321.

(G) Pavement replacement extending to the edge of asphalt pavement not abutting concrete shall have a safety edge or thickened edge constructed per Detail 201 as deemed appropriate by the local jurisdiction.

For trench cuts, pavement widening, or other partial pavement installations greater than 300 feet in length the entire area shall be slurry seal coated in accordance with Section 332 or as otherwise specified. The 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 and 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 previously, and with approval of the local jurisdiction, the Contractor may deposit with the Street Maintenance Department for credit, a negotiated agreed upon amount. The Street Maintenance Department will incorporate this work into their street maintenance program.

336.2.4.2 Adjustments: When new or existing manholes, valves, survey monuments, clean outs, etc. fall within the limits of the permanent pavement replacement as discussed in this Section, the Contractor shall be responsible for adjusting the various items to the new pavement surface.

The Contractor shall coordinate with the Engineer and with representatives of the various utilities regarding the adjustment and inspection of the work. The Contractor shall be responsible for obtaining and complying with all specifications, special requirements, and details for the adjustment of utility company facilities. When adjusting the Agency's utilities, survey monuments, etc., the adjustment will comply with these specifications and details.

The work will be done in compliance with OSHA standards and regulations regarding confined space entry. The Contractor shall remove all material attached to the lids and/or covers including that of prior work. The method of removal shall be approved by the Engineer and/or the Utility Representative.

336.3 TYPES AND LOCATIONS OF TRENCH SURFACE REPLACEMENT:

Trench backfill shall be in place and compacted to the density required in Table 601-2 prior to the placement of the asphalt concrete structural section or other surfacing.

Laying a single course or the base course(s) of the asphalt concrete pavement replacement for trenches shall never be more than 1320 feet behind the ABC placement for the pavement replacement.

Type of surface replacement required for trenches shall be as noted on the plans or special provisions and construction shall be in accordance with Detail 200-1 and 200-2. If a trench repair type is not noted on the plans or specified in the special provisions, the following criteria will govern:

Type A trench repair will be used for all asphalt concrete paved streets where the excavation is essentially longitudinal or parallel to traffic. Full depth longitudinal joints shall not be located within forty-eight inches (48") of an asphalt pavement edge

or within a lane wheel path. The lane wheel path for a traffic lane is the entire lane width except the area within one foot of a traffic lane line stripe and except the center two feet of the lane. The lane wheel path for a designated bike lane is the entire lane width except the area within six inches (6") of a bike lane edge stripe. When the surface match point is located within 48" of an asphalt pavement edge, all asphalt surfacing shall be removed to the asphalt edge, the replacement surfacing shall extend to the asphalt edge. The traffic lane wheel path restrictions for full depth longitudinal joints do not apply for offset joints that provide at least a six-inch horizontal offset between the surface course joint and the joint in the underlying asphalt layer. The depth of the asphalt surface course shall be equal to or greater than the minimum thickness recommended in Table 710-1.

T-Top trench repair will be used where the excavation is essentially transverse or not parallel to traffic, including trenches that go through an intersection.

Type B trench repair shall only be used when specified by the local jurisdiction.

Type D trench repair will be used to repair surfaces other than asphalt concrete or Portland cement concrete pavement. The surface replacement shall be of a like type and depth as the existing material, compacted to the densities required in Section 601.

Where a longitudinal trench is partly in pavement, the pavement shall be replaced to a neat straight line located at the outer limits of the existing pavement.

Where asphalt pavement replacement extends to an uncurbed asphalt edge, the agency designated edge treatment shown in Detail 201 (Type A, Type B, or Safety Edge) shall be installed.

Where a trench is in a landscaped or graded area outside of pavement, no special surface treatment is required except as indicated by plans or specifications.

336.4 MEASUREMENT:

Measurement for surface replacement shall be by the square yard, based on actual field measurement of the area covered except as noted below.

(A) In computing pay quantities for surface replacement of Type B trench repair, the default pay width will be based on the dimension calculated from Table 601-1 for the "Maximum Width at Top of Pipe Greater Than O.D. of Barrel." The pay width will be adjusted to the minimum required field width when relocation of the pavement match point is due to the remnant requirement or when pavements less than 4" thick are required to be adjusted outside of a wheel path.

(B) In computing pay quantities for surface replacement of a T-Top or Type A trench repair, the default widths will be based on the dimension calculated from Table 601-1, for the "Maximum Width at Top of Pipe Greater Than O.D. of Barrel" plus 24 inches. The pay width will be adjusted to the minimum required field width when relocation of the pavement match point is due to the remnant requirement or when pavements less than 4" thick are required to be adjusted outside of a wheel path. In all cases, the minimum pay width for T-Top or Type A surface replacement shall be 48 inches.

(C) In computing pay quantities of surface replacement for Type D trench repair, pay widths will be based on the dimension calculated from Table 601-1 for the "Maximum Width at Top of Pipe Greater Than O.D. of Barrel." In all cases, the minimum pay width for Type D surface replacement shall be 48 inches.

(D) Where a longitudinal trench is partly in asphalt pavement, pay quantities shall not exceed actual pavement replacement quantities. The measurement shall be the area as allowed for the respective Type A or Type B trench repair limited to that portion located within the existing pavement. The minimum 48 inch pay width for the Type A pavement replacement does not apply when the trench is partially in pavement.

(E) 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 trench repair width shall be considered and included in the bid item for such structure.

(F) Any pavement replacement in excess of the specified pay widths necessitated by the installation of valves, tapping sleeves and valves, valve bypasses, and concrete thrust blocks shall be included in the bid price for these items.

(G) Measurement of pavement and surfacing replacement shall be made along the finished surface excluding any extra replacement required due to Contractor caused damage. The measured quantity shall be computed to the nearest square yard.

(H) No separate measurement or payment will be made for the required construction of a Detail 201 edge treatment.

336.5 PAYMENT:

Direct payment for pavement or other surface replacement will be made for replacement over all pipe trench cuts except as otherwise noted in the special provisions. Payment for surface replacement over other work shall be included in the cost of constructing that work.

Payment for temporary pavement replacement shall be included in the cost of the pipe.

Payment for pavement replacement shall include the replacement cost of any existing pavement markings that have been degraded, obscured, obliterated or removed.

When a Contractor has the option of jacking and/or boring or open cut construction, and elects to construct a pipeline by the jacking and/or boring method, the Contractor will be paid for the replacement of such items of work as pavement, curb and gutter, sidewalk, driveway, and alley entrances, as allowed for open cut construction.

- End of Section -

SECTION 337

ASPHALT PAVEMENT CRACK SEALING AND CRACK FILLING

337.1 DESCRIPTION:

This work consists of furnishing and placing sealant or filler material in Contractor prepared cracks and joints of asphalt concrete pavements. All cracks and joints, including the space between asphalt concrete pavement and concrete curb and gutter, which have a clear opening of one-quarter inch (¼") or greater, shall be sealed for the length of the crack that equals or exceeds one-eighth inch (⅛") in width.

337.2 MATERIALS:

337.2.1 Material for Category 1 Cracks: Cracks and joints, which have a clear opening ranging from one-quarter inch (¼") to one and one-half inches (1½"), shall be classified as category 1 cracks. Sealant materials for category 1 cracks shall be a premixed, single component mixture of asphalt cement, aromatic extender oils, polymers, and granulized rubber in a closely controlled manufacturing process. Materials shall conform to the following specifications when heated in accordance with ASTM D5078 and the manufacturer's maximum safe heating temperature.

TEST	REQUIREMENT
Cone Penetration (ASTM D5329)	20-40
Resilience (ASTM D5329)	30% Minimum
Softening Point (ASTM D113)	210°F (99°C) Minimum
Ductility, 77°F (25°C) (ASTM D113)	30 cm Minimum
Flexibility (ASTM D3111 *Modified)	Pass at 30°F (-1°C)
Flow 140°F (60°C) (ASTM D5329)	3 mm Maximum
Brookfield Viscosity 380°F (193°C) (ASTM D2669)	90 Poise Maximum
Asphalt Compatibility (ASTM D5329)	Pass
Bitumen Content (ASTM D4)	60% Minimum
Tensile Adhesion (ASTM D5329)	400% Minimum
Maximum Heating Temperature	400°F (204°C)
Minimum Heating Temperature	380°F (193°C)
Flash Point (ASTM D92)	450°F Minimum

*Specimen bent 90° over a 1-inch mandrel within 10 seconds.

337.2.2 Material for Category 2 Cracks: Cracks and joints, which have a clear opening ranging from one and one-half inches (1½") to three inches (3"), shall be classified as category 2 cracks. Filler material for category 2 cracks shall be hot applied, pourable, high bonding mastic for application in unconfined areas and for vertical-side recessed configurations. Upon curing, the material shall provide a flexible waterproof seal. The material shall be traffic ready in thirty minutes or less when installed in accordance with the manufacturer's instructions. Agency approved material shall be used for sealing category 2 cracks.

337.2.3 Material for Category 3 Cracks: Cracks and joints which have a clear opening greater than three inches (>3") shall be classified as category 3 cracks. Material for filling category 3 cracks shall be asphalt concrete 3/8" Marshall mix compliant with Section 710 and have 100% of the aggregate passing the 3/8" sieve.

337.2.4 Product Submittals: Prior to application of category 1 crack sealant and category 2 crack filler material, the Contractor shall submit to the Engineer for approval the material manufacturer's product specifications and installation recommendations. Installation recommendations shall include surface preparation, product installation, and curing requirements. For sealant material, a Certificate of Compliance (per Section 106) shall be submitted to the Engineer. Asphalt mix design for category 3 crack filler material shall be submitted to the Engineer for approval.

Prior to and during production, when requested by the Engineer, the Contractor shall provide material samples to the Engineer for testing to verify the quality of the materials and to ensure conformance with specifications.

337.3 CLEANING AND PREPARING CRACKS OR JOINTS:

Immediately prior to application of sealant, all cracks and joints shall be cleaned of debris and dust. Cracks and joints shall be vacuumed during final cleaning.

337.3.1 Routing: When specified in contract documents, cracks shall be routed to remove loose asphalt edges creating a stable surface for sealant attachment. Routing shall remove at least 1/8" from each side and produce vertical, intact surfaces with no loosely bonded aggregate. Routing of joints and cracks shall produce clean stable edges extending to a depth of at least three quarters of an inch (¾"). Routed surfaces of cracks are subject to acceptance or rejection at the Engineer's discretion.

337.3.2 Vacuuming: Final cleaning shall thoroughly clean cracks and joints to a minimum depth of 1" for cracks that are ¾" or narrower and to the full asphalt depth for cracks that are wider than ¾". Surfaces are to be inspected to assure adequate cleanliness and dryness.

High pressure, 90 psi minimum, dry oil free compressed air shall be used for final cleaning and dust removal from cracks. The high-pressure tool shall be integral with a vacuum unit to collect the dust and residue. Both sides of the crack or joint shall be cleaned.

337.4 APPLICATION OF CRACK SEALANTS AND CRACK FILLERS:

337.4.1 Weather: In no case shall crack sealant or fillers be placed during damp roadway conditions such as wet roadway surfaces or with damp material inside the cracks. Operations stopped by the Engineer due to weather, shall be at no additional cost to the contracting Agency. If installing at night, ensure that dew is not forming on the pavement surface.

Sealant and filler material shall only be applied when pavement temperature exceeds 40°F (4°C). If pavement temperature is lower than 40°F (4°C), it may be warmed using a heat lance that puts no direct flame on the pavement.

337.4.2 Temperature: Sealant and category 2 filler material temperatures are to be maintained at the maximum heating temperature recommended by the manufacturer.

337.4.3 Sealant Equipment: The melter applicator unit shall be a self-contained double boiler device with the transmittal of heat through heat transfer oil. It shall be equipped with an on board automatic heat controlling device to permit the attainment of a predetermined temperature, and then maintain that temperature as long as required. The unit shall also have a means to vigorously and continuously agitate the sealant to meet the requirements of Appendix X1.1 of ASTM D6690. The sealant shall be applied to the pavement under pressure supplied by a gear pump with a hose and wand and direct connecting applicator tip. The pump shall have sufficient pressure to apply designated sealant at a rate of at least three (3) gallons (11.4 L) per minute. Melter applicators shall be approved for use by the sealant manufacturer.

337.4.4 Placement of Sealant and Crack Filler Materials: Sealant and crack filler materials shall be applied in cracks and joints uniformly from bottom to top and shall be filled without formation of entrapped air or voids.

Sealant placement in cracks and joints shall slightly overfill the crack or joint then be leveled with a 3" sealing disk or V-shaped squeegee to create a neat band extending approximately 1" on each side of the crack or joint for surface waterproofing. The band shall be as thin as possible and shall not extend more than 1/8-inch above the pavement surface. If the pavement is to be overlaid with hot mix asphalt within six months of sealant application, sealant placement shall be recessed ¼" in the crack with no over band.

Application of category 2 crack filler material shall comply with the material manufacturer's installation recommendations including but not limited to surface preparation, application equipment, and application procedures. No filler material shall be installed until all cracks to be filled have been inspected and approved by the Engineer.

All machines, tools, and equipment for installation of category 3 crack filler shall be subject to the Engineer's approval. Prior to application of category 3 crack filler, the prepared crack shall be inspected and approved by the Engineer. Tack coat shall be applied to both sides of the crack. Hand tamp, vibratory plate compactor and rollers are acceptable for final compaction of filler material. Depending on depth of crack, lower lifts shall be compacted using a steel rod with a 1½" diameter head.

During and after placement of sealant and crack filler materials, the Contractor shall protect against harm to persons or animals that may be exposed to the hot material.

337.4.5 Opening to Traffic: Sealant and mastic materials shall not be exposed to traffic until fully cured. If the area must be opened to traffic, blotter material shall be applied to the surface of all uncured material.

All sealant filled cracks that have a clear opening of 1½ inches or greater shall have blotter material applied prior to opening to traffic.

On two lane roads or where traffic may come in contact with hot sealant or mastic before it cures, a blotter or specialized bond breaking material shall be used to prevent asphalt bleeding and/or pickup of material by vehicular traffic. Blotter material shall be compatible with the crack sealant or mastic and any surface treatment being used.

337.5 UNACCEPTABLE WORK:

The Contractor, at no additional cost to the contracting Agency, shall correct unacceptable work.

Unacceptable work shall include, but not be limited to, unsealed or unfilled cracks, material wastage on the sides of the roadway, and excess quantities of material on the roadway that adversely affects driving.

The Contractor shall not progress to a new area until the unacceptable work is corrected to the satisfaction of the Engineer. Correction of unacceptable work shall be accomplished within five working days after notification from the Engineer of the unacceptable work.

337.6 MEASUREMENT:

The Contractor shall meet with the Engineer or the Engineer's designated representative on a daily basis and supply a signed daily report indicating the date and identifying for each road segment:

- The linear feet of crack routing performed.
- The amount of category 1 crack sealing material applied in total pounds and the total square yards of pavement sealed.
- The amount in pounds of category 2 crack filling material installed.
- The linear feet of category 3 cracks filled.

Crack routing will be measured by the linear foot. The measurement length will be the length of routed crack, not the length of each routed side.

Measurement for payment of category 1 crack sealing will be by the square yards of pavement surface area crack sealed or by the pounds of sealant placed.

Category 2 crack filling will be measured by the pounds of filler material placed or as otherwise indicated in the fee proposal.

Category 3 crack filling will be the measured linear feet of cracks filled.

337.7 PAYMENT:

Payment for accepted pavement crack routing, sealing, and crack filling will be at the contracted unit prices. Payment shall be full compensation for furnishing all labor, materials, equipment, tools, and incidentals used for surface preparation, placement of materials, and cleanup.

- ***End of Section*** -

SECTION 340

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

340.1 DESCRIPTION:

The various types of concrete curb, gutter, sidewalk, curb ramps, driveways and alley entrances shall be constructed to the dimensions indicated on the plans and standard detail drawings.

340.2 MATERIALS:

Concrete shall conform to the requirements of Section 725. Concrete class shall be as noted on the standard details.

Expansion joint filler shall be ½-inch thick preformed bituminous material in compliance with Section 729, unless otherwise noted.

340.2.1 Detectable Warnings: Detectable warnings shall consist of raised truncated domes aligned in a square grid pattern in conformity to the Americans with Disabilities Act Accessibilities Guidelines (ADAAG). Truncated domes shall have the following nominal dimensions: base diameter of 1.0 inches (0.9 inches minimum) top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and height of 0.2 inches. Dome center-to-center spacing of 2.35 inches, measured between the most adjacent domes on the square grid. Dome center-to-center spacing for radial installations shall be 1.6 inches minimum and 2.4 inches maximum with a base-to-base spacing of 0.65 inches minimum. Detectable warning panels shall be installed with the dome spacing and alignment maintained across adjoining panels.

Detectable warnings shall contrast visually with adjoining surfaces, either light-on-dark or dark-on-light. Specific colors to be used shall be approved by the local jurisdictional agency prior to installation. Detectable warnings shall have integral color throughout.

Detectable warning materials shall be durable with a non-slip surface not subject to spalling, chipping, delamination, or separation. All detectable warnings shall be approved by the local jurisdictional agency prior to installation.

Detectable warnings shall be either placed in freshly poured concrete (wet-set) or recessed into pre-formed concrete. Detectable warnings using wet-set placement shall have the bottom of the detectable warning continuously supported by the underlying concrete with no air voids. Detectable warnings placed into pre-formed recesses in the concrete shall have a firm fit without gaps along the edges, and be able to resist movement (i.e. sliding, rocking, or lifting) once in place.

340.3 CONSTRUCTION METHODS:

Existing concrete shall have a clean vertical edge where it is to be joined by new construction. Sawcutting is required when the existing matching edge is not a straight vertical edge.

340.3.1 Subgrade Preparation: 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. Removal and replacement of soft or unsuitable materials will be paid for as extra work.

Subgrade classified as marginally expansive or expansive as defined in Table 340-1 shall be treated as follows unless the construction documents require alternative measures for mitigation of expansive soils. The upper 6 inches of marginally expansive soils shall be compacted per Section 301.3 at a moisture content between 0% to 3% above optimum moisture per ASTM D698. Expansive soils shall be considered unsuitable and shall be treated or removed and replaced with material as directed by the Engineer. Alternate corrective measures contained in an existing geotechnical report or new site analysis can be submitted to the Engineer for approval. The submittal of alternative corrective measures must be a recommendation of an Arizona registered engineer and have the professional seal affixed.

Table 340-1			
Description	Percent Fines (– #200 sieve) (1)	Plasticity Index (2)	Additional Testing
Non-expansive	> 20%	≤ 15	None
Potentially expansive		> 15	Perform Swell Test (3)

Description	% Swell (3)
Non-expansive	< 1
Marginally expansive	1 – 3
Expansive	> 3

(1) Tested in accordance with ASTM C117
(2) Tested in accordance with AASHTO T-90 (wet prep per AASHTO T-146)
(3) Swell Test: Samples for swell tests shall be re-molded in accordance with ARIZ 249 (ADOT Materials Testing Manual) to 95% of maximum dry density at optimum moisture as determined by ASTM D698 and tested for one-dimensional expansion in accordance with the applicable portions of ASTM D4546 applying a surcharge of 144 psf.

Material removed for 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.

340.3.2 Formwork: 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, curb ramps, 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.

340.3.3 Concrete Placement: 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. The surface shall then be struck off and worked to grade and cross-section with a float.

If machine placement is used, the machine shall place, consolidate and finish the concrete in one complete pass, requiring a minimum of hand finishing producing a dense and homogeneous section. A form shall trail behind the machine for such a distance that no appreciable concrete slumping will occur. Final finishing shall be as specified in Section 340.3.7, Form Removal and Finishing.

340.3.4 Joints: Shall be constructed in a straight line, vertical plane and perpendicular to the longitudinal line of the sidewalk, curb and gutter, single curb, etc., except in cases of curved alignment, where they shall be constructed along the radial lines of the curve.

Curb and gutter joints shall match the location of concrete pavement joints when abutting concrete pavement.

The space between joints in curbs and gutters (space between contraction joints or between contraction and expansion joints) shall not exceed ten feet.

Sidewalk that abuts curb or gutter shall have joints that match the curb or gutter joints. The space between sidewalk joints shall not exceed 125% of the sidewalk width (for example: maximum joint spacing for 5 foot wide sidewalk is 6.25 feet).

340.3.4.1 Expansion Joints: Expansion joints shall be constructed to the full depth and width of the concrete. The expansion joint material shall extend fully through the concrete and one inch into the subgrade with the top of the expansion joint material one-quarter inch below the top surface. Expansion joint material shall be secured in place prior to placement of concrete.

Expansion joints shall be installed along all abutting structures to provide complete separation from the structure.

Sidewalk, curb, and gutter expansion joints shall be installed at all radius points, at both sides of each driveway, at both sides of each alley entrance. The maximum distance between expansion joints shall be 50 feet.

340.3.4.2 Contraction Joints: Unless otherwise specified, the large aggregate in contraction joints shall be separated to either side of the joint for a minimum depth equal to 25% of the concrete thickness; the finished depth shall be a minimum of 3/4 inch.

340.3.5 Edges: All exposed edges shall be shaped with a suitable tool to form edges having the shape as indicated on the referenced detail.

340.3.6 Detectable Warnings: Detectable warnings shall be installed perpendicular to the direction of pedestrian/wheelchair travel and have a minimum width of 24 inches measured perpendicular to the edge of the roadway or rail crossing. The base surface of detectable warnings shall be installed flush with the adjacent walkway surface; the truncated domes shall extend above the walkway surface. The boundary between detectable warnings and the adjacent walkway shall provide a flush uniform surface that will not cause ponding of water nor present a tripping hazard. Partial domes at the edge of the detectable warning shall be made flush to match the base surface of the detectable warning. Detectable warnings installed on curb ramps shall extend the full width of the ramp depression.

When detectable warnings are modules inset into the curb ramp, the bottom surface of the sidewalk shall be lowered a distance equal to or greater than the module thickness to maintain the minimum sidewalk thickness. The sidewalk bottom surface shall have a minimum transition taper length of 12” between the thickened and normal depth sections of sidewalk. The detectable warning surface shall be located so that the edge nearest the curb line is 6 inches minimum and 8 inches maximum back from the face of curb.

Detectable warning surfaces for pedestrian at-grade rail crossings not located within a street or highway shall be installed on each side of the rail crossing, located as shown on plans. Detectable warnings shall extend the full width of the pedestrian walkway.

340.3.7 Form Removal and Finishing: The front face form shall not be removed before the concrete has taken 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. Any portion of concrete damaged while stripping forms shall be repaired or replaced at no additional cost to the Contracting Agency.

After the forms are removed, the joints shall be tooled and the surface finished with a float to remove all imperfections. As needed, retool joints after finishing to prevent groove bonding. In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The concrete work shall have a true surface; shall be free from sags, twists, or warps; have a uniform appearance; and be true to the lines, grades, and configurations indicated on the drawings.

Surfaces shall be light broom finished; flow lines shall be troweled for a smooth finish.

If the evaporation rate on the concrete surface exceeds the rate of bleeding of the concrete due to weather conditions, materials used, or for any other reason, and there is any likelihood of the fresh concrete checking or cracking before the curing operation, measures shall be taken to prevent the rapid evaporation of water from the surface during finishing operations. When allowed by the Engineer, the addition of water to the surface may be permitted as an indirect fog spray with approved spray equipment immediately after screeding and/or between finishing operations. A commercial evaporation reducer that forms a monomolecular film may also be sprayed onto the concrete surface in accordance with the manufacturer’s recommendations. At no time will free water/evaporation reducer be worked into the concrete surface. Approved measures shall continue until curing operations per Section 340.3.8, Curing, are started in the particular area affected. The Contractor shall stamp the

company name and year on each end of the sidewalk or curb ramp constructed. The letters shall not be less than 3/4 inch in height and the depth of the stamped impression shall be between 1/8-inch and 1/4-inch.

340.3.8 Curing: As soon after the completion of the finishing operation as the condition of the concrete will permit, all exposed surfaces shall either be sprayed with a pigmented curing compound or sealed with a material conforming to Section 726. Curing compound shall be applied under pressure through a spray nozzle in such manner and quantity as to entirely seal all exposed concrete surfaces with a uniform film. The membrane shall be applied in two applications for a total coverage of 150 square feet per gallon. Concrete surfaces shall be kept damp until the curing compound is applied. Should the curing compound 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 curing compound over the damaged area.

The need for adequate curing is greatest during the first few hours after placement of the concrete.

340.3.9 Tolerances: The face, top, back, and flow line of the curb and gutter shall not deviate in excess of 1/4-inch over 10 feet, as tested with a 10-foot straightedge or curve template, longitudinally along the surface.

The surface of concrete sidewalk or curb ramp shall not deviate in excess of 1/8-inch over 5 feet as tested with a 5-foot straightedge except for the 1/4-inch recess of the preformed material in expansion joints.

All finished concrete widths and alignments shall not deviate from the plans, typical sections or standard details referenced within the construction documents, by more than 1/2 inch.

When required by the Engineer, gutters shall be water tested. The Contractor shall establish flow in the length of gutter to be tested by supplying and distributing water from a hydrant, tank truck or other source. After the supply of water is shut off and water has stopped flowing, the gutter shall be inspected for evidence of ponding. The work shall be deemed deficient if water is found ponded in the gutter to a depth greater than 1/2 inch or ponding extends onto the adjacent asphalt pavement.

Areas between elevations shown on the plans shall be straight graded or smoothly transitioned through a vertical curve in a manner approved by the Engineer or as otherwise indicated on the construction documents.

Slopes of Pedestrian facilities shall not exceed the maximum grades indicated in ADA guidelines: sidewalk cross slope of 2%, ramp slope of 8.33%, ramp and landing cross slope of 2% and flared side (wing) slope of 10%.

340.3.10 Deficiencies: 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. Replacement or reconstruction shall be from joint to joint.

Concrete work that does not comply with requirements of Section 340.3.9, Tolerances, shall be removed and replaced. Remove and replace gutters that exceed the ponding tolerance. Grinding shall only be allowed if approved by the Engineer.

340.4 BACKFILLING:

Unless otherwise specified the Contractor shall backfill behind the curbs, sidewalk or curb ramps with soil native to the area to the lines and grades shown on the plans.

340.5 MEASUREMENT:

340.5.1 Concrete Curbs and Gutters: The various types of curb and gutter shown on the plans and in the proposal will be measured along gutter flow line through inlets, catch basins, driveways, curb ramps, etc., by the lineal foot to the nearest foot for each type, complete in place. Measurement for curb terminations and transitions shall be included with the linear measurement of the various types of curb or curb and gutter as shown on the plans and in the proposal.

Curb and gutter type shall be based on the configuration of the final exposed surfaces. The increased curb and gutter depth required at valley gutter aprons or driveways shall not be measured as a separate pay item; any additional Contractor cost shall be included in the unit cost associated with the valley gutter, driveway or other associated item.

340.5.2 Concrete Flat Work: Sidewalks, driveways, alley intersections, valley gutters and aprons will be measured to the nearest square foot complete in place.

340.5.3 Curb Ramp Installations: Curb ramp installations shall be measured as complete installed units. Curbing (single curb or curb and gutter) located at the edge of roadway shall be measured and paid for separately. The surface area of curb ramps shall not be included in the measured quantity for sidewalk. Detectable warnings are an integral part of curb ramp installations and shall not be measured. Ramp curbs located behind the walkway are an integral part of parallel curb ramp and combination curb ramp installations and shall not be measured.

Unless otherwise indicated by standard details, curb ramps located within a curb return shall include the entire curb return area excluding the edge of roadway curbing. Curb ramp installations shall be categorized and measured by curb return radius, the number (one or two) of curb ramps contained within the return, and the type of curb ramps (perpendicular, parallel, or combination).

Each curb ramp not located within a curb return shall be categorized by type and measured as a complete unit. Perpendicular curb ramps shall include the area from the back of curb between the outer edges of the ramp wings to the top of the curb ramp, ending prior to and excluding the top landing. The landing area at the top of the perpendicular curb ramp is to be included in the measured sidewalk area. Parallel and combination curb ramps shall include the ramp curb and all surfaces between the ramp curb and the back edge of the roadway curbing.

340.6 PAYMENT:

Payment will be made in accordance with the unit prices 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.

Over-excavation of soft, expansive or unsuitable materials and installation of granular materials will be paid separately and not included within the above measured pay items.

- End of Section -

SECTION 342

INTERLOCKING CONCRETE PAVER INSTALLATIONS

342.1 GENERAL:

The Contractor shall furnish all necessary labor, material, tools and equipment to complete the proper installation of interlocking concrete pavers used in medians, crosswalks, intersections and other locations noted in Contract Documents. This includes furnishing a 10-foot straightedge to accomplish the testing required by this specification.

342.2 MATERIALS:

342.2.1 Aggregate Base Course: Aggregate Base Course shall be per Table 702-1.

342.2.2 Portland Cement Concrete: For installations subject to vehicular traffic, Portland cement concrete used for headers or underlying base slabs for pavers shall be Class A per Section 725. At locations not subject to vehicle traffic loads, the Portland cement concrete shall be a minimum of Class B per Section 725.

342.2.3 Sand: Sand used for laying course shall conform to ASTM C33 except for the gradation. The gradation shall comply with Table 342-1.

TABLE 342-1								
SAND GRADATION								
Sieve Size	3/8 inch	No. 4	No. 8	No. 16	No.30	No. 50	No. 100	No. 200
Percent Passing	100	95-100	85-100	15-85	25-60	10-30	2-10	0-1

342.2.4 Concrete Pavers: Pavers shall have a minimum thickness of 80 mm (3.15 inches) when installed in vehicular traffic bearing areas and 60 mm (2.36 inches) when installed in non-traffic bearings areas. Pavers shall be of an interlocking design conforming to ASTM C936. Pavers shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. The Contractor shall submit two samples of each type of pavers used on the project for review and approval by the Engineer prior to any work. The pavers and materials used in their manufacture shall conform to the following:

(A) **Compressive Strength:** Pavers shall have a minimum compressive strength of 8,000 psi in accordance with ASTM C140.

(B) **Absorption:** The average absorption shall not be greater than 5 percent, with no individual unit absorption greater than 7 percent.

(C) **Portland Cement:** Cement shall comply with Section 725.2, Type II.

(D) **Aggregates:** Aggregates shall conform to ASTM C33 (washed, graded sand and rock, no expanded shale or lightweight aggregates).

(E) **Other Constituents:** Coloring pigments shall be applied integrally to the concrete. Air entraining admixtures, coloring pigments, integral water repellents, and finely ground silica shall be previously established as suitable for use in concrete and either shall conform to ASTM standards where applicable, or shall be shown by test or experience not to be detrimental to the concrete.

(F) **Physical Properties:** The size, shape, design and color of the pavers shall be as noted in the Contract Documents.

342.2.5 Expansion Joint Filler: Expansion joint filler material shall be 1/2-inch premolded joint filler that complies with Section 729 and ASTM D1751.

342.2.6 Joint Sealant: Joint sealant shall be elastomeric joint sealant conforming to ASTM C920, Type S, Grade NS, Class 25.

342.3 CONSTRUCTION PROCEDURES:

342.3.1 Subgrade: The subgrade shall be constructed true to grades and lines shown on the plans in compliance with subgrade tolerances and compaction requirements as specified in Section 301.

342.3.2 Aggregate Base Course: When aggregate base course is specified, the aggregate base course shall be constructed true to grades and lines shown on the plans in compliance with grade and cross-section tolerances and compaction requirements of Section 310.

342.3.3 Concrete Header and Base Slab: 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 Portland cement concrete.

The Portland cement concrete shall be thoroughly spaded away from the forms so that there will be no rock pockets next to the forms. Compacted by mechanical vibrators may be used when approved by the Engineer. Tamping or vibrating shall continue until the mortar flushes to the surface, and the coarse aggregate has been tamped below the surface.

All edges shall be shaped with a suitable tool to form a rounded edge of radius as shown on the referenced detail.

The Portland cement concrete header face form shall not be removed before the concrete has taken the initial set and has sufficient strength to carry its own weight. The concrete header outer form shall not be removed until the concrete has hardened sufficiently to prevent any damage to the concrete. Any porting 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 and top of the concrete header shall be tested with a 10-foot straightedge or curve template, longitudinally along the surface. Any deviation in excess of 1/4-inch in 10-feet shall be corrected at no 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 340.

342.3.4 Expansion Joints: Expansion joints in the concrete base slab shall be constructed to the full depth and width of the concrete base slab with the top of the filler material recessed one-half inch below the top surface of the concrete base slab unless otherwise specified. After the concrete is cured, the top one-half inch shall be filled to the surface of the concrete with joint sealant.

Expansion joints in the concrete base slab and header shall be aligned. Joints shall be constructed in a straight line and vertical plane perpendicular to the longitudinal line of the concrete header, except in cases of curved alignment when they shall be constructed along the radial lines of the header. Expansion joints shall be located at 50-foot maximum intervals. Pavers shall be placed continuously over the expansion joints.

342.3.5 Contraction Joints: Contraction joints in the base slab and header shall be aligned. Joints shall be constructed in a straight line and vertical plane perpendicular to the longitudinal line of the concrete header, except in cases of curved alignment when they shall be constructed along the radial lines of the header. Contraction joints in the concrete base slab shall be constructed one-half inch in width to a depth of one inch and located at 10-foot maximum intervals. Contraction joints shall be filled to the top surface of the concrete base slab with joint sealant.

342.3.6 Sand Laying Course: The maximum thickness of the sand course shall be one-inch. Screeding boards shall be used to ensure a uniform thickness. The sand shall not be compacted, walked on or wet down.

342.3.7 Concrete Pavers: The concrete pavers shall be clean and free of foreign materials before installation. Paving work shall be true to line and grade and shall be installed to properly coincide and align with adjacent work and elevations. All edges shall be fixed or retained to secure the perimeter pavers and the sand laying course. The pavers shall be laid in such a manner that the desired pattern is maintained and joints between the pavers are as tight as possible.

The Contractor shall lay the pavers starting from the longest straight line and from a true 90 degrees corner. The pavers shall be installed hand-tight and level on the undisturbed sand course in a manner that eliminates gaps between pavers and between pavers and headers. The maximum gap between pavers shall not exceed 3/16 inch. String lines or other approved methods shall be used to hold all pattern lines true. Gaps between pavers at headers exceeding 3/8-inch shall be filled with pavers cut to fit. Cutting shall be accomplished using a masonry saw. The cut paver shall be placed with the clean surface edge exposed to the traffic (vehicular or pedestrian).

After the pavers are in place, they shall be vibrated into the sand laying course. After vibration, approximately 1/4 inch of clean masonry sand shall be placed over the paver surface, allowed to dry, and vibrated into the joints with additional vibrator passes and brushing so as to completely fill joints. Excess sand shall be swept from the surface.

The finished paver surface shall be tested longitudinally and transverse to the concrete header or curb with a 10-foot straightedge along the surface. Any deviation in excess of 1/8-inch shall be corrected at no additional cost to the Contracting Agency.

Any broken or damaged pavers shall be removed and replaced. Replacement pavers shall be tamped into place and the joints filled with masonry sand as specified herein. The completed installation shall be cleaned of all debris, surplus material and equipment.

342.4 MEASUREMENT:

Concrete paver installations of the various types as shown on the plans will be measured to the nearest square foot. Separate measurements shall be made for areas subject to vehicle traffic and areas not subject to vehicle traffic.

Headers of the various types as shown on the plans will be measured by the linear foot to the nearest foot.

342.5 PAYMENT:

Payment for concrete pavers in areas subject to vehicle traffic will be at the contract unit price set forth in the proposal. Payment shall be full compensation for all labor, materials, tools and equipment required for the subgrade preparation, construction of the concrete base slab, and installation of concrete pavers.

Payment for concrete pavers in areas not subject to vehicle traffic will be at the contract unit price set forth in the proposal. Payment shall be full compensation for all labor, materials, tools and equipment required for the subgrade preparation, installation of aggregate base and concrete pavers.

Payment for each type of header will be at the contract unit price set forth in the proposal. Payment shall be full compensation for all labor, materials, tools and equipment required for the construction complete in place in conformance with the contract documents.

- ***End of Section*** -

SECTION 343

EXPOSED AGGREGATE PAVING

343.1 DESCRIPTION:

Exposed aggregate paving consists of placing a concrete slab with exposed aggregate in the surface of the finished concrete. This exposed aggregate paving is designed for decorative or pedestrian use only. It should not be used in areas subject to vehicular traffic.

343.2 MATERIAL:

343.2.1 Concrete: Concrete shall be Class A per Section 725 with a maximum slump of 3 inches.

343.2.2 Exposed Aggregate: The exposed aggregate shall be uncrushed riverrun rocks. The Contractor shall provide at least a 10-pound sample for approval by the Engineer prior to any aggregate paving.

(A) When the paving is for decorative use only, no pedestrian traffic, the aggregate shall not be larger than 3 inches or smaller than 1 ½ inches.

(B) When the paving is to be used for pedestrian traffic, the aggregate shall be not larger than 2 inches or smaller than 1 inch.

343.3 CONSTRUCTION PROCEDURE:

The Contractor shall construct a sample panel 3 feet by 3 feet for inspection and approval by the Engineer, prior to actual construction. When approved, this panel shall be used as a standard for the remainder of the work.

After the slab has been placed, screeded and darbied, the aggregate shall be hand-scattered so that the entire surface is evenly covered. The surface shall be reworked so that the aggregate will be embedded just beneath the surface. The concrete shall completely surround and lightly cover the aggregate leaving no holes or voids.

A non-staining surface retarder will be applied to provide a surface penetration of at least 1/8-inch and the surface will be lightly screed to ensure penetration. The surface will be covered with a protective material for the period of time recommended by the retarder manufacturer. After this time has elapsed, the upper, retarded layer of concrete will be removed using a water jet stream and a brush. The protective cover will be replaced and the concrete allowed to cure. After curing, the surface shall be cleaned and a silicone seal applied.

343.4 MEASUREMENT AND PAYMENT:

Measurement will be by the square foot. Payment will be made at the unit bid price per square foot. This price shall be full compensation for all labor, material, tools, and equipment required to complete the work.

- ***End of Section*** -

SECTION 345

ADJUSTING FRAMES, COVERS AND VALVE 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.

The Contractor may elect to remove old frames, covers, and valve boxes and then install new frames and/or boxes in accordance with standard detail drawings at no additional cost to the Contracting Agency.

The Contractor shall be responsible for maintaining an accurate description and location of all items to be adjusted. The locations shall be referenced with map documentation by the use of swing ties or GPS locations. This information shall be supplied to the Engineer and utility owner(s) prior to taking any action that would hide or restrict access to the items to be adjusted.

Any missing or defective frames, covers, valve boxes or related hardware shall be reported to the Engineer in writing during the initial location process to allow for timely replacement. The Engineer shall be responsible for providing replacement items to the contractor. The contractor is responsible for providing items required to accomplish the required adjustments such as additional adjusting rings, valve box extensions, meter box extensions, and pull box extensions.

345.2 LOWERING PROCEDURE:

If required, manholes, valve boxes, or survey monuments located within the paved areas to be milled or reconstructed shall be lowered to an elevation that will allow required work to be accomplished without damaging the facilities. Care shall be taken to prevent entrance of any material into the lowered facilities. Lowering shall be to a depth that will prevent damage to the utility during the construction activities.

All manhole frames, valves boxes, survey hand hole frames and related items removed by the contractor during the lowering process shall be maintained in a secure area, and the contractor shall bear full responsibility for the material. Any hardware items lost or damaged by the contractor shall be replaced in kind, at no additional cost to the Contracting Agency.

Preparation for Milling: Temporary asphalt concrete shall be placed over the steel plate filling the excavated area. The temporary pavement shall be maintained until removed during the adjustment to final grade. For manholes located on major streets that are to be kept opened to vehicular traffic, hot mix asphalt shall be used to backfill the excavated areas and compacted flush with the existing pavement prior to opening up to traffic. In residential or low volume streets with minimal traffic, cold mix or other approved product may be used for temporary pavement. No measurement or payment shall be made for temporary pavement placement or removal.

345.3 ADJUSTING FRAMES:

The Contractor shall loosen frames in such a manner that existing monuments, cleanouts, manholes, and valve boxes will not be disturbed or damaged. Debris shields shall be used to prevent debris from entering sanitary or storm sewers. All loose material and debris shall be removed from the excavation and the interiors of structures prior to resetting frames. If dirt or debris enters the sewer system, the contractor shall be responsible for cleaning the sewer system for a minimum of one reach (the next downstream structure from the contamination point.)

Frames shall be set to match finished grade or the elevations and slopes established by the Engineer. Manhole frames shall be firmly blocked in place with masonry or metal supports. Spaces between the frame and the facility shall be sealed on the inside to prevent any concrete from entering the hand hole or manhole. A Class AA concrete collar 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.

Adjustments of utilities, if located within the asphalt pavement, shall be made after placing the final surface course when there is only a single lift of pavement required. When there are multiple lifts of pavement required, adjustments may be made before the final surfacing or as directed by the Engineer.

After removal of the temporary asphalt pavement in the area of adjustment, and prior to placement of the final concrete collar ring (as shown on Details 270 and 422) the asphalt pavement in proximity of the adjustment shall be rolled with a self-propelled steel wheel roller if requested by the Engineer.

345.4 ADJUSTING VALVE BOXES:

Valve boxes shall be adjusted to the new elevations indicated on the plans, or as established by the Engineer.

Adjustable valve boxes shall, if possible, be brought to grade by adjustment of the upper movable section. Any excavated area shall be filled with Class AA 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 AA 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 elevations shall be as described in Subsection 345.2 This adjustment shall be known as Type A.

345.5 ADJUSTING MANHOLE AND VALVE COVERS WITH ADJUSTMENT RINGS:

Adjusting rings may be used to raise manhole covers in asphalt pavements when deemed acceptable by the Engineer. The amount of adjustment, thickness of seal or overlay, and cross slope will be considered when using adjusting rings. Each location where an adjusting ring is used must have a sufficient depth of asphalt to assure the proper installation and operation of the ring. The rings shall be made of a concrete, non-metallic, polypropylene or fiberglass material and installed per the manufacturer's specifications. The rings shall be approved by the Engineer.

The concrete collar ring around the frame or valve box shall be circular, and shall be a minimum of eight (8) inches thick, placed flush with the adjacent new pavement surface. Concrete shall be a minimum of Class AA on all paved streets. All concrete shall be obtained from plants approved by the Engineer.

If required by the Contracting Agencies specifications or details, a single No. 4 rebar hoop will be placed in each adjustment collar. The hoop diameter shall be such that its placement is centered between the edge of the manhole frame or valve box, and the outer edge of the concrete collar, the depth of the hoop shall be centered in the thickness of the collar. Each concrete ring shall be scored radially at quarter-circle points. Score lines shall be ¼ -inch wide by ½ - inch deep. The concrete collar surface shall be rough broom finished. (See Details 270 and 422).

Traffic shall not be allowed on the concrete collars until the concrete had reached a minimum compressive strength of 2500 psi on residential and 3000 psi on collector and major streets. On major streets, the contractor shall use "high-early" in the concrete mix, approved by the Engineer, to minimize delay in reopening the street(s) to traffic.

345.6 MEASUREMENT:

The quantities measured will be the actual number of frames, covers and valve boxes of each type, adjusted and accepted.

345.7 PAYMENT:

Accepted quantities will be paid for at the contract unit price. Payment shall be compensation in full for all materials, labor, equipment and incidentals necessary to complete the work.

- End of Section -

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, conduits, curbs and gutters, and other items necessary for the accomplishment of the improvement.

350.2 CONSTRUCTION METHODS:

350.2.1 Utilities: The removal of existing improvements shall be conducted in such a manner as not to injure active utilities or any portion of the improvement that is to remain in place.

A utility may be abandoned in place below a new major structure that is part of the work only if approved by the Agency and solidly filled with grout using methods approved by the Agency. All abandoned utilities to remain and the approved abandonment method shall be noted on the installation record drawings.

Utilities to be removed by the Contractor shall be disconnected and taken out in accordance with the requirements of the utility owner to the limits shown on the plans. Utility removal shall not be performed until a release has been obtained from the utility stating that their respective service connection and appurtenant equipment have been disconnected, removed or sealed and plugged in a safe manner.

The Engineer shall be notified when utilities are encountered that are not shown on the plans.

350.2.2 Others: 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.

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.

Portions of asphalt concrete pavements designated on the plans for removal shall be done in accordance with Section 336.

Removal of trees, stumps, roots, rubbish, and other objectionable materials in the right-of-way shall be done in accordance with Section 201.

350.2.3 Backfill and Disposal: Backfill of all excavated areas below structures shall be in accordance with Section 206.4. Backfill and compaction of all other excavated areas shall be compacted to the densities as prescribed in Section 601 (trenches) or Section 211 (holes, pits or other depressions).

All surplus materials shall be immediately hauled from the jobsite and disposed of in accordance with Section 205.6.

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 mailboxes.

(C) Remove signs and bases in right-of-way.

(D) Remove planter boxes, block walls, concrete walls, footings, headwalls, irrigation structures, and storm water inlets.

(E) Install plugs for pipes and remove existing plugs as necessary for new construction.

(F) Remove wooden and concrete bridges.

(G) Remove median island slabs.

(H) Remove pavements and aggregate base where called for outside the roadway prism.

350.4 PAYMENT:

Payment for removals will be made at the unit proposal price which price shall be full compensation for the item complete, as described herein or on the plans.

- ***End of Section*** -

SECTION 355

UTILITY POTHOLES-KEYHOLE METHOD

355.1 DESCRIPTION:

This specification covers the requirements for coring, vacuum excavation, backfilling, and reinstatement of the asphalt core into asphalt pavement.

355.2 EXCAVATION:

Excavation requires coring a circular hole through asphalt pavement using drilling/coring equipment and removal of the intact asphalt pavement core. The vertical alignment of the coring operation shall be perpendicular to the horizon and cutting shall be extended the full depth of the existing pavement section.

Pavement cores shall not be greater than 24 inches in diameter, shall not be spaced closer than 3 feet between cores (edge to edge), shall not contain a joint or any pavement cracks greater than 1/8-inch wide, and shall only be obtained from pavements where the asphalt concrete section is at least 4 inches thick.

Contractor shall place a temporary mark (paint or chalk) on the pavement core and adjacent pavement prior to cutting to insure that the pavement core when replaced will have the same orientation as found in the original pavement.

Pavement cores shall be either removed from the work site or stored in a safe and secure on-site location. The cores shall be made readily available for reinstatement into the pavement.

Soil shall be removed by air/vacuum extraction methods to expose utilities. The zone of soil removal shall remain essentially within a vertical plane extending below the edges of the core hole.

The Contractor shall dispose of all excess materials.

355.3 BACKFILL AND COMPACTION:

355.3.1 Backfill Using Mechanical Compaction: Backfill shall be aggregate base per Section 702 or native backfill material per Section 601, placed in maximum 6 to 8-inch loose lifts.

Backfill compaction shall be determined by use of a compression wave amplitude monitoring device manufactured specifically for the purpose of measuring soil compaction. This device shall measure the compression wave amplitude as compaction progresses using below grade piezoelectric transducer wave sensors and an above-grade electronic monitor. The device shall signal the operator of successful compaction (the compaction wave amplitude becomes asymptotic for continued compaction effort) for each lift.

At time of compaction backfill material shall have sufficient available moisture to be compacted based on the physical appearance (soil ball) method as specified in USDA Soil Conservation Service Agricultural Information Bulletin 199, described as follows:

> Firmly squeeze a palm-size sample of soil into a ball by hand. Granular soils with sufficient available moisture will tend to ball under pressure, but seldom holds together for long. Cohesive soils with sufficient available moisture will form a ball that can be rolled into approximate ¼" wide ribbons between the palms of the hands without breaking apart, leaving no free water on the hand.

A compaction sensor shall be placed at the bottom of the first loose lift. A new sensor shall be placed for every 48 inches of compacted fill depth.

Pneumatic compaction equipment (pneumatic rammers or equivalent) shall be used for compaction of the backfill material. The size of the compactor shall not exceed one-half the diameter of the hole.

Mechanical compaction on each lift shall be continued until the electronic monitor signals that compaction is complete. A new lift shall not be placed until a positive signal has been received. Remove backfill soil and sensor if the monitor does not give a positive compaction signal after repeated compaction efforts. Repeat backfilling and compaction with a new sensor.

Contractor shall provide compaction documentation to the Agency upon request.

355.3.2 Slurry Backfill: If mechanical compaction is not used, the Contractor shall use ½-sack CLSM as backfill in accordance with Section 728.

355.3.3 Leveling Course: A 1-1/2-inch to 2-inch thick leveling course of compacted crushed gravel meeting the requirements of ASTM C33, No. 8 coarse aggregate shall be placed above the backfill and directly below the asphalt concrete pavement section.

355.4 PAVEMENT RESTORATION:

The pavement surface shall be restored to its original condition by setting the reinstated pavement core flush with and in its original orientation.

Bonding agent meeting the requirements of Section 708 shall be used for pavement core reinstatement. Excess bonding material shall be removed from the restored pavement surface. A "patched" appearance shall be avoided in surface restoration wherever possible.

The contractor shall reinstate the pavement core within 24 hours of cutting the pavement. Holes left open longer than 24 hours after cutting shall be covered with an approved steel road plate capable of supporting traffic loads. The steel plate must be rounded with a fitted collar that, when inserted into the hole, will prevent the steel plate from tipping, tilting, bouncing or spinning out of the hole under traffic conditions. An asphalt mix shall be used to ramp pavement up to the steel plate along all edges.

355.5 SURFACE TOLERANCES:

The reinstated core shall be flush and level with the adjacent pavement. Gaps attributable to the positioning of the core shall be less than 1/16-inch between the bottom of a minimum 3-foot long straightedge and the surface of the pavement in any direction on the surface of the keyhole core, except across the pavement crown or drainage gutters.

355.6 DEFICIENCIES:

Where the pavement core is found to be fractured or defective upon removal, or becomes damaged after removal and prior to reinstating, the defective or damaged core shall not be used to reinstate the pavement. Pavement repair shall be performed in accordance with Detail 212, Type A Pavement Repair.

A pavement core is considered unacceptable when one of the following conditions exist:

(a) The core contains any vertical cracks wider than 1/8-inch extending full depth or partial depth through the core; or

(b) Any deteriorated piece of the core is larger than 10 percent of the overall area of the core.

(c) Two or more successive layers of asphalt concrete in the core become horizontally delaminated and cannot be rebounded to each other with the bonding compound.

All unacceptable pavement cores shall be removed from the job site.

355.7 MEASUREMENT:

Each acceptable utility pothole repair shall be counted. No distinction shall be made based on size of the utility pothole or method of repair.

355.8 PAYMENT:

Payment at the contract price for utility pothole repair complete in place shall be full compensation for all labor, equipment and material required for a complete in place installation. Payment includes traffic control and disposal of all excess materials.

- ***End of Section*** -

SECTION 360

TELECOMMUNICATIONS INSTALLATION

360.1 DESCRIPTION:

This work shall consist of the installation of underground telecommunications facilities within the public right-of-way.

360.2 TRENCHING, BACKFILL AND RESTORATION:

All work shall be done in accordance with Section 601.

360.3 CABLE INSTALLATION:

(A) "Trunk Lines" Cable providing telecommunications service by connecting regions or states or by connecting central offices within a metropolitan area. Such cable shall be installed as described below:

(1) If the cable is to be installed within an open trench, the cable shall be placed within schedule 40 PVC conduit or equal with a minimum inside diameter of 4 inches. The conduit shall be buried at a minimum depth of 48 inches below finished grade measured to the top of the conduit. A color-coded plastic warning tape with a minimum thickness of 5 mil and a minimum width of 3 inches shall be installed in the trench and centered over the PVC conduit at a depth of from 18 to 30 inches below finish grade.

(2) Cable crossings under existing paved streets shall be accomplished by jacking or boring unless open trenching is authorized by the Engineer or Agency. The cable shall be placed within a schedule 40 PVC conduit or better at a minimum depth of 48 inches.

(B) Telecommunications cables other than "trunk lines" shall be installed as described below.

(1) If a cable is to be installed within the right-of-way of an arterial or collector street, it shall be placed at a minimum depth of 36 inches below finished grade. A color coded plastic warning tape as described in "A" shall be placed 18 inches below the surface.

(2) If a cable is to be installed within the right-of-way of a local/residential street, it shall be placed at a minimum depth of 24 inches below finished grade.

(3) Cable crossings under existing, paved streets shall be accomplished by jacking or boring unless open trenching is authorized by the Engineer or Agency.

360.4 CABLE LOCATING (FIBER OPTIC):

If a cable, which is to be installed is fiber-optic, a tracing or locating wire shall be installed with the cable.

360.5 PAYMENT:

Payment will be made at the contract unit price bid per lineal foot.

- End of Section -

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PART 400

RIGHT-OF-WAY AND TRAFFIC CONTROL

Section	Last Revised	Title	Page
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430	2014	Landscaping and Planting	430-1
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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 intersection 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.

Subject to the approval of the Traffic Engineer, the Contractor shall furnish and install the 25 MPH Construction Zone Speed Limit Signs. 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 1 1/2 times the contract bid price for all hours worked in excess in either of the above time periods.

- End of Section -

SECTION 405

SURVEY MONUMENTS

405.1 DESCRIPTION:

This work shall consist of furnishing and installing survey monuments at the locations shown on the plans or directed by the Engineer. The work also includes the preparation and recording of a corner record or results of survey in accordance with the Arizona State Board of Technical Registration requirements.

Monuments shall conform to the standard details or details shown on the plan.

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 shall be furnished by the Contractor unless otherwise specified.

405.3 CONSTRUCTION:

Monuments may be cast in drilled holes without the use of forms.

Survey monuments shall be set vertically in the ground.

The brass cap assembly shall be firmly embedded in the concrete cylinder before the concrete has acquired its initial set. The concrete cylinder shall be so located that, the reference point will fall within a 1 inch circle in the center of the brass cap.

The tops of survey monument covers shall be set flush with the pavement surface.

405.4 MEASUREMENT:

Survey monuments will be measured by the number of units of each type of monument constructed and accepted.

405.5 PAYMENT:

Payment for monuments will be at the contract unit price 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, as shown on the plans or as directed by the Engineer including preparing and recording a corner record or results of survey.

– End of Section –

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 A615 plain, intermediate grade, 1/2 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 contact, 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 inches 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 two 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.

- End of Section -

SECTION 415

FLEXIBLE METAL GUARDRAIL

415.1 DESCRIPTION:

The work under this section shall consist of furnishing all materials, equipment, and labor needed to construct new guardrail of the type indicated and at the locations shown on the plans.

Guardrail end treatments shall be as specified on the plans or special provisions.

415.2 MATERIALS:

The rail elements, bolts, nuts and other fittings shall conform to the specifications of AASHTO M-180, except as modified in this section. The rail metal shall conform to AASHTO M-180, Type I, Class A and in addition 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 2-1/2 times the thickness of the plate.

Guardrail specified to be constructed with weathering steel (sometimes called Corten steel) shall conform to the requirements of AASHTO M-180, Type IV, Class A and use ASTM A588 steel.

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

All materials shall be new, except as otherwise noted on the plans or special provisions.

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

Nails shall be 16 penny common galvanized.

Bolts shall have shoulders shaped to prevent the bolts from turning.

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

Guardrail reflector tabs shall be either 3003-H14 Aluminum strip 0.063 ± 0.004 inches thick, or steel strip 0.078 ± 0.008 inches thick galvanized in accordance with ASTM A653 coating designation G 90. The reflector material shall be high-reflectivity sheeting, either silver-white or yellow and shall conform to the requirements of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction. Adhesive for sheeting attachment to the metal tab shall be of the type and quality recommended by the sheeting manufacturer. Reflector tabs shall conform to the Reflector Tab Detail of Maricopa County Department of Transportation Standard Detail 3002.

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

6” by 8” Post and Block	1200 psi
8” by 8” Post and Block	900 psi
10” by 10” Post and Block	900 psi

When the plans show guardrail systems using 8” by 8” timber posts and blocks, the Contractor may use 8 1/4” nominal size posts and blocks with a stress grade of 825 pounds per square inch.

At the time of installation, the dimensions of timber posts and blocks shall vary no more than plus or minus 1/2” from the nominal dimensions as specified on the project plans. The size tolerance of rough sawn block in the direction of the bolt holes shall vary no more than plus or minus 3/8”.

All timber shall have a preservative treatment as per the requirements of AASHTO M-133.

Structural steel shapes shall conform to the requirements of ASTM A36 and be galvanized in conformance with the appropriate requirements of AASHTO M-111. Dimensions shall meet the dimensional requirements of the American Institute of Steel Construction.

Steel tubes shall conform to the material requirements of ASTM A500 or A501 and be galvanized in conformance with the requirements of AASHTO M-180, Type 1.

415.3 CONSTRUCTION REQUIREMENTS:

415.3.1 General: The construction of the various types of guardrail shall include the assembly and erection of all component parts complete at the locations shown on the project plans or as directed by the Engineer. Guardrail systems shall be either the 28-inch Strong Post W-Beam Guardrail system as detailed in the 2800 series of Maricopa County Department of Transportation Standard Details or the 31-inch high Midwest Guardrail System (MGS) as detailed in the 3100 series of Maricopa County Department of Transportation Standard Details. Strong Post W-Beam Guardrail elements and Midwest Guardrail System elements shall not be mixed within any guardrail run unless a transition section is specified by the design documents.

Posts shall be as indicated by plans, standard details, or special provisions. Only one type and size of post and block shall be used for any one continuous length of guardrail.

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

Workmanship shall be equivalent to good commercial practice and all edges, bolt holes and surfaces shall be free of torn metal, burrs, sharp edges and protrusions.

The various types of guardrail shall be constructed with wood posts and wood blocks, except as otherwise noted on the plans.

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. All metalwork shall be fabricated in the shop. No punching, cutting or welding shall be done in the field, except as provided for by the project plans. All metal cut in the field shall be cleaned and the galvanizing repaired in accordance with Section 771.

Where field cutting or boring of wood posts and blocks is permitted, the affected areas shall be thoroughly swabbed with at least two passes of the same type of wood preservative as initially used.

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

All bolts shall extend beyond the nuts a minimum of two threads, except that all bolts adjacent to pedestrian traffic shall be cut off flush to the nut.

Bolts extending more than 2" beyond the nut shall be cut off to less than ½" beyond the nut.

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

Diameter of Bolt	Torque, Foot/Pounds
5/8"	45-50
3/4"	70-75
7/8" and larger	120-125

All bolts, other than those specified to be torqued, shall be securely tightened.

When guardrail is being constructed under traffic, the work shall be conducted so as to constitute the least hazard to the public. Guardrail work shall be performed in the direction of traffic flow when feasible.

Any section of guardrail that is removed for modification shall be replaced within five calendar days of the date the guardrail is removed, unless otherwise directed by the Engineer. At the end of each day, incomplete guardrail sections having an exposed end toward oncoming traffic shall have an appropriate temporary protective end treatment acceptable to the Engineer set securely in place together with approved overnight traffic control devices set in place.

415.3.2 Delineation: The maximum spacing between reflector tabs shall not exceed six posts. The slotted part of the tab shall be installed under the mounting bolt head so that the Reflectorized surface of the tab faces oncoming traffic. The exposed ends of the slotted part of the tab shall be bent up against and then over the top of the bolt head. The color of the reflective portion of the barrier markers shall conform to the color of the adjacent edge line. Silver-faced reflector tabs shall be installed on the right hand side of all roadways, and yellow-faced tabs shall be installed on the left-hand side of one-way, or median divided roadways.

415.3.3 Roadway Guardrail: Wood posts shall be used for new guardrail installations unless otherwise indicated by plans or special provisions. Wood posts shall either be driven or placed in manually or mechanically dug holes; however, driven posts will not be permitted at locations where damage to the curb, gutter, sidewalk, buried items, shoulders or pavement might occur. The Engineer will be the sole judge as to whether driving of posts will be allowed. Driving of posts shall be accomplished in a manner that will prevent battering, burring, or distortion of the post. Any post which is damaged to the extent it is unfit for use in the finished work, as determined by the Engineer, shall be removed and replaced at no additional cost to the Agency.

The posts shall be firmly placed in the ground. The space around posts shall be backfilled with select earth, free of rock, placed in layers approximately 4 inches thick and each layer shall be moistened and thoroughly compacted to the density of the surrounding material. Half-sack control low strength material conforming to Section 728 may be used in lieu of select earth.

Where pavement is disturbed in the construction of guardrail, the damaged surfacing shall be repaired as approved by the Engineer.

Where a culvert or other obstacle is at an elevation, which would interfere with full depth post placement the Engineer may require the use of Bolted Guardrail Anchors Nested Guardrail, MGS Long Span Installation, or other modification as, may be appropriate.

Wood blocks shall be toe nailed to the wood post with one 16 penny galvanized nail on each side of the top of the block. Wood blocks shall be set so that the top of the block is no more than ½" above or below the top of the post, unless otherwise shown on the project plans.

Rail elements shall be spliced at 25 foot intervals or less. Unless otherwise shown on the project plans rail elements for 28-inch high Strong Post W-Beam Guardrail system shall be spliced at posts and rail elements for 31-inch high Midwest Guardrail System shall be spliced between posts. All rail splices shall be lapped in the direction of traffic in the nearest adjacent lane. Rail elements shall have full bearing (set flush) against posts. When the radius of curvature is 150 feet or less, the rail elements shall be shop curved.

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

415.3.4 Bolted Guardrail Anchors: Where the elevation of the top surface of a concrete box culvert or other similar installation prevents the placement of a post of the specified length, the posts shall be shortened and anchored in accordance with Maricopa County Department of Transportation Standard Detail 3010.

415.3.5 Nested Guardrail: This work shall consist of furnishing and constructing nested guardrail, Type 1, 2, or 3, as shown in Maricopa County Department of Transportation Standard Details 2808-1 through 2808-3.

415.3.6 MGS Long Span Installation: This work shall consist of furnishing and constructing guardrail as shown in Maricopa Department of Transportation Standard Detail 3108.

415.3.7 Guardrail to Structure Transitions: Guardrail transitions shall be constructed in accordance with requirements shown on the plans and special provisions.

415.4 MEASUREMENT:

The limits of measurement for 28-inch high Strong Post W-Beam guardrail system elements shall be as detailed in Maricopa County Department of Transportation Standard Detail 2816, unless otherwise noted on the plans or special provisions. The limits of measurement for 31-inch high Midwest Guardrail System elements shall be as detailed in Maricopa County Department of Transportation Standard Detail 3116, unless otherwise noted on the plans or special provisions.

Guardrail, of the type shown on the project plans, will be measured by the linear foot along the face of the rail element from center to center of posts, exclusive of guardrail terminals, guardrail end terminal assemblies, nested guardrail (Types 1, 2 and 3) MGS long spans, and guardrail transitions.

Delineation is considered a part of installation of guardrail and hence will not be measured as a separate item.

The accepted quantities of guardrail posts secured with bolted guardrail anchors will be measured by the unit each.

Nested guardrail, Types 1, 2, or 3, MGS long spans, and guardrail transitions will be measured by the unit each, complete in place and accepted as shown on the plans.

415.5 PAYMENT:

Payment for accepted quantities of each type of guardrail will be made at the contract unit price. Payment shall be full compensation for furnishing materials and installing guardrails, complete in place including excavation, backfill, and disposal of surplus material.

Payment for Bolted Guardrail Anchors will be at the contract unit price, and shall be full compensation for the work, complete in place, including steel brackets, hardware, excavation, backfill, removing and replacing surfacing, cutting and fitting steel beam posts or timber posts, drilling anchor bolt holes in steel posts, timber posts, and box culverts, and disposal of surplus materials.

Payment for guardrail transitions will be at the contract unit price. Payment shall be full compensation for furnishing materials and installing guardrail transitions, complete in place including excavation, backfill, and disposal of surplus material.

- ***End of Section*** -

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. When installation procedures are not covered within these specifications, standard details, special provisions, plans or other documents, installation will comply with ASTM F567.

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 C concrete footings, which footings shall be crowned at the top to shed water. Footings for line posts for 72 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 72 inches shall be shown on plans. 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 3/8 inch steel truss rods with turnbuckles used as tension members.

Unless otherwise specified all fence shall be installed with a top rail, 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 × 3/8 inch high carbon steel tension bars and not less than 12 gage × 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. Tire 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 3/8 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 two 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 therefore.

- End of Section -

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.

- End of Section -

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 manner 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 per cubic yard for furnishing and placing topsoil, which price shall be full compensation for the item complete, as described and specified.

- ***End of Section*** -

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 "Surflan" 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, 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 Multi-folium) seed will be planted.

The rate of seeding shall be 3 1/2 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 Surflan, or equal, shall be applied over the entire area, in accordance with the manufacturer's recommendations. 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 concerning 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 species 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 inches 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 1/2 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 Engineer 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, 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.

- ***End of Section*** -

SECTION 440

SPRINKLER IRRIGATION SYSTEM INSTALLATION

440.1 DESCRIPTION:

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.

440.2 GENERAL:

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.

440.3 MATERIALS:

Prior to the start of construction, the Contractor shall submit shop drawings per Section 105 on all material for approval of the Engineer. All materials shall conform to Section 757.

440.4 LANDSCAPE IRRIGATION SYSTEM REMOVAL AND RESTORATION:

When construction encroaches into an existing landscaped irrigation system, the Contractor shall remove the conflicting portion of the system within the right-of-way and/or easements and any portion, which may remain under the proposed improvements, whether shown or not shown on the plans. If the removals affect other areas of the system not in conflict with the construction, the Contractor shall permanently or temporarily restore or modify the existing system to provide water to the unaffected areas. The restoration or modifications shall be completed within 24 hours after the disruption occurs or notification by the Engineer.

The Contractor shall restore the affected landscape irrigation system to an operational condition equal to or better than the existing system. When necessary, bubbler and/or sprinkler heads shall be reinstalled at the edge of the new improvements. The reconstructed or modified system shall provide completed irrigation coverage without overspray onto walks, pavement, walls, buildings, etc.

The Contractor shall have the option to salvage and reuse existing materials. In the event that it is not feasible to reinstall the salvaged materials, new materials shall be installed.

To provide ample notification for owners who desire to remove and restore their own system, the Contractor shall notify the affected property owners at least fourteen (14) days prior to the scheduled removal of the irrigation system.

When determined by the Engineer that the existing sprinkler system cannot be practically restored, the existing system shall be plugged and removed as directed.

Unless specified by the agency and called out in the bid documents, this work shall be considered incidental to the contract and no separate payment shall be made to comply with these provisions.

440.5 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 provided 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.

440.6 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 D2855, 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 the previously made joints 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.

440.7 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 an approved material by the contracting agency.

440.8 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 inches 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.

440.9 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 stub-out 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 with 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 inches 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 inches 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.

440.10 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 elevated 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.

440.11 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.

-End of Section-

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PART 500

STRUCTURES

Section	Last Revised	Title	Page
505	2017	Concrete Structures	505-1
506	2012	Precast Prestressed Concrete Members	506-1
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SECTION 505

CONCRETE STRUCTURES

505.1 DESCRIPTION:

Concrete bridges, culverts, catch basins, manholes, 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 and testing thereof shall conform to the requirements of Section 725. Reinforcing shall conform to the requirements of Section 727.

Safe and suitable ladders shall be provided to permit access to all portions of the work.

505.1.1 Minor Structures: Concrete structures such as cattle guards, catch basins, median barriers, headwalls, and other miscellaneous structures as defined by the Engineer are hereby defined as Minor Structures. Such Minor Structures, at the option of the Contractor, may be either constructed of cast-in-place concrete, or furnished as precast units. Precast units shall be fabricated in accordance with shop drawings submitted by the Contractor and approved by the Engineer, in accordance with the requirements of Section 105.2. All structures not defined as Minor Structures shall be classified as Major Structures.

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 placement 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.

Precast Concrete Minor Structures shall be founded in accordance with the requirements of Section 206.4.5.

505.3 FORMS:

Forming plans for cast-in-place bridge decks and cast-in-place bridge superstructures shall be prepared in accordance with the requirements of Section 105.2.

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 inches 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 5/8 inch thick, and the studdings or joints shall be spaced not more than 12 inches, center to center. Plywood less than 5/8 inch thick, otherwise conforming to the requirements specified, may be used with a continuous backing of 5/8 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 15/8 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 3/4 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 placement.

The Contractor may at his own option, place 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 placed 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 placed 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 placed 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 placed may be left in place.

Regardless of the method used in the placement of 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 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:

Falsework construction and erection shall not commence until the Contractor has received written approval of the sealed final falsework shop drawings.

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 concrete were placed 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 determined by the Contractor's Engineer.

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 is 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 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 design shall be in accordance with the requirements of Section 105.2.

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.

The Contractor will be allowed the following tolerances when placing, tying and supporting reinforcing steel:

(1) In slabs and beams, horizontal bars shall be within ¼ inch measured vertically, of the position indicated on the plans.
(2) In vertical walls, columns, wings, and similar members, clearance from the forms shall be within ¼ inch of the clearance shown on the plans.
(3) In slabs or walls, long runs of bars may vary up to 2 inches in spacing; however, the specified number of bars shall be placed.

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: Bending of reinforcing steel shall conform to the requirements of the AASHTO LRFD Bridge Construction Specifications Section 9.4.

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 two meshes.

505.5.4 Dowels:

505.5.4.1 Dowel Placement: Dowel placement shall consist of drilling or coring dowel holes in concrete, furnishing and placing anchoring materials, and placing reinforcing steel dowels in accordance with the details shown on the Project Plans, and the requirements of the project Special provisions and these Specifications.

Dowel holes shall be cored where dowels are to be placed:

(A) in bridge decks and other thin concrete sections, and the depth of the dowel hole shown on the project plans projects to 3 inches or less from the opposite face of the concrete section, or

(B) within 4 inches from an existing concrete edge.

Cored holes shall be intentionally roughened after coring.

All holes shall be blown clean with compressed air, prior to applying the anchoring material.

The diameter of the holes for the dowels shall be 1/8" larger than the diameter of the dowels to be placed. The depth of the holes for the dowels shall be as shown on the Project Plans.

The anchoring materials for the dowels shall be an epoxy adhesive conforming to the requirements of Section 505.5.4.2, unless otherwise specified on the Project Plans and/or the project Special Provisions, or as approved by the Engineer.

505.5.4.2 Anchoring Materials: Epoxy materials shall be used for anchoring dowels. The Contractor shall, upon request, submit Certificates of Compliance or Analysis, complete with supporting documentation, to the Engineer for all epoxy materials to be used for anchoring dowels on a specific project, in accordance with the requirements of Section 106.2. The epoxy materials shall be provided by the Contractor in general conformance with the requirements of Section 1015-1 General Requirements of Section 1015 EPOXY MATERIALS of the current Arizona Department of Transportation (ADOT) Standard Specifications for Road and Bridge Construction, amended to date.

Epoxy resin base anchoring adhesive shall be used for anchoring dowels in concrete. High viscosity, or non-sag epoxies in the form of a gel, shall be used for horizontal or near-horizontal applications, where flow out of the anchoring hole is a problem. Low and medium viscosity epoxies may be used in vertical anchoring holes that open upward. The anchoring product shall specifically be designed for the designated application, according to the manufacturer's product literature.

Epoxy resin base anchoring adhesive shall provide the specified minimum tensile pullout resistance, when tested in accordance with Arizona Test Method 725, as modified in accordance with Section 505.5.4.3 of these specifications. The pot life of the anchoring material shall be determined in accordance with AASHTO T-237, Part I. The determined pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater.

505.5.4.3 Dowel Strength Requirements: The epoxy resin base anchoring adhesive shall provide the following minimum pullout resistances:

#4 dowels:	12.0 Kips
#5 dowels:	18.6 Kips
#6 dowels:	26.4 Kips
#7 dowels:	36.0 Kips

Arizona Test Method (ATM) 725 is a Tensile Proof Dowel Test, developed by ADOT to specifically test #6 reinforcing steel dowels anchored in Portland cement concrete with an epoxy adhesive. When testing reinforcing steel dowel sizes, the anchoring hole (ATM 725: PREPARATION – 4. (a)) shall be modified as follows; the rotary hammer drill bit size (ATM 725: APPARATUS – 2. (a)) shall be modified accordingly:

#4 dowels:	5/8" diameter x 8" long
#5 dowels:	3/4" diameter x 10" long
#6 dowels	7/8" diameter x 12" long
#7 dowels	1" diameter x 14" long

The Contractor may opt to conduct pullout tests with hole lengths other than those required above, based on the adhesive manufacturer's product literature and recommendations; however, test results shall demonstrate that the tested system provides the required pullout resistances.

505.6 PLACING CONCRETE:

No concrete shall be placed in any forms supported by falsework until the Contractor's Professional Engineer has inspected the completed falsework, and has issued a properly sealed and signed certificate that the falsework has been constructed according to the approved falsework drawings.

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 two 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.

Concrete for columns shall be placed using 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 Construction Joints in Major Structures: 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 placing 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 wastewater employed in washing the concrete surfaces shall be such that the wastewater 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

505.6.3 Bridge Deck Joint Assemblies:

505.6.3.1 Description: This work shall consist of furnishing and installing expansion devices including the seals, anchorage system, and hardware in accordance with the project plans and these specifications.

505.6.3.2 Materials: Elastomer Seals shall be of the Compression Seal or Strip Seal type, and shall conform to the requirements of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction Section 1011-5.

Steel shapes and plates shall conform to the requirements of ASTM A36, or ASTM A588.

505.6.3.3 Construction Requirements:

(1) **General:** Deck joint assemblies shall consist of elastomer and steel assemblies, which are anchored to the concrete at the deck joint. The seal armor shall be cast in the concrete. The completed assembly shall be properly installed in the planned position, shall satisfactorily resist the intrusion of foreign material and water, and shall provide bump-free passage of traffic. For each size of seal on a project, one piece of the seal material supplied shall be at least 18 inches longer than required by the project Plans. The additional length will be removed in the presence of the Engineer and used for materials testing. Upon request, Certificates of Compliance conforming to the requirements of Section 106.2 shall also be submitted by the Contractor.

(2) **Shop Drawings:** Prior to fabrication, the Contractor shall submit shop drawings to the Engineer for approval, in accordance with the requirements of Section 105.2. The shop drawings shall show complete details of the method of installation to be followed, including a temperature correction chart for adjusting the dimensions of the joint according to the ambient temperature, and any additions or rearrangements of the reinforcing steel from that shown on the project plans.

(3) **Elastomer Seals**: Seals shall conform to the requirements specified.

(4) **Armor:** All steel for cast-in-place deck joint assemblies shall conform to the requirements specified.

(5) **Galvanizing:** All steel parts of strip seal assemblies shall be galvanized after fabrication, in accordance with the requirements of ASTM A123 and A153, unless ASTM A588 steel is used. Bolts shall be high strength, conforming to the requirements of ASTM A325M, with a protective coating of zinc, followed by a chromate and baked organic coating conforming to the requirements of ASTM F1135, Grade 3, 5, 6, 7, or 8 and Color Code A.

Steel parts of compression seal assemblies do not require galvanizing, plating, or painting.

(6) **Joint Preparation and Installation:** At all joint locations, the Contractor shall cast the bridge decks and abutment

backwalls with a formed blockout, sized to accommodate the pre-assembled joint assembly. The joint assembly will be anchored in the concrete to be placed with the secondary pour in the blockout. Prior to the secondary pour, the surface of the existing concrete in the blockout shall be coated with an approved adhesive specifically formulated for bonding new concrete to old concrete.

(7) **Welding:** All welding and inspection of welding for structural steel shall be performed in accordance with the requirements of the latest revision of the AASHTO/AWS D1.5M/D1.5 Bridge Welding Code. The use of electro-slag welding process on structural steel will not be permitted.

Installed armor assemblies shall be covered or otherwise protected at all times prior to installing the elastomer portion of the joint assembly. The elastomer shall be installed at such time and in such manner that it will not be damaged by construction operations.

Immediately prior to the installation of the seal element, the steel contact surfaces of the joint armor shall be clean, dry, and free of oil, rust, paint, or foreign material. Any perforation or tearing of the seal element due to installation procedures or construction activities will be cause for rejection of the installed seal element.

During the installation of all proprietary deck joint assemblies, the manufacturer's representative shall be present. As a minimum, the representative shall be present during the placement of the joint assembly in the deck blockout, prior to the secondary concrete pour, and shall also be present during the installation of the seal element.

505.6.4 Water Stops: Water stops of rubber or plastic, shall be placed in accordance with the details shown on the project plans. Where movement at the joint is provided for, the water stops shall be of the type permitting such movement without damage. Water stops shall be mechanically spliced, vulcanized, or heat-sealed to form continuous watertight joints, in accordance with the manufacturer's recommendations, and as approved by the Engineer.

505.6.5 Longitudinal Joints between Precast Bridge Deck Units: After erection of the units and at the time requested by the Engineer, the longitudinal shear key joints between units shall be thoroughly packed with a pre-packaged non-shrink grout or a sand-cement grout with an expansion agent approved by the Engineer. The Contractor shall then transversely connect the deck units with the connection rods, stressing and anchoring them as shown on the project plans.

505.7 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 watertight 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. The Contractor shall use the wet burlap method for the water cure of all concrete in bridge decks and approach slabs, unless otherwise authorized by the Engineer.

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 two 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 therefore, 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 shall be used wherever it is practical and shall 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 honeycombs 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 final floating of the plastic concrete, bridge decks subject to vehicular traffic shall be textured transversely. Apparatus producing textured grooved shall be mechanically operated from an independent self-propelled bridge. Grooves shall be 1/16 to 1/8 inch in width and 3/32 to 6/32 in depth. Center to center spacing of the grooves shall be as follows: 7/8 inch, 3/4 inch, 1 inch, 3/4 inch, 1-1/8 inch and then repeated or other measurements as approved by the Engineer. Texturing shall be completed before surface of concrete is torn or unduly roughened by texturing operation. Grooves that close following texturing will not be permitted and will have to be retextured. Hand tine brooms shall be available on the job site, at all times during texturing operation, to repair faulty texturing grooves.

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 1/8 inch from the lower edge of the straightedge. Areas showing high spots of more than 1/8 inch shall be corrected by cutting or planning. The cutting or planning machine shall be a rotary type, equipped with an adjustable cutter and having a minimum wheelbase of 10 feet. Areas showing low spots of more than 1/8 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 1/8 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 than that produced by the methods specified herein.

The surface shall be sweat finished by means of a steel trowel followed by a light broom finish.

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 carborundum 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 Finish 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 traveling 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.

505.10 DIMENSIONAL TOLERANCES:

The maximum allowable tolerances or deviations from dimensions shown on the project plans or the approved shop drawings shall be as follows:

505.10.1 Cast-in-Place Concrete:

(A) Variation from plumb in the lines and surfaces of columns, piers, abutment and girder walls:
In any 10 foot or less length: 0.4 inches
Maximum for the entire length: 1 inch

(B) Variation in cross-sectional dimensions of columns, piers, girders, and in the thickness of slabs and walls:
+ 1/4 inch
- 1/8 inch

(C) Girders alignment (deviation from straight line parallel to centerline of girder measured between diaphragms):
1/8 inch per every 10 feet in length

(D) Variation in footing cross-sectional dimensions in project plans:
+ 2 inches
- ½ inch

(E) Variation in footing thickness:
Greater than specified - No Limit
Less than specified - 5 percent of specified thickness up to a maximum of 1 inch

(F) Subgrade Tolerances:
Slab poured on subgrade excepting footing thickness:
+ 1/4 inch
- 3/4 inch

(G) Girder Bearing Seats:
Deviation from plane surface (flatness): ± 1/8 inch in 10 feet.
Deviation from required elevation:
+ 1/4 inch
- 1/8 inch

(H) Cast-in-Place concrete box girder superstructures:
Deviation in overall depth:
+ 1/4 inch
- 1/8 inch
Deviation in slab and wall thickness:
+ 1/4 inch
- 1/8 inch
Deviation of post-tensioning ducts:
± 1/4 inch

505.10.2 Minor Precast Concrete Structures: Precast units that do not comply with the dimensional tolerances specified herein will be rejected. Precast units that show evidence of cracks, pop outs, voids or other evidence of structural inadequacy, or imperfections that will reduce the aesthetics of the unit after final placement will be rejected. The maximum allowable tolerances or deviations from the dimensions shown on the drawings shall be as follows:

(A) **Over-all dimensions of member:** ± 1/4 inch per 10 feet, maximum of ± 3/4 inch.

(B) **Cross-sectional dimensions:** sections 6 inches or less ± 1/8 inch
Sections 18 inches or less and over 6 inches ± 1/4 inch
Sections 39 inches or less and over 18 inches ± 1/4 inch

(C) **Deviations from straight line:**
Not more than 1/4 inch per 10 feet
All exposed, sharp corners of the concrete shall be filleted ¾ inches with a maximum allowable deviation of ± 1/8 inch.

505.11 MEASUREMENT:

505.11.1 Reinforcing Steel: When reinforcing steel is scheduled for payment as a specific item, it will be measured in pounds, based on the total computed weight for the size and length of bars, or for the area of welded wire fabric, as shown on the Project Plans or as approved by the Engineer.

Unit bar weights for deformed and plain billet-steel bars will be the nominal unit weights specified in AASHTO M-31 (ASTM A615).

Area unit weights for steel welded wire fabric will be calculated based on specified wire spacing's and unit weights for specified wire types and sizes. Unit weights for plain wire shall be based on the nominal areas specified for Wire Size Numbers in AASHTO M-32 (ASTM A82). Unit weights for deformed wire shall be the nominal unit weights specified for Deformed Wire Size Numbers in AASHTO M-225 (ASTM A496).

If the area unit weights for steel welded wire fabric are specified on the Project Plans or in the Special Provisions, both the Contractor and the Engineer shall independently calculate the area unit weight, using specified wire spacing's, types and sizes, and the criteria in the preceding paragraph. Any apparent discrepancy between the specified and calculated area unit weights shall be resolved by the Engineer prior to the Contractor placing the order for the steel welded wire fabric.

Lap splices made for the convenience of the Contractor will not be included in the measurement for payment.

Reinforcing steel for Minor Structures, as defined in Section 505.1.1, will not be measured, but will be included in the items unit price or specified method of payment, unless otherwise called out on the Project Plans or in the Special Provisions.

Dowel Placement will be measured by the unit each.

505.11.2 Concrete: When concrete is scheduled for payment on the basis of cubic 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. The quantity will be based on the concrete having the specified plan lengths, widths/depths, and thicknesses. However, all concrete shall be placed to line and grade within the tolerances specified in Section 505.10, or as approved by the Engineer as being reasonable and acceptable for the type of work involved. No volumetric deductions will be made for rounded or beveled edges, space occupied by reinforcing steel, metal inserts, or openings 0.5 square yard or less in area.

The quantity of concrete will be calculated considering any mortar used to cover construction joints as being concrete. The cost of cement used in any mortar for covering construction joints, patching, or other uses in the structure being constructed, in excess of that required for the design mix of the adjacent concrete, shall be absorbed in the cost of the item of work of which said mortar is a part.

505.11.3 Deck Joint Assemblies: Deck joint assemblies will be measured to the nearest tenth of a foot. Measurement will be made along the centerline of the joint, at the surface of the roadway, from face-to-face of curb or barrier. No measurement will be made for that portion of the deck joint assembly required by plan details to extend through the barrier face or curb; that portion of the joint assembly will be considered incidental to the sealing of the joint.

505.11.4 Bridge Railing, Curbs, Barriers, and Approach Slabs:

Bridge Pedestrian Fence and Curb, Bridge Pedestrian Fence and Parapet, and Bridge Fence and Parapet will be measured to the nearest tenth of a foot, from end post to end post.

Bridge Traffic and Pedestrian Rail will be measured to the nearest foot, determined from the outside dimensions of the rail.

Bridge Concrete Barrier will be measured to the nearest tenth of a foot.

Barrier Concrete Barrier Transition will be measured as a unit for each constructed.

Reinforced Concrete Approach Slab will be measured to the nearest square yard.

505.12 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.

505.12.1 Reinforcing Steel: The accepted quantities of reinforcing steel, of the type indicated on the Project Plans or specified in the Special Provisions, and measured in conformance with Section 505.11.1 will be paid for at the contract unit price per pound, complete in place.

The accepted quantity of dowels placed will be paid for at the contract unit price for Dowel Placement, which shall be full compensation for the work, complete in place. Steel reinforcement furnished for the dowels will be measured and paid for under the pay item Reinforcing Steel.

No measurement or direct payment will be made for dowels, which are required to replace existing reinforcing steel that is damaged as a result of the Contractor's operations; the Contractor shall furnish and place such dowels at his own expense.

505.12.2 Concrete: Payment for Portland cement concrete structures will be made in conformity with the terms of the contract and will be based on unit prices and/or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, materials, tools and equipment, preparation of subgrade for placing of concrete, and doing all work required to construct the structures in conformity with the plans and specifications.

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. 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.

An adjustment in the contract unit price, to the nearest cent, will be made for the quantity of concrete represented by the results of cylinder strength tests that are less than the specified 28-day compressive strength. Strength tests will be conducted in accordance with Section 725.8. The adjustment in contract unit price, if the concrete is accepted, will be based on Table 725-2 in Section 725.9.

The contract unit price for structural concrete shall include full compensation for all items incidental to providing a concrete structure complete in place, including waterstops, roadway drains, scuppers, metal inserts, and bearing pads.

505.12.3 Minor Concrete Structures and Accessories:

The accepted quantities of:

Minor Structures	Each
Deck Joint Assemblies	0.1 Foot
Bridge Pedestrian Fence and Curb	0.1 Foot
Bridge Pedestrian Fence and Parapet	0.1 Foot
Bridge Fence and Parapet	0.1 Foot
Bridge Traffic and Pedestrian Rail	Foot
Bridge Concrete Barrier	0.1 Foot
Bridge Concrete Barrier Transition	Each
Reinforced Concrete Approach Slab	Square Yard

will be paid for at the unit price and/or lump sums as set forth in the proposal. The contract unit price shall include full compensation for all labor, materials, tools and equipment necessary to provide the concrete structure or accessory complete in place, including all concrete, reinforcing steel, and items embedded in the concrete, such as anchor bolts, grates and frames, metal inserts, etc.

- End of Section -

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 special provisions.

This work shall include the manufacture, transportation and storage of girders, slabs, and other structural members of precast prestressed concrete and shall also include the placing of all precast prestressed concrete members.

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 proposes 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 cubic 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 that 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 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 A421, high-tensile wire strand confirming to ASTM A416, or high-tensile strength alloy bars conforming to the following requirements:

High-tensile strength alloy bars shall be thermal stress relieved to produce 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.	25×10^6	25×10^6

Diameter tolerances shall conform to ASTM A29.

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 1/4 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 materials that can be removed prior to installing prestressing steel.

All enclosures, 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 of 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 one percent of the total capacity of the ram used, not to exceed two 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 five 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 prestressed 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 or ASTM A416 and A421 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 strands 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 members 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.

506.10 PAYMENT:

Precast prestressed concrete members, 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 that are in the stockpile at the manufacturer's plant.

- ***End of Section*** -

SECTION 510

CONCRETE BLOCK MASONRY

510.1 DESCRIPTION:

All materials for concrete block masonry shall conform to the requirements of Sections 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 1/4 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 3/8 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 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 three 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.

- ***End of Section*** -

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 breaking 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 1/4 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 centerlines of vertical joints plumb and the brick laid equidistant from the centerline with not more than 1/8 inch variation in the width of these joints. The brick in each separate stack shall not vary more than 1/8 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 3/8 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 sufficient only to dampen the face but not of such quantity to cause water to flow down over the masonry.

511.5 REINFORCED GROUTED BRICK MASONRY:

Mortar in all bed joints shall be held back 1/4 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 5/8 inch thick shall be solidly filled with mortar as brick are laid. Head joints 5/8 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 immediately removed, and the surface cleaned.

In masonry that is more than two tiers in thickness, including pilasters and columns, the interior shall be of whole or half bricks placed into grout with not less than 3/4 inch of grout surrounding each brick or half brick. Except at the finish course, all grout shall be stopped 1 ½ 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.

- ***End of Section*** -

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 that shall show details, dimensions, sizes of materials, 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 False work: The Contractor shall be fully responsible for designing and providing false work capable of supporting all loads that 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 proposes 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 materials 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 A153.

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 1 ½ percent. The weight of cast steel or cast iron to be paid for will not exceed the computed weights by more than 7 ½ percent. If the scale weight of any member is less than 99 ½ 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, performed 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 considered 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.

- ***End of Section*** -

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 A53. Grade B structural steel conforming to ASTM A36, or tubular sections of hot rolled mild steel, as shown. Aluminum handrails shall conform to the requirements of either ASTM B429 for round extruded tube or ASTM B221 for semi-hollow extruded tube with rounded corners.

Welding shall be performed by the electric arc process and shall be done in conformance with AASHTO/AWS D1.5, Bridge Welding Code. 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.

Provide Series 300 stainless steel fasteners for aluminum alloy handrails.

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 5/8 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.

- ***End of Section*** -

SECTION 525

PNEUMATICALLY PLACED MORTAR

525.1 DESCRIPTION:

The work under this section shall consist of furnishing all material and pneumatically placing, by means of suitable equipment and competent operators, either premixed Portland cement and fine aggregate (dry mix process) or premixed concrete (wet mix process).

525.2 DRY MIX PROCESS:

The dry mix process shall consist of thoroughly mixing a proportional combination of fine aggregate and Portland cement, and conveying this mixture through a delivery hose to a special nozzle where water is added and combined with the dry ingredients prior to discharge. The nozzle water ring shall be cleaned daily.

The fine aggregate shall be material sand, conforming to ASTM C33, with Gradation No. 1 as shown in Table 525-1 and with not less than 3 percent or more than 7 percent moisture by weight.

Portland cement and mixing water shall conform to the requirements of Section 725.

The dry mix shall consist of 1 part Portland cement and 4.5 parts of fine aggregate by weight. Machine mixing will be required. This operation of proportioning and mixing shall be subject to the approval of the Engineer.

525.3 WET PROCESS:

The wet process shall consist of premixing by mechanical methods a proportional combination of Portland cement, aggregate and water required to produce mortar or concrete and conveying this mortar or concrete through the delivery hose to the special nozzle where additional compressed air is added prior to discharge. The air ports in the nozzle shall be cleaned daily.

The Portland cement concrete used for the Wet Mix Process shall conform to Section 725 and shall be Class A (3000 psi) unless otherwise specified. In no event shall a slump greater than 4 inches be used. As the work approaches the vertical, the maximum slump shall not exceed 1 inch.

The fine and coarse aggregate shall conform to ASTM C33 using one of the three gradations shown in Table 525-1. Unless otherwise specified, Gradation No. 1 will be used.

TABLE 525-1

PNEUMATICALLY PLACED MORTAR GRADATION (A.C.I. TABLE 2.2.1)

Sieve size	Percent by weight passing individual sieves		
	Gradation No. 1	Gradation No. 2	Gradation No. 3*
3/4 in.	—	—	100
½ in.	—	100	80-95
3/8 in.	100	90-100	70-90
No. 4	95-100	70-85	50-70
No. 8	80-100	50-70	35-55
No. 16	50-85	35-55	20-40
No. 30	25-60	20-35	10-30
No. 50	10-30	8-20	5-17
No. 100	2-10	2-10	2-10

*Batch fine and coarse aggregates separately to avoid segregation.

525.4 REINFORCING STEEL:

Reinforcing steel bars or welded-wire fabric shall conform to Section 727 and shall be 6 x 6 - W 1.4 x 1.4 welded wire fabric unless otherwise specified. Reinforcement shall be placed as closely as possible to the center of the mortar.

525.5 EQUIPMENT:

Prior to the start of construction, the Contractor shall demonstrate that his equipment, materials and operators are capable of providing a finished structure in accordance with the specifications. For this demonstration, the Contractor shall provide test panels, 30 inches by 30 inches, with a depth the same as the structure, but not less than 4 inches. A separate panel shall be provided for each shooting position to be used (overhead, slope and/or slab) and one-half of each panel shall contain reinforcement as used in the structure. Cores will be taken for visual inspection and compressive strength tests. The Engineer has the authority to accept or reject equipment, materials and/or operators based on his evaluation and his decision will be final.

If the Contractor can present valid, factual documentation to the satisfaction of the Engineer that his equipment, materials and operators have produced satisfactory results on similar work within the past six months, the Engineer may eliminate the test panel procedure.

525.6 SURFACE PREPARATION:

The surface on which the mortar is to be placed shall be compacted and true to line and grade as required by the plans and specifications. The surface shall be uniformly moistened so that water will not be drawn from the freshly placed mortar. Placement of the mix shall not start until the temperature is 35° F and rising and shall stop when the temperature is 40°F and falling.

525.7 FORMS AND GROUND WIRES:

Forms shall be plywood or some other suitable material, true to line and grade, sufficiently rigid to resist deflection during mortar placement.

Ground or gauging wires shall be installed where necessary to establish the thickness and finish lines of the structure.

525.8 JOINTS:

Construction joints shall be tapered to a shallow edge from not more than one inch thick over a width of approximately one foot except where the joint will be subjected to compressive stress. In this case, square joints shall be constructed. Joints shall be thoroughly cleaned and wetted prior to any additional application.

Install control joints in accordance with the plans. Reinforcement will not extend across control joints.

525.9 FINISHING:

Unless otherwise specified, the natural gun finish will be provided.

525.10 CURING:

Curing shall be accomplished using Type 2 compound as specified in Section 726. Application rate shall be not less than one tenth of a gallon per square yard. Subsection 505.6.2 Adverse Weather Concreting is applicable.

525.11 TESTING:

Tests to determine the quality of the mortar will be performed by the Engineer periodically during the course of work. Test panels shall be prepared by the Contractor.

Test panels shall be at least 12 inches square and as deep as the structure, but not less than 4 inches. Cores shall be taken from the panel for visual and compressive strength tests. The minimum compressive strength at the end of 28 days shall be 3000 psi.

The Engineer may allow the use of 6 inches by 12 inches hardware cloth cylinders for testing in lieu of the test panels. These cylinders will be furnished by the Contractor.

All rebound pockets and any mortar, defective in the compressive strength test, shall be cut out and replaced.

525.12 PAYMENT:

Payment for pneumatically placed mortar will be made at the unit price per square yard or the lump sum as set forth in the proposal. Such payment shall be full compensation for furnishing all labor, tools, equipment and accomplishing all work in conformity with the plans and specifications.

- ***End of Section*** -

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 does not leave a stippled texture in the paint file.

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 of the steel shall conform to the surface preparation specifications of the Steel Structures Painting Council.

Unless otherwise specified, the commercial blast method shall be used.

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 painting is required, the method of cleaning will be as directed by the Engineer or as specified in the special provisions.

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 in Section 530.8.1 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 one 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 perceptible color difference between the paint coat being applied and the preceding coat.

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.

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 one 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 two 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 one full coat of paint No. 15.

530.9.4 Metal Guardrails: Metal guardrails when required to be painted shall be painted with two 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 one 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 therefore 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.

- End of Section -

PART 600

WATER, SEWER, STORM DRAIN AND IRRIGATION

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SECTION 601

TRENCH EXCAVATION, BACKFILLING AND COMPACTION

601.1 DESCRIPTION:

The work covered by this specification consists of furnishing all labor, equipment, appliances, materials, and performing all operations in connection with the excavation, backfilling and compaction of trenches for pipe installations.

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.

The Trench Cross-Section Detail shown on Detail 200-2 illustrates the terminology used in this specification.

See Section 620 for cast-in-place concrete pipe.

Pipe materials that are considered to be rigid include reinforced concrete pipe, non-reinforced concrete pipe, reinforced concrete cylinder pipe, vitrified clay pipe, steel casings, cast iron, and ductile iron pipe.

Pipe materials that are considered to be flexible include thermoplastic pipes (HDPE, SRPE, PP, PVC) and corrugated metal pipe.

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 any portion of the backfill.

601.2.2 Trench Widths: Trenches for a single pipe shall conform to the dimensions in Table 601-1. Multiple pipe installations in a single trench shall be installed in accordance with details on the plans or in the special provisions.

Table 601-1 TRENCH WIDTHS

Size of Pipe (Nom. Dia.)	Maximum Width at Top of Pipe Greater Than O.D. of Bell	Minimum Width at Springline Each Side of Pipe Barrel
Rigid Pipes:		
Less than 18 inches	16 inches	6 inches
18 inches to 24 inches inclusive	19 inches	7.5 inches
27 inches to 39 inches inclusive	22 inches	9 inches
42 inches to 60 inches inclusive	30 inches	12 inches
66 inches to 78 inches inclusive	42 inches	15 inches
84 inches to 96 inches inclusive	50 inches	19 inches
102 inches to 120 inches inclusive	60 inches	24 inches
Flexible Pipes:		
Less than 18 inches	20 inches	8 inches
18 inches to 24 inches inclusive	23 inches	9.5 inches
27 inches to 39 inches inclusive	28 inches	12 inches
42 inches to 60 inches inclusive	34 inches	14 inches
66 inches to 78 inches inclusive	44 inches	16 inches
84 inches to 96 inches inclusive	48 inches	18 inches
102 inches to 120 inches inclusive	54 inches	21 inches

The width of the trench shall not be greater than the maximum indicated in Table 601-1, 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 shoring, bracing, and for proper installation of the work.

If the maximum trench width as specified in Table 601-1 is exceeded at the top of the pipe, additional load bearing capacity to compensate for the increased pipe loading may be required by the Engineer. The Contractor shall provide, at no additional cost to the Contracting Agency, the additional load bearing capacity. This may require changing the material requirements of initial backfill, a higher strength pipe, a concrete cradle, cap or encasement, or other means approved in writing by the Engineer. Where safety or undermining situations occur, a controlled low strength material (CLSM) backfill as specified in Sections 604 and 728 may be used as needed.

601.2.3 Trench Grade: Alignment and elevation stakes shall be furnished by 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 Contractor will also furnish the Engineer with cut sheets.

For all pipe 12 inches or greater in diameter, the Contractor shall excavate for and provide a bedding at least 4 inches thick or 1/12 the O.D. of the pipe barrel whichever is greater. This bedding material shall be placed at a uniform density with minimum compaction and fine graded as specified herein.

601.2.4 Fine Grading: The bedding or the bottom of the trench when bedding is not required 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 or other joint types and for proper sealing of the pipe joints.

601.2.5 Over-excavation: 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 needed to accommodate the required bedding depth.

Unauthorized excavation below the specified trench grade line shall be refilled at the Contractor's 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 D6938. When AASHTO T-99, method A or B, and T-191 are used for density determination, ARIZ 227c will be used for rock correction.

Whenever rock is encountered in the trench bottom, it shall be over-excavated to a minimum depth of six inches below the bottom of the pipe barrel. This over-excavation shall be filled with bedding 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 over-excavation and the granular fill required.

601.2.6 Excavation for Manholes, Valves, Inlets, Catch Basins and Other Accessories: The Contractor may place concrete directly against excavated surfaces for cast-in-place items, provided that the faces of the excavation are firm, 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 excavate as needed to place bracing, shoring, and forms or to place the precast structure.

Any unnecessary excavation below the elevation indicated for the foundation of any structure shall be replaced with the same class of concrete specified for the structure or with 1-1/2 sack controlled low strength material as specified in Section 728. When the replacement material is structural concrete, the material shall be placed at the same time as the structure. However, when using 1½ sack controlled low strength material, placement of the material shall be per Section 604, which requires a time lag between placement of the controlled low strength material and the structural concrete. The placement of the additional material shall be at no cost to the Agency.

601.2.7 Pavement and Concrete Cutting and Removal: Where trenchless methods are not used and trenches or other excavations lie within the Portland cement concrete section of streets, alleys, driveways, or sidewalks, etc., such concrete shall be completely removed between the closest adjacent joints. Removal methods shall produce neat, straight lines in such a manner that the remaining adjoining concrete will not be damaged.

Sidewalk, curb, gutter, and other concrete flatwork shall have complete joint-to-joint replacement of all damaged sections. The construction replacing damaged concrete sections and joints shall be compliant with Section 340.
The existing joint system in Portland cement concrete pavement (PCCP) shall be maintained. Reconstruction of PCCP panels and joints shall be in accordance with Section 324.

Initial asphalt pavement removal shall be clean-cut to be the minimum width required for conduit installation and proper trench compaction. No ripping or rooting will be permitted outside the pavement cut limits. Surfacing materials removed shall be hauled from the job site immediately, and will not be permitted in the backfill.

Final pavement removal for pavement matching and surface replacement shall occur after the final backfill and the aggregate base material are in place and compacted. Pavement matching and final surface replacement shall be in accordance with the requirements of Section 336.

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 placed 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 commencement 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 Sheathing: 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 to prevent overloading of the pipe during backfill operations. The cost of the bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price for the pipe or other item, which necessitated the work.

All shoring and sheathing 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 construction 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 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. Steel plates shall be installed in accordance with Detail 211. 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 shall be maintained at all times. Steel plates with adequate trench bracing shall be used to bridge across trenches as needed to provide driveway access to adjacent properties where trench backfill and temporary patches have not been completed during regular work hours.

601.3 PROTECTION OF EXISTING UTILITIES:

601.3.1 Utilities: Unless otherwise shown on the plans or stated in the specifications, all utilities, either 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 appurtenance, 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 (Sections 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.

Backfill, around utilities that are exposed during trench excavation, shall be placed in accordance with the utility's haunching and initial backfill requirements.

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 location as necessary as determined by the Engineer.

601.4 FOUNDATION, BEDDING, HAUNCHING, BACKFILLING AND COMPACTION:

601.4.1 Foundation: The bottom of an excavation upon which a structure is to be placed or the bottom of a trench where the elevation is set below the pipe elevation shown on the plans or as directed by the Engineer. The elevation of the trench foundation is determined from the desired pipe elevation by taking into account the bedding and pipe wall thicknesses. The foundation surface will consist of native material or replacement material required due to over-excavation.

601.4.2 Bedding: Bedding is the material upon which a pipe is to be placed.

The bedding material type shall be ABC per Section 702 unless otherwise specified.

601.4.3 Haunching: Haunching is the material placed between the bedding and springline. If placed in lifts, the lift thickness shall not exceed 2 feet (1 foot for flexible pipe) and shall be deposited and compacted to the specified density uniformly on each side of the pipe to prevent lateral displacement of the pipe.

The haunching material shall be ABC per Section 702. With Agency approval, an alternative granular material or CLSM may be used.

601.4.4 Initial Backfill: The material placed between the springline to 12 inches above top of pipe. Initial backfill shall be placed in lifts that shall not exceed 2 feet (1 foot for flexible pipe) and which can be effectively compacted depending on the type of material, type of equipment, and methods used.

Initial backfill material shall be ABC per Section 702. With Agency approval, an alternative granular material or CLSM may be used, and with agency approval, native backfill with no piece larger than 1½ inches may be used for concrete pipe.

601.4.5 Final Backfill: Material placed above the initial backfill to the top of the trench or to the bottom of the road base material. Final backfill shall be placed in horizontal layers not more than twelve inches in depth before compaction. With Agency approval, an increase in the loose non-compacted lift depth may be obtained for a project based on specific equipment, methods, and soil conditions. For approval of an increase of the non-compacted lift depth the Contractor shall demonstrate to the satisfaction of the Agency that the required density will be obtained using the Contractor identified equipment and methods. The non-compacted lift height shall not be more than can be compacted to the required density with the equipment and methods being used.

Final backfill shall be CLSM per Section 604, ABC per Section 702, and/or granular material or native backfill material per Section 601.4.8.

Backfill under street pavement shall be constructed per Detail 200-1 with the type of trench and surface replacement as noted on the plans or in the special provisions. Unless otherwise noted, backfill under single curb, curb and gutter, attached sidewalk, driveways, valley gutters, etc. shall be the same as the adjacent street pavement.

601.4.6 Compaction Densities: Trench backfill shall be thoroughly compacted to not less than the densities shown in Table 601-2 when tested and determined by AASHTO T-99 and T-191 or ASTM D6938. When AASHTO T-99, method A or B, and T-191 are used for density determination, ARIZ-227c shall be used for rock correction.

Backfill material shall be within 2 percentage points of its optimum moisture content while being compacted.

When backfill material is CLSM and it is placed in accordance with Section 604, no compaction testing is required, the compaction density shall be deemed acceptable.

TABLE 601-2
MINIMUM TRENCH COMPACTION DENSITIES

Backfill Type	Location	From Surface To 2 feet Below Surface	From 2 feet Below Surface To 1 foot Above Top of Pipe	From 1 foot Above Top of Pipe to Bottom of Pipe
I	Under any existing or proposed pavement, curb, gutter, attached sidewalk, roadway shoulders, and other areas within right-of-way subject to vehicular traffic, or when any part of the trench excavation is within 2-feet of the existing pavement, curb, or gutter.	100% for granular 95% for non-granular	95%	95%
II	On any utility easement or right-of-way outside limits of Type I backfill.	85%	85%	90%
III	Around any structures (manholes, etc.) or exposed utilities outside limits of Type I backfill.	95% in all cases		

601.4.7 Water Consolidation: Jetting is the only acceptable water consolidation method and its use is restricted. Jetting may only be used in Type I Backfill for the haunching and initial backfill zones and in Type II Backfill locations as defined in Table 601-2.

Water consolidation by jetting shall use a 1 1/2 inch pipe of sufficient length to reach the bottom of the lift being settled and shall have 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.

When jetting is used within the haunching and initial backfill zones, the Contractor shall be responsible for establishing each lift depth so as to avoid floating the pipe being placed and shall make any needed repair or replacement at no cost to the Contracting Agency. For pipes larger than 24 inches I.D., the first lift shall not exceed the springline of the pipe and subsequent lifts shall not exceed 3 feet.

Where jetting is used and the surrounding material 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.

If jetting does not obtain the required compaction density, mechanical compaction methods shall be used to meet the compaction requirements. Water consolidated backfill material may need to be removed and replaced.
Jetting within Type I backfill locations shall not be used unless the material in which the trench is located and the backfill are both granular material. No exception shall be made for construction within new developments.

601.4.8 Granular Material and Native Backfill Material: For purposes of this specification, granular material is material for which the sum of the plasticity index and the percent of the material passing a No. 200 sieve does not exceed 23. The plasticity index shall be tested in accordance with AASHTO T-146 Method A (Wet Preparation), T-89 and T-90. The percent of the material passing a No. 200 sieve shall be tested in accordance with ASTM C136 and ASTM C117.

Native material used for backfill shall be sound earthen material free from broken concrete, broken pavement, wood or other deleterious material with no piece larger than 4 inches.

601.4.9 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 or another entity's right-of-way outside the limits of the Contracting Agency shall be accomplished in accordance with their permit and/or specifications.

601.4.10 Test Holes: Boring logs shown on the plans do not constitute a part of the contract and are included for the Contractor'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 Contractor 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.

601.4.11 Bedding and Backfilling for Electronic, Telephonic, Telegraphic, Electrical, Oil and Gas Lines: The bedding and backfill for these underground facilities shall be native material or sand, which conforms to the grading requirement of ASTM C33 for fine aggregate. When backfill material consists of aggregate base course, crushed stone, or other material containing stones, only sand will be used within the bedding, haunching, and initial backfill zones. The bedding depth shall be six inches. Compaction shall be in accordance with Table 601-2.

601.5 CONTRACTOR CERTIFICATION OF INSTALLATION PROCEDURES:

When requested in the Special Provisions or by the Engineer prior to installation, the Contractor shall furnish to the Contracting Agency an affidavit (certification) from the pipe manufacturer (or his designee) stating that the Contractor is familiar with the manufacturer's suggested installation methods and procedures and the manufacturer's suggested installation methods and procedures are consistent with MAG requirements.

When required by the Special Provisions, the pipe manufacturer or his designee will review the Contractor's methods and procedures for pipe installation in the field. The Contractor will make any adjustments in the installation as recommended by the manufacturer or his representative. If necessary, the Contractor may be required to reinstall or provide corrections to pipe installed prior to the field review at no cost to the Agency. Once the manufacturer or his representative has reviewed the

Contractor's installation methods and the Contractor has adjusted his installation methods as recommended by the same, the manufacturer or his representative shall furnish to the Contracting Agency an affidavit (certification) that the Contractor's installation methods and procedures, at the time of the review, complied with the manufacturer's installation practices. The affidavit must provide the name of the manufacturer's representative witnessing the pipe installation.

601.6 PAVEMENT REPLACEMENT AND SURFACE RESTORATION:

601.6.1 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.

601.6.2 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.

601.6.3 Cleanup: The job site shall be left in a neat and acceptable condition. Excess soil, concrete, etc., shall be removed from the premises.

601.6.4 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.

601.7 PAYMENT:

No pay item will be included in the proposal or 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 per linear foot for furnishing and laying pipe.

- End of Section -

SECTION 602

TRENCHLESS OR OPEN CUT INSTALLATION OF STEEL CASING

602.1 DESCRIPTION:

The Contractor shall furnish all labor, material and equipment as required for the installation of steel casing by a) Trenchless operation; using horizontal earth auger boring, hand tunneling or pipe ramming, or b) Open Cut operation; using trenching, placement and backfill for the protection of underground utilities.

602.2 MATERIALS:

602.2.1 Steel Casing Fabrication:

Steel casing shall conform to ASTM A283 Grade C, ASTM A252 Gr.2, ASTM A53, ASTM A139, (American Petroleum Institute "API" Specification) API 5L Gr B, API 5L X42 or API 5L X52. Welding shall use matching filler metal requirements as listed in AWS D1.1 Table 3.1. Shop and field joints shall be welded in accordance with AWS D1.1/D1.1M. Welding shall be performed by AWS D1.1 qualified personnel.

602.2.2 Steel Casing Wall Thickness: The minimum wall thickness for steel casings shall be in accordance with Table 602-1.

Table 602-1

Casing Diameter (inches)	Minimum Wall Thickness (inches)
8	.322
10	.365
12, 16, 18, 20, 24, 30 and 36	.375
42, 48	.500
54, 60	.625
66, 72, 78	.750
84 and up	1.00

602.2.2.3 Steel Casing Diameter for Trenchless Installations: The steel casing for pressurized carrier pipes shall be a minimum of 12-inches larger than the largest outside dimension of the carrier line, (including pipe bells and flanges) or the size indicated on the plans, whichever is greater. Unless otherwise directed by the Contracting Agency or by special design, the steel casing for gravity carrier pipes shall be a minimum of 18-inches larger than the largest outside dimension of the carrier line, (including pipe bells and flanges) or the size indicated on the plans, whichever is greater.

602.2.2.4 Steel Casing Diameter for Open Cut Installations: The steel casing for pressurized carrier pipes shall be a minimum of 6-inches larger than the largest outside dimension of the carrier line, (including pipe bells and flanges) or the size indicated on the plans, whichever is greater. The steel casing for gravity carrier pipes shall be a minimum of 12-inches larger than the largest outside dimension of the carrier line, (including pipe bells and flanges) or the size indicated on the plans, whichever is greater.

602.3 TRENCHLESS OPERATION:

Before starting operations, the Contractor shall submit in accordance with Section 105.2, detailed shop drawing of the bore pit and receiving pit shoring, bulkheads, carrier pipe installation method, and welder certifications. The contractor shall submit a letter of certification for the casing listing conformity to 602.2.1 and the ASTM or API stenciled on the outside matching the certification letter. The contractor shall submit a procedure detailing the trenchless installation method selected from 602.1 to be used for the project, if a geotechnical report is not available in the contract documents, the contractor shall define the soil limitation for the method selected.

The bore and reception pits for the trenchless operation shall be shored to safeguard existing sub-structures and surface improvements and to protect against ground movement. Survey of the bore alignment shall be taken prior to the installation of steel casing and taken after the installation of steel casing and shall be presented to the Engineer.

Steel casing larger than 36-inches grout connections shall be provided at a maximum spacing of every 20-feet located at 12 o'clock in the steel casing. Upon completion of the boring operation, the contractor shall inspect each grout hole to determine if grouting is required, any gap greater than 2-inches outside the casing will require the boring contractor to grout fill the gap. After grouting, the grout holes shall be closed with a threaded plug. The grout shall be a flowable fill.

Steel casing 36-inches and smaller installed by horizontal earth auger boring, hand tunneling or pipe ramming will not require outside grouting unless caving or earth movement occurs.

Unexpected loose soil conditions that do not accommodate the method submitted by the contractor, (horizontal earth auger boring, hand tunneling or pipe ramming), shall be brought to the agency attention to determine further course of action. Contractor shall stop boring until an alternative method is mutually agreed on.

602.4 DEWATERING:

Any water encountered during the operation shall be disposed of by the Contractor in a manner that will not damage public or private property or create a nuisance or health problem. The cost of furnishing pumps, pipes and equipment for dewatering shall be considered incidental to the work and no additional payment shall be made.

602.5 CARRIER PIPE PLACEMENT:

The tolerances allowed for the alignment and grade of carrier pipe shall comply with requirements of Section 610, 615 or 618 as applicable. The Contractor shall be responsible to obtain the required line and grade for the carrier pipe, the carrier pipe shall not contact or rest on the casing.

Pressurized carrier pipes, (i.e. water, gas, force main) shall be placed using casing spacers, wood skids or steel pipes for rails. Casing spacers shall be installed 3 per joint minimum with 8-foot maximum spacing. The annular space between the casing and carrier line shall be left empty unless otherwise directed. When the annular space is to be filled, 3/8-inch pea gravel shall be used.

Gravity carrier pipes, (i.e. sewer, storm drain, irrigation) shall be placed using grade casing spacers, wood skids or steel pipes for rails. The annular space between the casing and carrier line shall be left empty unless otherwise directed. When the annular space is to be filled, 3/8-inch pea gravel shall be used.

Bulkheads consisting of brick and mortar or concrete shall be constructed on the ends of the casing; bulkheads shall be a minimum of 8-inches thick. Alternative casing end closures may be substituted for brick and mortar or concrete bulkheads if approved by the Engineer.

PVC conduits for dry utilities, (i.e. communications, fiber, electric) shall be placed using non-metallic PVC casing spacers. The annular space between the casing and carrier line shall be filled as indicated in the contract documents.

After completing the carrier pipe installation, the Contractor shall remove all loose and disturbed material in the bore pits and backfill the pits in accordance with Sections 601 and 336.

602.6 MEASUREMENT AND PAYMENT:

Measurement for steel casing shall be the number of horizontal linear feet from the end of casing in the bore pit to the end of casing in the reception pit; or from the beginning of the placed casing to the end of placed casing for an open cut installation. Payment for steel casing shall be full compensation for furnishing all labor, material, tools, and equipment required for the installation of steel casing, complete in place including but not limited to placement of carrier pipe, annular space fill material (when required), bulkheads, and the excavation and backfilling of pits. Payment for steel casing does not include payment for the carrier pipe. A separate payment will be made for the carrier pipe and any required testing of the carrier pipe.

- End of Section -

SECTION 604

PLACEMENT OF CONTROLLED LOW STRENGTH MATERIAL

604.1 DESCRIPTION:

The work covered by this specification consists of furnishing all materials, labor and equipment for the placement of controlled low strength material (CLSM).

The type of backfill to be used shall be as specified in the special provisions, plans or by the Engineer.

The following is a brief description of the types of CLSM and their intended uses:

1/2 SACK**:** General trench backfill in areas where future excavation into the backfill with conventional hand tools is anticipated or in areas of low loading such as streets, parking areas, behind retaining walls, etc.

1 SACK**:** General trench backfill and backfill behind retaining walls where additional strength is required above that of 1/2 sack CLSM.

1-1/2 SACK**:** Structural backfill under foundations and as thermal fill and/or mechanical protection of duct banks and conduits.

2 SACK**:** General pipe bedding and encasement around vitrified clay pipe.

604.2 MATERIALS:

CLSM shall conform to the requirements of Section 728. Ready-mixed concrete shall not be used in lieu of CLSM without prior approval from the Engineer and shall be subject to rejection.

604.3 PLACEMENT:

The controlled low strength material shall be placed directly into the excavation. The CLSM shall be placed in a uniform manner that will prevent voids in or segregation of the material. Foreign material, which falls into the trench prior to and during placing of the CLSM, shall be immediately removed. The CLSM shall have consistency, workability, plasticity, flow characteristics and pumpability (when required) such that the material when placed is self-compacting. Mechanical compaction or vibration may be used to consolidate around structures, pipes, multiple conduits, etc., otherwise no mechanical compaction or vibration shall be required. The total elapsed time between the initial addition of water to the CLSM and the completed placement shall not exceed 90 minutes.

When CLSM is used for backfill around pipes or conduits, the CLSM shall be placed equally on both sides of pipe or conduit to prevent lateral displacement. In addition, the CLSM shall be placed in lifts. The height of each lift shall not exceed the depth that will cause floating of the pipe or conduit. When placing the CLSM in greater lift depths, sufficient anchorage shall be provided so the pipe or conduit will not float.

Where CLSM is used for backfill around pipes or conduits with a depth less than 20 feet, the width of the excavation shown on the plans or in Section 601 may be reduced so that the minimum clear distance between the outside of the pipe or conduit and the side of the excavation (each side) shall be 12 inches for pipes or conduits 42 inches and larger, 6 inches for pipes or conduits between 4 inches and 42 inches and 3 inches for pipes or conduits 4 inches and smaller.

When CLSM is used behind retaining walls, the depth of each lift shall be limited so it will not induce hydraulic loads greater than the design loads.

For long trenches or installations, which require a large amount of CLSM, bulkheads of wood, dirt, sand bags, etc. can be used to control the material's flowability. The bulkhead shall be removed prior to the continuation of the backfilling.

CLSM shall NOT be permitted to come in contact with any aluminum, copper or brass materials, e.g., aluminum pipes or culverts, copper water pipe, saddles, fittings, etc. Protection shall be any combination of the following: place a layer of

noncorrosive material around the pipe e.g., native material, import material, etc. or provide a protective covering or wrapping such as polyethylene wrap per Section 610.6. Pipes smaller than 4 inches can be completely wrapped with tape as per Section 610.6 or approved equal.

Generally, CLSM does not resist freezing and thawing and in some cases may propagate the condition. CLSM mixes must be modified where long term freeze-thaw durability is indicated as a concern. The mix design shall have an air content of no less than six percent by volume, when tested in accordance with ASTM D6023.

604.4 PERFORMANCE TESTING:

CLSM placed within the traveled way or otherwise to be covered by paving or embankment materials, shall not be covered until one of the following performance criteria have been met:

(A) When a person of average weight and shoe size can walk on the surface of the CLSM without creating greater than 1/8-inch indents in the material, or
(B) When the in-place CLSM has reached a strength of 30 psi, when tested in accordance with ASTM D4832, or
(C) When a ball drop indentation of 3-inches or less is obtained, when tested in accordance with ASTM D6024, or
(D) When a penetration resistance reading of 650 is achieved, when tested in accordance with ASTM C403.

Additionally, CLSM shall not be covered if proof rolling by pneumatic-tired or steel wheel vibratory roller results in the bringing of free water to the surface or results in surface undulation (pumping).

When CLSM is placed in foundation excavations, the material shall be protected from foundation loading and placement of foundation concrete prior to having reached initial set per ASTM C403, or allowed to set in place for 24 hours, whichever occurs first.

604.5 ACCEPTANCE:

CLSM shall be considered deficient and may be rejected at the discretion of the Engineer if:

(A) The CLSM is outside of the limits specified in Table 728-1 and/or
(B) The aggregate gradation is outside the limits specified in Section 728.2.

Rejected material not placed shall be immediately removed from the job site. Rejected material placed shall be removed and replaced with acceptable material. Removing and disposing of the rejected material shall be at no additional cost to the Contracting Agency.

604.6 PAYMENT:

No pay item will be included in the proposal nor direct payment made for CLSM unless specifically included in the Project Specifications and Fee Proposal. The cost for placing the material shall be included in the unit price for the specific work function (laying pipe, placing structure foundation, construction retaining wall, etc.).

- End of Section -

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, or corrugated metal 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. 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.

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 grading requirements in Table 605-1; 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 725.3; however, the requirements for grading, and reactivity, as stated therein, shall not apply. The minimum bulk specific gravity shall be 2.50, by ASTM C127.

TABLE 605-1			
FILTER MATERIAL GRADING - % PASSING			
Screen or Sieve Size	**TYPE**		
	F1	**F2**	**F3**
3/4”		100	100
3/8”	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 regarded depressions filled and compacted, and tested for straightness until grading is accomplished within the tolerance specified. No relative density will be required.

Pipe damage 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 approved by the Engineer.

605.6.4 In Trenches and Along Heels or Walls of 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.

- End of Section -

SECTION 607

TRENCHLESS INSTALLATION OF SMOOTH WALL JACKING PIPE

607.1 DESCRIPTION:

The Contractor shall furnish all labor, material and equipment as required for the trenchless operation for the installation of thirty-inch inside diameter (30" ID) and larger, tongue and groove smooth wall jacking pipe installed by horizontal earth pipe jacking or hand tunneling.

607.2 MATERIALS:

The jacking pipe shall be tongue and groove smooth wall reinforced concrete pipe per ASTM C76 class V, unless vitrified clay pipe per ASTM C1208, or centrifugally cast fiberglass reinforced polymer mortar pipe per ASTM D3262, is approved by Engineer.

607.3 TRENCHLESS OPERATION:

Before starting operations, the Contractor shall submit in accordance with Section 105.2, detailed shop drawing of the bore pit and receiving pit shoring, the jacking pipe, bulkheads, installation method, and the annular grouting mix design and grouting method. The proposed installation method and equipment shall be at the Contractor's option, no field construction shall commence until the proposed installation method is approved in writing by the Engineer. The Engineer's approval 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.

The bore and reception pits for the trenchless operation shall be shored to safeguard existing sub-structures and surface improvements against ground movement.

The leading section of jacking pipe shall be equipped with a tunnel shield. Excavation shall be carried out entirely within the tunnel shield and no excavation in advance thereof will be permitted. Every effort shall be made to avoid any loss of earth outside of the tunnel shield. Excavated material shall be removed from the jacking pipe as excavation progresses.

Upon completion of the jacking operation and if the grade of the jacking pipe is acceptable, all voids around the outside of the pipe shall be filled with grout.

607.4 DEWATERING:

All water encountered during the trenchless operation shall be disposed of by the Contractor in a manner that will not damage public or private property or create a nuisance or health problem. The cost of furnishing pumps, pipes and equipment for dewatering shall be considered incidental to the work and no additional payment shall be made.

607.5 MEASUREMENT AND PAYMENT:

Measurement for jacking pipe shall be the number of horizontal linear feet from the end of jacking pipe in the bore pit to the end of jacking pipe in the reception pit.

Payment for jacking pipe shall be full compensation for furnishing all labor, material, tools, and equipment required for the trenchless installation of the jacking pipe, complete in place including but not limited to shop drawings, dewatering, jacking pipe, bulkhead placement, grouting, and the excavation and backfilling of pits.

When a Contractor has the option of jacking and/or boring or open cut 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 pavements, curb and gutter, sidewalk, driveway and alley entrances, as allowed for by open cut construction.

- End of Section –

SECTION 608

HORIZONTAL DIRECTIONAL DRILLING

608.1 DESCRIPTION:

This specification covers requirements for installation of underground infrastructure using the trenchless technology method known as Horizontal Directional Drilling (HDD). All installations shall be in accordance with the approved HDD Consortium's "Horizontal Directional Drilling Good Practices Guideline, Third Edition" and updates thereof.

The HDD method involves first drilling a pilot bore in the location(s) as indicated on the plans, and then next enlarging the drilled pilot bore to facilitate the installation of the required pipe line or bundle, herein referred to as the "product pipe." The pilot bore is enlarged approximately 1.5 times the size of the product pipe and then the product pipe is pulled into the enlarged borehole.

Installations are classified as small, medium or large, which serves as a general indication of the level of equipment required for the installation. The size of bore is measured in inch-feet and is calculated by multiplying the nominal product pipe diameter in inches by the minimum allowable length of crossing in feet as indicated on the plans or as can reasonably be inferred from the locations of such bends, fittings, service connections, valves and any other equipment requiring excavation and/or connection to the pipe line at a specified location. The bore size refers to each individual bore, not the total footage of the permitted design.

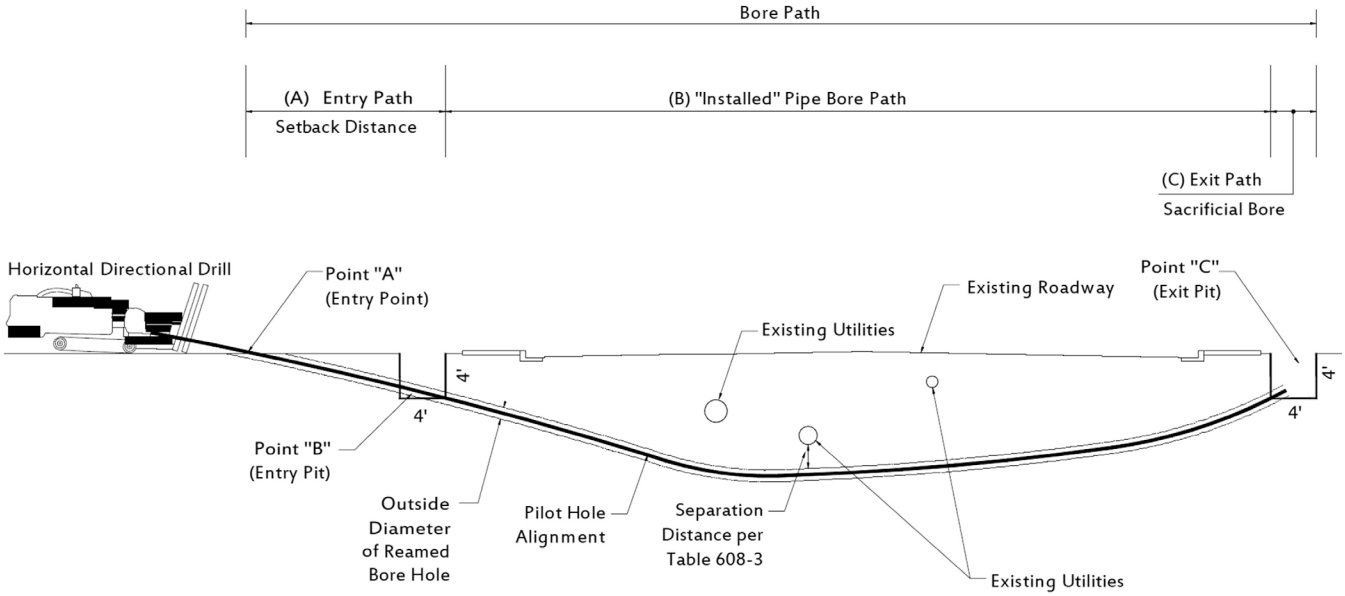
Bore size calculation: 200 foot installation of a 4 inch diameter pipe has a bore size of 800 in-ft.
(200 ft. × 4 in. = 800 in-ft.)

TABLE 608-1	
CLASSIFICATION OF BORE SIZES	
Classification	**Bore Size**
Small	Up to 6,000 in-ft.
Medium	6,001 in-ft. to 15,000 in-ft.
Large	Above 15,000 in-ft.

608.2 HDD TERMS AND DEFINITIONS:

(A) **Pilot Hole:** The initial controlled drilled horizontal shaft used to guide the enlargement to design size and eventual installation of the product pipe.
(B) **Reaming:** The back reaming hole opener is attached to the drill pipe and rotated and pulled back through the pilot hole to enlarge the bore in one or more passes to the size needed for product pipe installation.
(C) **Pullback:** The pipe installation pulled back by a swivel/pulling head connected behind the reamer, which pulls the prepared product pipe into place.
(D) **Drilling Fluids:** Fluids consisting of water, bentonite, and any approved additives such as environmentally safe polymers, lubricants, and viscosifiers.
(E) **Bore-tracking Equipment:** Methods and systems generally defined as a walkover or non-walkover. To be specified by the Contractor and used to measure the actual accuracy of the bore to the specific line and grade. The bore path is monitored during the pilot bore by taking periodic readings of the inclination and azimuth of the probe located within the sonde housing.
(F) **Bore-tracking Pit:** An excavated area for entry, exit, slurry sump or any other excavation used to manage, control, and track the progress of the bore.
(G) **Critical Structure:** Any pipeline, utility, building, structure, bridge, pier, or similar construction partially or entirely located within a zone of active excavation.

Figure 608-1



The setback distance is dependent upon elevation difference from A (surface) to B (desired grade), entry angle of rig, and bending radius of drill rods.

608.3 MATERIALS:

All product pipe material shall be of the size, type, and class as shown on the plans.

Sectional pipe is pipe that requires assembly of the joints, such as a bell and spigot pipe. Sectional pipe shall be specifically designed for installation by HDD.

Non-sectional pipe is pipe that requires joining together by a fusion or welding process. It is assembled prior to pulling the product pipe into the bore hole.

Non-sectional pipe that requires fusion of the joints, such as HDPE or Fusible-PVC, shall be fused by a skilled operator. The Contractor is responsible for using qualified personnel to ensure the fusion process follows the pipe manufacturer's recommended procedures. The Contractor shall submit certification from the pipe manufacturer or an accredited training agency documenting personnel qualifications. Untrained personnel shall not be permitted to perform fusion of any pipe on the project. The Contractor shall use a data-logger or manually record the following information for each fused joint in the product pipe line, unless the product pipe is used as a sleeve, pulled through a sleeve, or used for dry utilities.

- Date and time of joint
- Temperature
- Fusion pressure applied to joint
- Joining/fusion time
- Cooling time

Solid tracer wire AWG #14 or larger shall be pulled with the product pipe to ensure compliance with ARS 40-360.22, paragraph M.

608.4 RECORD DOCUMENTS AND SUBMITTAL REQUIREMENTS:

Submittal requirements are based on the bore size classification as shown in Table 608-2. The required items contained in items 1 through 10 shall be submitted prior to the authorization to commence field construction. Copies of all documents shall be maintained at the construction site and be available for inspection.

TABLE 608-2
SUBMITTAL REQUIREMENTS

Required Record Document	Bore Size Classification		
	Small	Medium	Large
1. Agency Approved Plans	•	•	•
2. Personnel Qualifications	•	•	•
3. Surface Survey		•	•
4. Bore Plan/Profile		•	•
5. Drilling Fluid Management Plan		•	•
6. Equipment & Site Setup			•
7. Drilling Fluid Pressure Calculations			•
8. Pipe Stress and Pullback Calculations			•
9. Bore Data	•	•	•
10. As-Built	•	•	•

608.4.1 Agency Approved Plans: The facility owner shall submit plans for approval to the Agency in whose right-of-way the facility owner is proposing to install the new utility. Any changes from the approved plans will require a re-submittal of plans and re-approval. Plans are to identify the location of all property lines, right-of-way, and easements within the project construction limits. No work is to take place outside of the construction limits as shown on the agency-approved plans.

608.4.2 Personnel Qualifications: The Contractor shall provide a competent and experienced individual familiar with the equipment and the type of HDD operations to be performed. The individual shall be present onsite while HDD operations are being performed and be in direct charge and control of the HDD operations. Documentation of experience and appropriate training evidenced by a certificate of attendance from a training program shall be provided upon request.

608.4.3 Surface Survey: A surface survey is not required for small bores unless specified by contract or permit documents. A surface survey requires the contractor, prior to starting the drilling operation, to submit to the Engineer a surface survey of elevations along the planned bore alignment, with the maximum interval between elevations of ten feet (10'). Upon completion of the installation of the product pipe, the Contractor shall have a second survey performed and shall have the elevations compared with the pre-bore survey elevations. The second survey and the comparative results shall be submitted to the Engineer. Any change in elevation of a paved surface greater than ½ inch shall be considered excessive and shall be repaired at the Contractor's expense. Any elevation deviation of a paved flow line that is greater than ¼ inch shall be considered excessive and shall be repaired at the Contractor's expense.

608.4.4 Bore Plan/Profile: A scaled plan and profile drawing of the proposed pilot bore shall be submitted by the Contractor. The bore plan/profile shall show existing surface features and grade, the proposed pilot bore size and path, and all existing utilities with dimensioned vertical and horizontal clearances.

608.4.5 Drilling Fluid Management Plan: Indicate the type and amount of the drilling fluid planned to be used on the project. Include safety data sheets for the identified drilling fluid components and additives. The drilling fluid plan is developed based upon the anticipated soil conditions, and a sufficient supply of fluid is to be available to enable successful completion of the bore. Indicate the intended method of disposal of spent drilling fluids and include approvals from off-site disposal sources. The Drilling Fluid Management Plan shall identify contingency measures to be employed in case of inadvertent returns. The contingency plan may include containment with sediment control devices, removal with vacuum equipment or other such

contingency measures as appropriate. In all cases, the plan shall indicate that if primary control measures fail and inadvertent returns cannot be controlled, work will be suspended until such a time as the plan can be revised and effective control measures can be implemented.

608.4.6 Equipment & Site Setup: Specifications on directional drilling equipment shall be used to ensure that the equipment will be adequate to complete the project. Equipment list is to include, but not be limited to drilling rig, mud system, mud motors (if applicable), down-hole tools, guidance system, and rig safety systems. Include calibration records for guidance equipment. Identify the site setup dimensions and where the equipment shall be located. Equipment shown on the site layout is to include but not be limited to drilling rig, mud system, drill rod stockpile and mud return pit. Identify the pipe staging and assembly areas.

608.4.7 Drilling Fluid Pressure Calculations: Provide documentation sealed by an Arizona registered professional engineer for the calculations of minimum required and maximum allowable drilling fluid pressures anticipated throughout the bore to maintain drilling fluid circulation and minimize the occurrence of inadvertent returns. Indicate how such pressures shall be monitored and recorded throughout the progression of the bore. Provide manufacturer's specifications for the down hole fluid pressure monitoring system(s) and properly calibrate such system(s) prior to commencing the installation.

608.4.8 Pipe Stress and Pullback Calculations: Submit documentation indicating the product pipe manufacturer's specified maximum allowable bending radius and maximum allowable pulling force for the pipe being installed. Provide calculations sealed by an Arizona registered professional engineer that show the anticipated bending radii for each segment of the pipe and the total anticipated pulling force required to complete the installation and that the maximum radius and the maximum allowable pulling forces for the pipe are within tolerable limits. The drill rig to be employed shall be capable of exerting a pullback force of at least two times that of the total anticipated pulling force required to complete the installation of the pipe specified. Furnish documentation indicating how the pulling forces introduced to the pipe will be monitored and indicate the methods that will be employed to record such data and ensure that the force exerted on the pipe does not exceed the pipe's maximum allowable pulling force.

608.4.9 Bore Data: Identify the installed location of the bore by writing down each rod and indicating the depth and pitch. Submit a copy of this information when requested.

- Rod/joint number
- Depth and pitch of locate reading

608.4.10 As-Built: Identify the installed location of the bore on a scaled drawing referencing any benchmark information provided on the original construction drawings. In addition, indicate the location of all existing utilities as provided on the original construction drawings and verified in the field, as well as any undisclosed utilities as discovered in the field throughout the prosecution of this work. Also, submit copies of any drilling fluid logs, pipe fusion logs, and any other such information as it pertains to the work undertaken pursuant to this specification.

608.5 CONSTRUCTION:

608.5.1 Horizontal Directional Drilling Equipment: The HDD equipment is to have the following:

- an electronic "walkover" tracking system or a Magnetic Guidance System (MGS) to accurately guide boring operations;
- a system to monitor maximum pullback pressure during pull-back operations;
- a system to detect electrical current from the drill string, with an audible alarm that automatically sounds when an electrical current is detected;
- a vacuum unit of sufficient capacity to handle the drilling fluid volume; and
- trained and competent personnel to operate the systems.

All equipment shall be in good, safe condition with sufficient supplies, materials, and spare parts on hand to maintain the system in good working order for the duration of the project.

608.5.2 Guidance System: An electronic "walkover" tracking system, or a MGS probe or proven (non-experimental) gyroscopic probe, and interface for continuous and accurate determination of the location of the drill head shall be used during the drilling operation. The locating system shall be capable of determining the in ground position of the drill head and shall be accurate to ±2% of the distance from the transmitter to the receiver. It shall enable the driller to guide the drill head by providing information on the pitch; roll and clock face orientation of the drill head. The locating system shall be capable of determining the depth of the drill head from the transmitter to the surface at any location along the path of the bore. The locating system shall be calibrated per the manufacturer's specifications prior to commencing the bore.

608.5.3 Drilling Fluid (Mud) System: A self-contained, closed, drilling fluid mixing system of sufficient size to mix and deliver drilling fluid composed of bentonite clay, uncontaminated water, and appropriate additives shall be used. The mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be of sufficient capacity to supply an amount of drilling fluid that is equal to the maximum rated output of the drilling fluid pump over at least a fifteen-minute duration. Ensure the drilling fluid is mixed per drilling fluid manufacturer's recommendations and continually agitate the drilling fluid during drilling operations. The Contractor shall be responsible to monitor drilling fluid properties and return fluid properties and shall modify the drilling fluid mix as appropriate for the soil conditions encountered. Contractor shall continually monitor and record any necessary drilling fluid properties such as viscosity as determined by a marsh funnel standard test method (ASTM D6910). The drill fluid pumping system shall be capable of delivering drilling fluid at a sufficient output rate and at minimum pressures as necessary to enable successful completion of the bore. Furnish pumping equipment and/or vacuum truck(s) of sufficient size to convey drilling fluid from containment areas, to storage and recycling facilities or disposal.

608.5.4 Directional Drilling Operation: Prior to drilling the pilot hole, "walk" the bore path with the locating system, as per the manufacturer's specifications, attempting to identify any areas of potential interference and record the results of such inspections. Verify that all known utilities have been located and there is no conflict with the proposed work. Ensure all utilities that run parallel within 2 feet of the proposed work are exposed at intervals sufficient to determine there will be no conflict with the proposed work. Comply with surface survey requirements.

Determine the depth of the drill head every 10 feet or every rod length, whichever distance is greater. Record location information for the entirety of the bore, either manually in a driller's log or automatically via the locating system. Make all recorded readings, and plan and profile information available at all times. Do not allow the deflection radius of the drill pipe exceed the deflection limits of the product pipe at any time throughout the crossing. Use white paint and mark the depth of the pilot bore on the ground at an interval not exceeding 10 feet.

Stabilize the open bore hole by means of bentonite drilling slurry pumped through the drill rod and through openings in the drill head or reamer. The drilling slurry shall be in a homogenous/flowable state serving as an agent to carry the loose cuttings to the surface through the annulus of the borehole. Calculate the volume of drilling fluid required for each reamer pass based upon hole size and soil conditions. The driller shall not be permitted to "outrun his mud" which is the condition occurring when the drilling penetration or retrieval rate is generating cuttings at a rate faster than the drill fluid pumping system can suspend and convey the cuttings out of the bore hole.

Contain all drilling fluids in pits or holding tanks for recycling or disposal. Monitor drill fluid circulation throughout the duration of the bore activity and immediately take corrective actions to restore fluid circulation should circulation be lost.

Upon completion of the pilot bore, ream the bore hole up to a large enough diameter to accommodate the pullback of the product pipe. The final reamed hole opening shall be 1.5 times the outside diameter of the product pipe for pipe lines 24 inches or less, or no larger than 12 inches plus the outside diameter of the product pipe for pipe lines greater than 24 inches.

Maintain a one (1) foot minimum separation between the outside of the pilot bore hole and the outside of the utility when no reaming is required to install the product pipe.

When the pilot bore hole is to be reamed, maintain a minimum separation between the outside of the pilot bore hole and the outside of existing utility equal to one foot greater than the largest required reamer diameter.

Minimum separation between the bore and any existing underground utility shall conform to Table 608-3.

TABLE 608-3	
MINIMUM SEPARATION FROM EXISTING UNDERGROUND UTILITIES	
Minimum Separation	**Type of Underground Utility**
2 foot vertical	Outside of bore to outside of wet utility (wastewater, storm, flood irrigation, water, etc.)
1 foot vertical	Outside of bore to outside of dry utility
6 foot horizontal	Running line to outside of wet utility

608.5.5 Handling Product Pipe: Care shall be taken during transportation of the product pipe to prevent it from being cut, kinked, or damaged. Use ropes, fabrics, or rubber protected slings and straps when handling pipes. Do not use chains, cables, or hooks inserted into the pipe ends. Use slings spread apart for lifting each length of pipe. Do not drop pipe or fittings onto rocky or unprepared ground.

Store pipe on level ground that is free of sharp objects that could damage the pipe. Limit the stacking of pipes to a height that will not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions. Where necessary due to ground conditions store the pipe on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

Handle assembled pipe in a manner that avoids damage to the pipe. The pipe is not to be dragged over sharp objects. Position slings to prevent stress on pipe joints. Product pipe that has cuts, gouges, or excessive deformation shall be removed and replaced.

608.6 MEASUREMENT:

Measurement of product pipe installed by HDD shall be by the lineal foot of pipe installed. Measurement shall be along the centerline of the product pipe, through all valves, fittings and manholes, from centerline to centerline of valves, fittings or structures or to the end of pipe.

608.7 PAYMENT:

Payment will be made at the contract unit price for each type and size of product pipe installed and accepted. Payment shall be compensation in full for the product pipe and furnishing all labor, material, tools, and equipment required for the horizontal directional drilled installation of product pipe, complete in place, including all related excavation, shoring and bracing, backfill, and compaction. When specified payment shall also include, testing, disinfecting, restoration, and connections to existing lines or works.

- End of Section -

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 pipes 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 water lines 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 pipes for water lines shall be of the classes shown on the plans or as specified below.

(A) The 4-inch through 16-inch diameter pipe sizes may be PVC C900 or ductile iron, except where a particular material is specified by the agency or the contract documents. All pipes shall be minimum 150 psi design unless otherwise specified.

(B) Pipe 16 inches and larger may be either ductile iron, or concrete pressure pipe-steel cylinder type.

Ductile iron and cast iron water pipe and fittings per: Section 750. Concrete pressure pipe-steel cylinder type per: Section 758. C900 PVC per: AWWA C900-07.

Service material containing brass or bronze must comply with the current NSF 61-8 standards at the time the project begins.

All brass or bronze service material must meet the current AWWA C800 standards.

Any product used in water line construction containing brass or bronze that comes in contact with potable water shall meet the current NSF standards and federal law.

Only such packing materials as are included in the list of acceptable materials in AWWA C600 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 sulfur compound caulking will not be permitted.

610.4 CONSTRUCTION METHODS:

610.4.1 Trenching/Cover: 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 minimum 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.

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 pipeline has been installed to the satisfaction of the Engineer, subject to the requirements for testing per Section 611.

610.4.2 Laying Pipe: No water main shall be deflected, either vertically or horizontally, in excess of that recommended by the manufacturer of the pipe or coupling.

If adjustment 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.

Curb stops with flushing pipes or fire hydrants shall be installed at the ends of dead-end mains according to standard details.

Thrust blocks shall be installed in accordance with this specification.

Valve boxes and covers shall be according to standard details.

Ductile iron pipe shall be installed in accordance with this specification and pipe and fittings shall be in accordance with Section 750.

PVC C-900 pipe shall be installed in accordance with AWWA C900 and Section 601.

610.4.3 Blocking and Restraints: 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 installed per details shown on the plans. The areas stipulated in the standard details are minimums and shall not be decreased.

If irregular soil or pressure conditions are encountered, a thrust block design revision or an alternate joint restraint system may be required by the Engineer.

When restrained/welded joints are specified to resist thrust forces, blocking is not required.

With the Engineers approval, restrained/welded joints may be used in lieu of thrust blocks.

Where restrained joints are specified on mains sixteen (16) inches in diameter and smaller, ductile iron pipe shall be used with an approved joint restraint method.

On mains sixteen (16) inches in diameter and larger where plans specify welding joints and where ductile iron pipe is furnished, joints shall be restrained by an approved joint restraint method for the distance specified.

610.4.4 Maintain Pipe Cleanliness / Pipe Cleaning: 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.

Every precaution shall be taken to prevent foreign material from entering the pipe. When on the project site, the ends of the pipe section shall be plugged, wrapped or tarped at all times when pipe laying is not in progress, which includes storage and staging at the site. The pipe shall be stored on a pallet, blocking or other means to prevent foreign materials from entering the pipe. The pipeline shall be protected by a watertight plug or other means approved by the Engineer when the pipe is in the trench if pipe laying is not in progress.

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.

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, and 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.

610.4.5 Testing: Hydrostatic testing shall be in accordance with Section 611 . After pressure testing and before placing in service, all water lines shall be disinfected. Disinfection shall be accomplished in accordance with Section 611. All corporation stops used for testing and chlorination shall be left in the pipeline with the stop closed and all connecting pipe removed.

610.5 SEPARATION:

610.5.1 General: Water lines and sewer lines shall be separated to protect water lines from contamination by sewer lines.

The angle of a water line and sewer line crossing shall be limited to between (45) forty-five degrees and (90) ninety degrees. Intersection angles of less than (45) forty-five degrees shall not be allowed.

Separation distances are measured from the outside diameter of the water or sewer line, or the centerline of a manhole.

When water and sewer lines cannot meet separation requirements, extra protection is required as described in Subsection 610.5.5 and shown in Standard Details 404-1, 404-2 and 404-3. Alternate construction techniques, materials, and joints shall be reviewed and approved by the Contracting Agency and Maricopa County Environmental Services Department.

Extra protection requirements for line crossings are measured from the closest outside surfaces of the sewer and water line.

Water line service connections to individual building supply and distribution plumbing shall not be placed below sewer lines, and shall otherwise comply with the separation requirements of the applicable plumbing code as applied by the Agency (Administrative Authority). Methods described for extra protection do not apply to these service lines.

Water and sewer lines shall not be constructed parallel within a common trench.

610.5.2 Water Line Separation from Gravity Sewer Lines: Water lines shall not be placed within two (2) feet horizontal and one (1) foot vertical above and two (2) feet vertical below gravity sewer lines.

Extra protection is required where a water line is placed within six (6) feet horizontal and two (2) feet vertical above a gravity sewer line.

Extra protection is required where a water line is placed within six (6) feet horizontal and any distance below a gravity sewer line.

610.5.3 Water Line Separation from Pressurized Sewer Lines: Water lines shall not be placed within six (6) feet horizontal and within two (2) feet vertical below or within two (2) vertical above a pressurized sewer line.

Extra protection is required where a water line is placed within six (6) feet horizontal and within six (6) feet vertical above a pressurized sewer line.

Extra protection is required where a water line is placed within (6) feet horizontal and any distance below a pressurized sewer line.

610.5.4 Water Line Separation from Manholes: Water lines shall not pass through or come into contact with any part of a sewer manhole and shall be separated six (6) feet horizontal from the center of a sewer manhole.

610.5.5 Extra Protection: New water lines that require extra protection from new sewer lines, shall have extra protection provided by using ductile iron pipe for both lines. Lines of standard pipe length shall be centered at the point of crossing so that no joints exist within six (feet) horizontal and only restrained or mechanical joints exist within ten (10) feet horizontal. Alternate encasement sleeving can be used to house the carrier pipe subject to Contracting Agency and Maricopa County Environmental Services Department approval.

New water lines that require extra protection from sewer lines shall have identification wrap and/or tape installed on the water and sewer lines for the length that requires extra protection for each line.

New water lines that require extra protection from existing sewer lines shall be constructed using the extra protection specified for new water lines, and the existing sewer line:

(1) shall be reconstructed using a standard length of ductile iron pipe centered at the point of crossing so that no joints exist within six (6) feet horizontal and only restrained or mechanical joints exist within ten (10) feet horizontal, or

(2) shall be encased in 6 inches of concrete for the horizontal distance of the line that requires extra protection but for a distance no less than ten (10) feet horizontal.

Alternate extra protection, subject to approval by Contracting Agency and Maricopa County Environmental Services Department, may be provided by:

(3) encasing existing sewer line in a steel casing per Section 602, centered at the point of crossing so that no joints exist within six (6) feet horizontal and only restrained or mechanical joints exist within ten (10) feet horizontal, or

(4) lining existing sewer line using Cured in Place Pipe for a horizontal distance from the point of crossing no less than ten (10) feet horizontal in each direction.

Existing water lines that require extra protection from new sewer lines shall provide for extra protection by:

(1) constructing the new sewer line and reconstructing the existing water line using ductile iron pipe for both lines with standard pipe lengths centered at the point of crossing so that no joints exist within six (feet) horizontal and restrained or mechanical joints exist within ten (10) feet horizontal, or

(2) encasement of both the existing water line and the new sewer line in six (6) inches of concrete for the horizontal distance of the lines that require extra protection but for a distance no less than ten (10) feet horizontal.

(3) Extra protection for existing ductile iron water lines can be met by the installation of restrained or mechanical joints on the existing water line within ten (10) feet horizontal of the crossing and either

(a) construction of new sewer line using a standard pipe length of ductile iron pipe centered at the point of crossing so that no joints exist within six (6) feet horizontal and restrained or mechanical joints exist within ten (10) feet horizontal, or

(b) encasement of the new sewer line in 6 inches of concrete for the horizontal distance of the line that requires extra protection but for a distance no less than ten (10) feet horizontal.

Alternate extra protection, subject to approval by Contracting Agency and Maricopa County Environmental Services Department, may be provided by:

(c) encasing new sewer line in a steel casing per Section 602 measured at the point of crossing so that no joint exists with six (6) feet horizontal and only restrained or mechanical joints exist with ten (10) feet.

610.6 POLYETHYLENE CORROSION PROTECTION:

610.6.1 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.

610.6.2 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 ultraviolet light will be less than 48 hours.

Otherwise, the material shall be pigmented with 2 to 2 1/2 percent of well-dispersed carbon black with stabilizers.

The polywrap shall be secured as specified below with 2-inch wide pressure sensitive tape not less than 10 mils thick. This flexible tape shall consist of a polyethylene or polyvinyl chloride backing with a synthetic elastomeric adhesive film comprised of butyl rubber. Tape shall remain flexible over a wide range of temperatures, with tensile strength and elongation properties in conformance with ASTM D1000.

The minimum tube size for each pipe diameter shall be per Table 610-1.

TABLE 610-1 (from AWWA C105-05)		
POLYWRAP FLAT TUBE WIDTHS		
Nominal Pipe Diameter (Inches)	**Cast Iron Or Ductile Iron With Push-On Joints (inches)**	**Cast Iron or Ductile Iron With Mechanical Joints (inches)**
4	14	16
6	16	20
8	20	24
10	24	27
12	27	30
14	30	34
16	34	37
18	37	41
20	41	45
24	54	53
30	67	.
36	81	.
42	81	.
48	95	.
54	108	.
60	108	.
64	121	.

610.6.3 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.

610.6.4 Payment for Polywrap: Payment for this item shall be per the provisions of Subsections 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.

610.7 VALVES:

Valves shall be installed in accordance with AWWA C600 or AWWA C603 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 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.

610.8 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 to 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 C76 Wall A or B. Vaults shall be kept moist for 7 days before backfilling.

610.9 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.

610.10 COUPLINGS, JOINTS, GASKETS AND FLANGES:

(A) **Couplings:** The couplings used to join the pipe to flanged valve adapters shall have a minimum working pressure of 150 psi, and shall have a fusion-bonded epoxy finish. The coupling sleeves shall be carbon steel with a minimum yield of 30,000 psi. The flanges shall have a minimum yield of 30,000 psi and be ductile iron or carbon steel for sizes up to 12", or high-strength, low-alloy steel for sizes 14" and larger.

(B) **Joints:** The joints and fitting shall conform to Sections 750 and 752.

Bolts and Nuts:

(1) Bolts, studs, and nuts used in underground field flanged connections or for connecting fittings shall be carbon steel compliant with ASTM A307, Grade A unless Grade B is specified. Bolts, studs, and nuts shall be in accordance with AWWA C111. Bolts and studs shall have Class 2A thread tolerance with the corresponding nuts having Class 2B tolerance. Bolts, studs and nuts shall have a hot-dipped zinc coating in accordance with ASTM F2329. All bolt diameters shall normally be 1/8 inch smaller than the bolt hole diameter. If specified, allowable exceptions to zinc coating shall be bolts, studs, and nuts made from 316 stainless steel per ASTM F593 or cadmium plated per ASTM B766. All bolts shall be hexagonal heads.

(2) The minimum requirement for underground mechanical joint connections using T-head bolts shall meet the requirements of AWWA C111 using a high strength low alloy steel manufactured for atmospheric corrosion resistance per ASTM A242.

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-ID "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 C150, 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 C203 and shall be applied to the top part of the pipe or fittings by daubers for at least two 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 two coats for a minimum thickness of 1/16 inch. The daubers and method of application shall conform to AWWA C203. No thinning will be allowed.

(C) **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 otherwise provided, all gaskets for pipelines shall be one piece full faced gaskets from one-ply cloth inserted SBR rubber material. Gaskets for flanges 20 inches and smaller shall be from 1/16 inch thick material. Gaskets for flanges 24 inches and larger shall be from 1/8 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 D2000, Class 4AA805A13.

(E) **Flanges:** Cast iron flanges shall conform to AWWA C110 as to material, diameter, thickness, drilling, etc. Steel flanges shall be ring or hub type, and shall conform to AWWA C207, Class D. All flanges shall be drilled and have flange diameters and bolt circles conforming to AWWA C110, except bolt holes will be 1/8 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.

610.11 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.

Only Agency personnel shall operate existing valves. The Contractor shall not operate valves in the existing system.

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 100% complete shutdown.

610.12 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 ductile iron pipe per Section 750.

610.13 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 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 be made prior to testing and disinfection of the new line.

(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.

610.14 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.

610.15 PAVEMENT AND SURFACING REPLACEMENT:

Pavement and surfacing replacement shall be in accordance with the requirements of Section 336.

610.16 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 of lateral line pipes shall start at the centerline of valve at connection to the main. Measurement of service lines shall be from the centerline of the new main to the connection at the meter. Measurement shall be to the nearest foot.

(2) Payment will be made at the contract unit price per linear foot of each type and size of pipe. 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, backfilling, compaction, maintenance of traffic, testing, disinfecting, connections to existing lines or works, and all work not specifically covered in other pay items.

(B) **Service Line Connections:** Measurement shall be of the number of unit connections made for water services, if called for in the bid. Each bid item unit shall consist of the connection to the water main and to the meter, as may be required in the plan details. Payment will be made at the contract unit price for each water 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. If no contract bid item exists for connections, then the cost for connections to meters and main lines shall be included in the corresponding pipe bid item unit price.

(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 contract unit price 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 bid, 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 inches 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 contract unit price 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 inches 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 contract unit price for the installation of each fire hydrant complete in place and in operating condition. The 6 inch ductile 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 service line installations shall be included in the contract unit price for service line pipe.

- ***End of Section*** -

SECTION 611

WATER, SEWER AND STORM DRAIN TESTING

611.1 DESCRIPTION:

The testing of new water lines, fire lines, force mains, sewer lines, and storm lines shall conform to the applicable testing procedures and inspection requirements as outlined herein, except as otherwise required on the plans, as modified in the special provisions or as directed by the Contracting Agency.

Water mains shall be isolated, disinfected, sampled and tested to meet the Safe Drinking Water Act Requirements per 40CFR Part 141.

The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pumps, measuring devices and all other equipment necessary for performing the tests including new or good condition pressure gages. If required by the Contracting Agency, Contractor shall pay for water used in the performance of the required flushing and pressure testing. Water quantities used shall be calculated or meter measured as directed and approved by the agency.

Unless otherwise provided for, the Contractor shall notify the Contracting Agency no less than 72 hours to schedule the start of the testing and disinfection cycle.

611.2 FLUSHING AND HYDROSTATIC TESTING:

Water lines, fire lines and force mains, including all fittings and connections, shall be pressure tested for water-tightness by subjecting each section to hydrostatic testing in accordance with applicable provisions of AWWA C600 and C605 (Latest Version), except as modified below.

611.2.1 Flushing Completed Main Lines:

(A) **Flushing Plan:** If required by the Contracting Agency, the Contractor shall submit a written flushing plan for review and approval prior to starting any flushing activities. The plan may be a written detailed narrative or a shop drawing submittal depending on complexity of the system or agency requirements. There may be different plans for initial flushing (debris) and a final flushing (high chlorine). The plan shall include and indicate all locations for the connection feed point, backflow protection device, measuring meter (if required), all valves and fire hydrants, all permanent or temporary air release points, testing/sampling riser ports, discharge outlets, proper de-chlorination procedure (for final flushing), and final disposal location/destination of the flushing water. The plan shall indicate the required sequential phasing to achieve a positive, one directional flushing action. For water lines greater than 16 inches, an engineered flushing plan shall be required.

(B) **Valve Operation:** Check with the Contracting Agency for any policy regarding the operation of existing valves or other appurtenances.

(C) **Line Filling:** 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 Contracting Agency, with at least 48-hour notice required before tests are scheduled. Measurement and documentation of the volume flow of water into and out of all lines shall be made by means of a pitot gage, meter supplied by the Contracting Agency, volume calculations based on design, system and conditions as monitored and approved by the Contracting Agency, or some other pre-approved device/set-up.

(D) **Preliminary (Debris) Flushing:** All mains 16 inches and smaller shall be flushed using clean potable water, prior to chlorination, as thoroughly as possible with the water pressure and outlets available. Flushing is intended to remove only light debris and should not be relied upon to remove heavy material. Contractors shall exercise care and proper workmanship in the pipe laying operation to not allow dirt and debris to get into the pipe. Dirt, bedding materials, rocks or other foreign debris may cause damage to valves and fire hydrants during flushing operations. When excessive or large debris is witnessed exiting the outlets during flushing, the valves and fire hydrants shall be further investigated and inspected to verify that they are in good working order.

(E) Required flow and openings (either taps or hydrants) to flush pipelines is at 3.0 ft./sec (40 psi residual pressure in water main) * Reference AWWA C651 (Latest Version).

Recommended Outlet Size Requirements for Flushing

Main Size	Minimum Outlet Size Required
4" thru 6"	3"
8"	4"
10" thru 16"	6"
Greater than 16"	Engineered Flushing Plan Required

Contracting Agency has final determination of size, number of blow offs and location of flushing inlets and outlets.

611.2.2 Hydrostatic Testing: Pressure testing may be performed before or after final backfilling. If the pipeline is properly and safely center-loaded, a visual inspection for leaks may be made along the pipeline, while the test section is under test pressure. Any visible leaks shall be repaired and a retest conducted. However, if mechanical compaction is to be used in the backfilling operations per AWWA C600 and C605, the pressure tests shall not be performed until final backfilling is 100% completed including compaction. Backfill and compaction shall be 100% complete for any restrained pipeline sections for the entire designated restrained distance prior to pressure testing. All pipe sections, stub laterals, fire hydrant laterals, blow-offs, and valves encompassed in the test section shall be verified to be open, water filled and pressurized. Actual hydrostatic monitor testing shall not begin until the pipeline has been filled entirely with water for at least 24 hours to allow for air venting and absorption.

(A) **Pressure Testing:** Unless otherwise noted in the contract documents, the minimum prescribed test pressure shall be at least 200 psi for lines smaller than 16 inches and 150 psi for lines 16 inches or larger, not to exceed 5 psi over the minimum prescribed test pressure, as measured at the lowest end of the section under test. The duration of each pressure test shall be at least 2 hours, during which time the test section shall not drop below the minimum prescribed test pressure. If the pressure in the pipe test section has not stabilized by the end of the testing period, a hydrostatic retest will be required.

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 C600 and C605, 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 2,640 feet in total pipe length shall be tested without written permission of the Engineer.

Contractor shall bleed all air out of new lines being tested. After all air has been determined to have been removed and the pressure has stabilized and maintained constant, the line shall be determined to be ready for testing. The Contractor shall furnish all necessary apparatus and assistance to conduct the testing.

(B) **Testing Allowance / Makeup Water:** If a testing allowance is permitted by the Contracting Agency, the makeup water volume shall be determined after the pressure test has been satisfactorily completed and all backfilling and compaction has been completed to top of trench. The allowance shall be defined as the maximum quantity of additional water necessary to be supplied into the pipe section under test to restore the ending test pressure to the beginning test pressure, after the pipeline has been filled with water and all air expelled.

The duration of each makeup water test shall be at least 2 hours. To pass the allowance testing, the quantity of makeup water from the pipeline shall not exceed the makeup water quantity allowed by the following formula:

$$A = \frac{LD\sqrt{P}}{148{,}000}$$

Where
A = testing allowance (makeup water), gallons per hour.
L = length of pipe tested, feet
D = nominal diameter of pipe, inches.
P = test pressure, pounds/square inch

If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the computed allowance for each size. Should the test on any section of the pipeline require more makeup water than allowed by the above formula, the Contractor shall locate and repair the defective pipe, fittings, or joint until the makeup water volume is within the specified allowance. All repairs and re-tests, if required, shall be made at the Contractor's expense.

611.3 DISINFECTING WATER MAINS:

611.3.1 Isolation: Unless otherwise directed by the Contracting Agency, new water mains shall be physically isolated from active distribution systems until initial disinfection and satisfactory bacteriological results have been completed. The means for protecting active distribution systems from contamination due to reverse flow shall be according to level of protection required by Arizona Administrative Code (A.A.C) R18-4-215. Physical breaks or gaps in the water main line are acceptable; or temporary insertion of a properly sized and certified reduced pressure backflow assembly ("jumper" set-up) is also an acceptable method. Check with Contracting Agency for specific requirements.

611.3.2 Disinfection: The method of chlorination used shall be approved by the Contracting Agency and must conform to NSF/ANSI 60 & 61 and the AWWA C651 (Latest Version) Standards. The Contracting Agency shall determine the number and locations for sample risers. The contractor is responsible for supplying equipment to properly dose the new main with a chlorine concentration not less than 10 parts per million (ppm). The Contracting Agency will verify the chlorine level is at 10 ppm at time of dosing and verify that after 24 hours of high chlorine solution sitting in the pipes that the chlorine concentration is at 10 ppm or greater. All new valves, hydrants and other appurtenances shall be operated fully to ensure full disinfection from the chlorine solution.

After 24-hour verification is complete, the water main shall be completely flushed of the high chlorine concentration. A chlorine neutralizing agent may be required during flushing discharge. Check with the Contracting Agency to confirm.

(A) **Methods of Applying Chlorine:** One of the following methods of application of chlorine shall be used, subject to the approval of the Contracting Agency.
- Liquid chlorine gas-water mixture.
- Calcium or sodium hypochlorite and water mixture.

(B) **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 or other potable water source on the pressure side of the gate valve controlling the flow into the pipeline extension.

(C) **Rate of Application:** Water from the existing distribution system or other approved potable water source of supply shall be controlled so the rate of flow shall not exceed 500 gpm, unless approved by the Contracting Agency, 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.

(D) **Retention Period:** The highly chlorinated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. This period should be at least 24 hours and no more than 48 hours.

If the circumstances are such that less than a 24-hour retention period must be used and upon approval by the Contracting Agency, the chlorine concentration shall be increased to 100 ppm not to exceed 300 ppm and retained for at least 2 hours. Under these conditions, special care should be taken to avoid chemical attack on pipes, valves, hydrants and other appurtenances.

(E) **Short Pipe Sections / Laterals / Stubs:** For short sections of new pipelines of up to twenty feet or less in length and where the new line cannot be isolated for testing or installation of a temporary backflow and metering set-up is not possible or feasible, the following procedure may be used with Contracting Agency approval on a case-by-case basis. Various modifications may be necessary or required depending on specific circumstances. This does not apply to small diameter domestic copper water services of up to two inches.

1. 100% of all new pipe materials/fittings used in the installation and tie-in from the existing main line to the backflow assembly on fire lines and up to the first meter, connection on domestic water lines shall be disinfected. Any new tie-in valves at the main line shall remain completely closed.

2. All new pipe materials/fittings used in the installation and tie-in are to be disinfected by swabbing with a chlorine solution of at least 200 ppm using NSF/ANSI 60 & 61 approved equipment, materials and chemicals. The chlorine solution shall be tested by the Contracting Agency or designated representative to ensure that it meets the strength requirements. Inspector shall witness the swabbing procedure and document results. A new swabbing device should be used for each new line.

3. The new lines and fittings shall remain empty and closed to the atmosphere for 24 hours to allow the high chlorine treatment sufficient time to disinfect.

4. After the 24-hour period, with Contracting Agency supervision, the new valves shall be operated, and the ends of the lines shall be opened at the largest port available to allow initial flushing of the high chlorine solution. The Contracting Agency shall test this first flow of water to verify that at least 10 ppm of chlorine is still present. The line can then continue to be sufficiently flushed until the chlorine levels are below 2.0 ppm as verified by the Contracting Agency.

5. The new lateral valves at the main tie-in shall then be closed and remain closed after flushing; the new lateral line shall remain charged with water and allowed to sit for an additional 24 hours.

6. After 24 hours, the Contracting Agency shall check the chlorine residual levels and collect microbiological samples for lab testing as detailed herein.

7. The new lateral valves at the main tie-in shall remain closed until the Contracting Agency receives the laboratory results that show a negative or "Absent" reading for both Total Coliform and E. Coli.

611.3.3 Final Flushing, Sampling and Testing: Following chlorination, all treated water in the newly laid pipeline shall be thoroughly flushed until the replacement water throughout the new pipeline can be proved, by laboratory testing, comparable in quality to the water served to the public from the existing water system. Prior to sampling for laboratory testing, the residual chlorine throughout the length of the pipeline shall be reduced to 2.0 ppm or less per Contracting Agency allowances. Once the required residual chlorine level in the pipeline is achieved, bacteriological samples shall be taken as outlined below.

The Contracting Agency or its authorized representative shall collect all samples for testing of the new water mains. To initiate the sampling and testing, the Contractor will present to the Contracting Agency or its authorized agent a written request for such work no later than 48 hours prior to the time when samples are to be taken. Samples shall be taken from a tap and riser located and installed in such a way as to prevent outside contamination. Samples shall never be taken from an unsterilized hose or from fire hydrants.

The number and types of sampling locations shall be per the flushing plan as approved or determined by the Contracting Agency or its authorized agent; and at a minimum, shall be as follows:

- Waterlines up to but less than 150 feet in length require one sampling riser installed as near the end as possible.
- Waterlines 150 feet to 300 feet in length, two sampling risers, one near each end of the line.
- Waterlines 300 feet to 2,640 feet in length, a minimum of three sampling risers. In addition, dead ends on main lines should be represented with a sampling riser.
- Waterlines greater than 2,640 feet in length shall require a minimum of one additional sampling riser per 1,000 feet.

The Contractor shall install the correct type of sampling risers at the locations shown on the approved flushing plan; or as otherwise directed by the Contracting Agency or its authorized agent. Samplingrisers must be at least 18 inches above grade and no more than 48 inches above grade. Sampling risers can be attached to service line curb stops, line blow-off outlets, tapped end-of-line caps, permanent industrial sampling stations or sampling specific taps (saddle, corp stop & riser). Sampling risers shall be made of rigid NSF/ANSI 60 & 61 approved piping material for potable water. The sampling riser outlet must be able to adjust the flow of water and shall not contain inside or outside threads. The sampling riser outlet shall be pointed downward perpendicular to the ground.

The specific method or combination of methods, sequencing, number of required samples at each sampling location and minimum wait times shall be determined by the Contracting Agency or its authorized agent. Some Contracting Agencies may require two sample sets and require or allow different wait times before samples can be taken. For two sample sets, allow 15 minutes between sampling times. The standard sampling methods are listed as follows:

(A) One sample (or set of samples) from each sampling location taken 24 hours after flushing high chlorine and no water use is examined in the laboratory using the Total Coliform (TC) method.
(B) Two samples taken on separate days from each sampling location. An additional sample (or set of samples) is taken after an additional 24 hours and no water use is examined in the laboratory using the Total Coliform (TC) method.
(C) Standard heterotrophic plate count (HPC) test. Samples shall be taken at the same location, and time, as the Total Coliform samples. At a minimum, each HPC test result must be reported as less than 500 CFU/ml or at a limit established by the Contracting Agency.

Laboratory and field analysis shall be done by methods approved by the Arizona Department of Health Services (ADHS).

Upon completion of laboratory testing, results of all tests shall be sent by the designated laboratory to the Contracting Agency. Results of laboratory analysis will be interpreted by the Contracting Agency and reported back to the Contractor. Under no circumstances shall the Contractor contact the laboratory. If there is a need to obtain test results before the actual written reports are submitted, such information shall be obtained only from the Contracting Agency. All reported test results must show a negative or "Absent" reading for both Total Coliform and E. coli.

If any sample in the initial treatment fails to pass the Total Coliform or HPC tests, all sample locations shall be resampled and retested at the Contractor's expense using the duplicate disinfection procedures listed above and shall be repeated until satisfactory results are obtained.

611.3.4 Final Connections: Any temporary air release blow-offs and test sampling risers shall be left exposed, accessible and protected during backfill operations until all testing is complete. After all testing has been completed and passed acceptance, all temporary blow-offs and sampling risers shall be properly lowered and terminated as directed by the Contracting Agency.

Connections to existing pipelines or existing valves shall not be made until after all new pipe main line or specific sections thereof, has satisfactorily passed all required hydrostatic and disinfection tests and the Contracting Agency gives approval to make the final connections and put new water mainline into service.

611.4 SEWER LINE TESTING:

Pressure testing of force mains shall be done in accordance with Section 611.2

Sewers and pipelines shall be subject to acceptance testing after backfilling has been completed but prior to the placement of the finished surface material.

The Contracting Agency reserves the right to require testing of the entire installation. Cost of repairs or corrections necessary to conform to the following testing requirements will be borne by the Contractor at no additional cost to the Contracting Agency.

(A) **Low Pressure Air Test:**

Testing will be accomplished by the means of "Low Pressure Air Testing." Tests may be conducted by the Contractor or an independent testing firm. However, acceptance tests shall be made only in the presence of the Engineer.

Test Procedure:

(1) Before testing, the pipe shall be thoroughly cleaned.
(2) The Contractor shall seal off the section of pipe to be tested at each manhole connection. Test plugs must be securely braced within the manholes.
(3) A minimum of two connecting hoses to link the air inlet test plug with an above ground test monitoring panel must be provided.
  (a) One hose is to induce air through the test plug and into the test chamber.
  (b) The second hose is for the purpose of monitoring the test pressure from within the enclosed pipe.
(4) UNDER NO CIRCUMSTANCES ARE WORKERS TO BE ALLOWED IN THE CONNECTING MANHOLES WHILE A PRESSURE TEST IS BEING CONDUCTED.
(5) Add air slowly into the test section. After an internal pressure of 4.0 psi is obtained, allow internal air temperature to stabilize.
(6) After stabilization period, adjust the internal air pressure to 3.5 psi, disconnect the air supply and begin timing the test.
(7) Refer to Table 611-1 to determine the length of time (minutes) the section under test must sustain while not losing in excess of 1 psi as monitored by the test gauge. If the section of line to be tested includes more than one pipe size, calculate the test time for each size and add the test times to arrive at the total test time for the section.
(8) Sections so determined to have lost 1 psi or less during the test period will have passed the leakage test. Those sections losing in excess of 1 psi during the test period will have failed the leakage test.
(9) Appropriate repairs must then be completed and the line retested for acceptance.

TABLE 611-1			
SANITARY SEWER AIR TEST			
Minimum Test Time for Various Pipe Sizes*			
Nominal Pipe Size, in.	T (time), min/100 ft.	Nominal Pipe Size, in.	T (time), min/100 ft.
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

* The time has been established using the formulas contained in ASTM C828, Appendix.

(B) **Hydrostatic Test:**

Exfiltration Testing (water):

Sanitary sewer testing by means of exfiltration should only be considered when low pressure air testing cannot be used and only with the approval of the Engineer.

Testing Procedure:

(1) The Contractor shall furnish all equipment for testing.
(2) Seal off the downstream end of the line and fill with water to a minimum head of 4 feet in a stand pipe at the high end.
(3) A period of at least one hour will be allowed for absorption time before making the test.
(4) A suitable meter or method of measuring the quantity of water used is necessary.

(5) The allowable water loss for sanitary sewers shall not exceed 0.158 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.

(C) **Deflection Test for HDPE and PVC Pipe:**

In addition to the tests prescribed above, the Contractor shall perform a deflection test on the system as directed by the Engineer. Any part of the installation that shows deflection in excess of 5% of the nominal inside diameter per Section 738 for HDPE pipe or in excess of 5% of the average inside diameter per ASTM D3034 for PVC pipe, shall be evaluated and appropriate remedy, if any, shall be performed.

After acceptance but prior to the termination of the warranty period, the Contracting Agency may test the long-term deflection of the sewer. If the Contracting Agency determines that the deflection has exceeded 7 ½% of the average inside diameter, that portion of the installation shall be corrected by the Contractor at no cost to the Contracting Agency.

(D) **Closed Circuit T.V. Inspection:**

The Contracting Agency reserves the right to visually inspect the interior of the sewer line using a television camera. Any defects in the pipe or construction methods revealed shall be corrected by the Contractor at no additional cost to the Contracting Agency.

611.5 POST INSTALLATION INSPECTION OF NEW MAINLINE STORM DRAINS:

(A) **Video Inspection:**

The Contractor shall provide the Engineer with an annotated video inspection record (either VHS or DVD format) of the new mainline storm drain pipeline. The video shall clearly show all joints, seals, connecting pipes, and manholes. This video shall be provided to the Engineer, and reviewed and approved by the Engineer prior to the Contractor being allowed to place the final pavement over the storm drain line.

(B) **Deflection Test for HDPE and PVC Pipe:**

In addition to the tests prescribed above, the Contractor shall perform a deflection test on the system as directed by the Engineer. Any part of the installation, which shows deflection in excess of 5% of the nominal inside diameter per Section 738 for HDPE pipe, or in excess of 5% of the average inside diameter per ASTM D3034 for PVC pipe, shall be evaluated and appropriate remedy, if any, shall be performed.

After acceptance but prior to the termination of the warranty period, the Contracting Agency may test the long-term deflection of the storm drain. If the Contracting Agency determines that the deflection has exceeded 7 ½% of the average inside diameter, that portion of the installation shall be corrected by the Contractor at no cost to the Contracting Agency.

611.6 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

The Contracting Agency will pay for the initial Sewer C.C.T.V. inspection. Any additional inspection(s) required, due to the failure of the initial inspection, shall be paid for by the Contractor.

No separate payment will be made for this Storm Drain Video or Deflection Testing; the cost of the video and deflection testing shall be included in the cost of the pipe.

- End of Section -

SECTION 615

SANITARY SEWER LINE CONSTRUCTION

615.1 DESCRIPTION:

The construction or extension of sanitary 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 MATERIALS:

Pipe used for sewer line construction, including specials, joints, and gaskets, shall be according to the following Sections, or as modified by the special provisions.

- Reinforced Concrete Pipe (RCP), see Section 735
- High Density Polyethylene (HDPE) Pipe, see Section 738
- Steel Reinforced Polyethylene (SRPE) Pipe, see Section 739
- Polypropylene Pipe (PP), see Section 740
- Vitrified Clay Pipe (VCP), see Section 743
- Polyvinylchloride Pipe (PVC), see Section 745
- Ductile Iron Pipe (DIP), see Section 750

615.3 TRENCHING:

Trench excavation shall be accomplished in accordance with Section 601, except as specified below, or as modified by special provisions.

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 flow line of the pipe.

The trench shall be dry when the fine grading of the trench bedding 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 12 inch and smaller diameter pipe and ±0.10 feet for 15 inch and larger diameter pipe.

615.4 SEPARATION:

To protect water lines from contamination by sewer lines, separation and extra protection shall be in accordance with Section 610.

Sewer lines that are constructed of ductile iron pipe for extra protection shall be internally lined for sewer service.

615.5 PIPE INSTALLATION:

Pipe shall be of the type, class, and size called for on the plans. 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 superfluous materials of every description.

The laying of the pipe shall be in trenches free from water or debris, and shall commence 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 closed 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.

615.6 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.

615.7 JOINTING:

615.7.1 Gasket Joints: Prior to joining pipes, 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 shall 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.

615.7.2 Water Stops: Water stops will be required when connecting pipes other than VCP or RCP to concrete structures, manholes, etc. The water stop shall comply with Section 738 and shall be installed per manufacturer recommendations.

615.8 SANITARY SEWER SERVICE TAPS:

Sanitary sewer service taps shall be constructed in accordance with standard details.

To maintain structural integrity of the pipe, service tap connections into an existing flexible pipe shall be made in accordance with the pipe manufacturer's recommendations.

When any damage occurs to the pipe, the Contractor shall perform repairs, as recommended by the manufacturer at no cost to the Contracting Agency. Damage to the pipe will include but not be limited to gouging, marring, and scratching forming a clear depression in the pipe.

The locations 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. Electronic markers shall be placed at no greater depth than electronic locating devices can locate them (typically 2'-4').

615.9 SANITARY SEWER CLEANOUTS:

Cleanouts shall be constructed at locations shown on the plans, in accordance with the standard details.

615.10 MANHOLES:

Manholes shall be constructed to conform with the requirements of Section 625 and standard details.

615.11 BACKFILLING:

Backfilling and compaction shall be accomplished in accordance with Section 601 except as modified by special provisions.

615.12 TRENCHLESS INSTALLATIONS:

Trenchless installation of pipe shall be in accordance with Section 602 or Section 607.

615.13 INSPECTION AND TESTING:

Testing and inspection shall be in accordance with Section 611.

615.14 PAVEMENT AND SURFACING REPLACEMENT:

Pavement and surfacing replacement shall be in accordance with Section 336.

615.15 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.

615.16 MEASUREMENT AND PAYMENT:

(A) **Sanitary Sewer Pipe and Fittings:**

Measurement will be made horizontally through 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.

Payment for the various sizes and types of pipe will be made at the contract unit price 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, compaction, sheeting and bracing, testing, and all incidental work not specifically covered in other pay items.

(B) **Sanitary Sewer Service Lines and Taps:**

Measurement of the number of taps installed will only be made when pay items for sanitary sewer taps are contained in the contract.

When pay items for sanitary sewer taps are contained in the contract, payment for sanitary sewer service taps will be made at the contract unit price and shall be compensation in full for furnishing and installing pipe and fittings needed to connect to the main, complete in place, as specified and called for on the plans and standard details, including all cost for furnishing and installing electronic markers, and all cost of excavation, removal of obstructions, shoring and bracing, backfilling, compaction, pavement replacement, maintenance of traffic, and all work incidental thereto.

The length of pipe required for the service lines shall be measured and payment made as Sanitary Sewer Pipe and Fittings. If no pay item is provided for the sanitary sewer taps, the connection cost including all costs for furnishing and installing electronic markers shall be included in the unit cost of the sanitary sewer pipe.

(C) **Sanitary Sewer Cleanouts:**

Measurement will be the number and type of cleanout installed.

Payment will be made at the contract unit price 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.

- ***End of Section*** -

SECTION 616

RECLAIMED WATER LINE CONSTRUCTION

616.1 GENERAL:

This specification prescribes standards for utility water mains for the purpose of conveying, under pressure, reclaimed water for permitted reuse. Installation of reclaimed water mains shall be constructed in accordance with these specifications for materials, installation, and identification.

616.2 MATERIALS:

Pipe materials shall be in accordance with Section 610.

Valves shall be in accordance with Sections 610 and 630.

Valve boxes shall be in accordance with Section 345, this Section and Detail 391-1 and 391-2. Frame and cover shall be in accordance with Detail 271, or per Agency requirements. Manholes shall be in accordance with Section 625, 787, this Section, and applicable Details.

616.3 INSTALLATION:

Pipe shall be installed in accordance with Sections 601, 610, and this Section.

Valves and risers shall be installed in accordance with this Section.

Valve box debris caps shall be installed in accordance with this Section and Detail 392.

When a reclaimed water main is adjacent to or crosses a potable water main, the reclaimed water main shall be considered a pressure or force sanitary sewer and comply with Details 404-1, 404-2 and 404-3 for separation and/or protection. When reclaimed water main is adjacent to or crosses a gravity, pressure or force sanitary sewer, the reclaimed water main shall be considered a potable water main and comply to Detail 404-1, 404-2 and 404-3 for separation and/or protection.

616.4 IDENTIFICATION:

The color purple shall be used for identifying all pipes, valves, and other equipment used for conveying reclaimed water.

Reclaimed water identification tape shall be an inert polyethylene plastic impervious to all known alkalis, acids, chemical reagents and solvents likely to be encountered in the soil. The tape shall be a minimum of 4.0 mils thick and no less than 3 inches wide. The tape shall be purple and shall have the words, “CAUTION: RECLAIMED WATER LINE” or similar wording printed in black lettering continuously along the entire length. Lettering shall be a minimum 1 ½ inches high. Spacing between the individual words of the message shall not exceed three inches.

Reclaimed water identification sleeving (pipe socks) shall be an inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents and solvents likely to be encountered in the soil. The sleeving shall be a minimum of 4.0 mils thick. The sleeving shall be purple and shall have the words, “CAUTION: RECLAIMED WATER LINE” or similar wording printed in black lettering continuously along the entire length. Lettering shall be a minimum 1 ½ inches high. Spacing between the individual words of the message shall not exceed three inches.

Reclaimed water identification decals shall be made of inert material resistant to cracking, peeling, and fading due to sunlight and heat. Decals shall have an aggressive adhesive to ensure permanent bonding to the surface that is being identified. The decals shall have the words, “CAUTION: RECLAIMED WATER - DO NOT DRINK” or similar wording printed in black lettering on a purple background. Lettering shall be a minimum 1-inch high. Spacing between the individual words of the message shall not exceed three inches.

Reclaimed water pipe identified by stenciling shall use paint or ink resistive to all known alkalis, acids, chemical reagents and solvents likely to be encountered in the soil. Stenciled pipe shall have the words, “CAUTION: RECLAIMED WATER - DO

NOT DRINK" or similar wording printed in black or white lettering on a purple background continuously along the entire length.

Lettering shall be a minimum of 1 ½ inches high lettering shall be placed on a painted purple band a minimum of 3 inches wide that runs the entire length of the pipe.

Reclaimed water locating tape shall be an inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents and solvents likely to be encountered in the soil. The tape shall be a minimum of 4.0 mils thick, 3 inch wide and contain a minimum thickness of 1/3 mil metallic foil or two embedded copper wires. The tape shall be purple and printed with the words, "CAUTION: RECLAIMED WATER LINE BELOW" or similar wordings printed in black lettering continuously along the entire length. Lettering shall be a minimum 1 ½ inches high. Spacing between the individual words of the message shall not exceed three inches.

Integral colored reclaimed water pipe shall be purple in color and shall have the words, "CAUTION: RECLAIMED WATER-DO NOT DRINK" or similar wording printed in black lettering at intervals no greater than 3 feet. Lettering shall be a minimum 1 ½ inches high. Spacing between the individual words of the message shall not exceed three inches.

Reclaimed water valve tags shall be inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents and solvents likely to be encountered in the soil. The tags shall be purple and shall have the words, "CAUTION: RECLAIMED WATER-DO NOT DRINK" or similar wording printed in black lettering. The lettering shall be a minimum of ½ inch high.

616.4.1 Below Ground Pipe:

(A) All below-ground reclaimed water pipelines shall be marked by identification tape, or sleeving, or integral coloring, or stenciling in conformance with this section.

Identification tape shall be installed parallel to the centerline and on top of the pipe. The identification tape shall be installed continuously for the entire length of the pipe and shall be securely fastened with plastic adhesive tape banded around both the pipe and identification tape at no more than 4-foot intervals.

Identification sleeving shall be installed so the wording runs along the top of the pipe. Care shall be exercised to avoid displacement of sock and to ensure its integrity.

Stenciled pipe shall be installed so the wording is parallel to the centerline and on top of the pipe.

(B) The Agency will need to maintain adequate records, install locating devices, conduct surveys, etc. to be capable of locating all below-ground reclaimed water mains as required by Arizona Revised Statutes 40-360. The means for locating the mains shall be at the discretion of the Agency. When locating tape is used, the tape shall be installed with the printed side up, directly above the pipe, parallel to the centerline, and buried 24 inches below the finished surface grade. The backfill shall be sufficiently leveled so that the tape is installed on a flat surface. Care shall be exercised to avoid displacement of the tape and to ensure its integrity.

In lieu of locating tape, a locating wire can be fastened by plastic adhesive tape to the top center of the pipe. The adhesive tape shall be banded around both the pipe and wire at no more than 4 foot intervals. The wire shall be continuous for the entire length of the pipe, without gaps, breaks, etc. The wire shall terminate above ground in a valve riser housing.

616.4.2 Above-Ground Pipe: All above ground pipe shall be identified by stenciling or decals in conformance to this section.

Stenciled pipe shall be installed so that the wording runs along both sides of the pipe.

Identification decals shall be placed on both sides of the pipe at intervals no greater than 3 feet. Surfaces shall be prepared to ensure proper adhesion of the decals.

616.4.3 Valves and Risers: Valve handles shall be affixed with tags in accordance with this section. Tags shall be securely fastened in a manner that ensures their visibility.

Riser pipes shall be painted purple both inside and out from the top of the pipe to at least one foot below the finished grade.

Debris caps shall be required in all valve housings per Detail 392, shall be colored purple, and affixed with tags in accordance with this section. Tags shall be securely fastened in a manner that ensures their visibility.

616.4.4 Valve and Manhole Covers: Valve and manhole covers shall be stamped with the words or shall have raised lettering with the words "RECLAIMED WATER". Reclaimed water valve covers shall be of a shape that is not interchangeable with potable water valve covers.

- End of Section -

SECTION 618

STORM DRAIN CONSTRUCTION

618.1 DESCRIPTION:

This section covers pipe line 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.

Installation of pipe under railways shall conform to the specifications and permit of the respective railway agency.

618.2 MATERIALS:

Pipe used for storm drain construction, including specials, joints, and gaskets, shall be according to the following Sections, or as modified by special provisions.

- Cast-in-Place Concrete Pipe (CIPP), see Section 620.
- Reinforced Concrete Pipe (RCP), see Section 735. For permitted construction reinforced concrete pipe strength shall be equal to or higher than Class III, A-III, HE-III, or VE-III.
- Non-Reinforced Concrete Pipe, see Section 736.
- High Density Polyethylene (HDPE), see Section 738.
- Steel Reinforced Polyethylene (SRPE) Pipe, see Section 739.
- Polypropylene Pipe, see Section 740.
- Corrugated Metal Pipe, see Section 760.

The size, type, and minimum strength of pipe shall be as shown on the plans, or as specified. Pipe stronger than that specified may be furnished at the Contractor's option and at no additional cost to the Contracting Agency.

When specified in the special provisions 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, special prefabricated pipe connections to the main line 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 Class 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.

618.3 CONSTRUCTION METHODS:

Trench excavation, backfilling, and compaction shall be accomplished in accordance with Section 601, except as specified below, or as modified by special provisions.

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 flow line. 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.

Trenchless installation of pipe shall be in accordance with Section 602 or Section 607.

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 pipe line unless otherwise approved by the Engineer. For closures and deflection angles greater than 10 degrees, joints shall be made by use of a bend, specially manufactured fitting, or by a concrete collar, per standard details.

618.4 POST INSTALLATION INSPECTION AND TESTING:

Post installation inspection and testing shall be in accordance with Section 611.5.

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.

618.6 PAYMENT:

(A) **Main Line Pipe:** Will be paid at the contract unit price 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 type of 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 contract unit price per linear foot, to the nearest foot for each type and 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.

- End of Section -

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 C150, Type II, and low alkali as per Section 725.

620.2.2 Sand aggregate used for concrete and mortar shall conform to Section 725.3. Maximum size of the aggregate shall not be greater than ⅓ of the minimum wall thickness up to and including a wall thickness of 4 ½ inches. The maximum aggregate size is 1 ½ inches.

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.

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 with a maximum allowable departure of 1 ½ inches. Departure from and return to specified alignment shall not exceed 2 inches per 10 linear feet 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 in-place 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 D6938.

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 6 inches 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 materials, 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 or is less than 50 degrees Fahrenheit. 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 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 11/4 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 (Subsection 620.2.5) approximately 1/4 inch 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 inside diameter, the minimum wall thickness shall be 2 inches.
For pipe with an inside diameter of 15 inches to 24 inches the minimum wall thickness shall be 2 ½ inches. For pipe exceeding 24 inches inside diameter, the minimum wall thickness shall be 1/12 of the inside diameter, plus ½ inch.
(3) Offsets at form laps and horizontal edges shall not exceed ½ inch for pipe having inside diameter not greater than 42 inches; 3/4 inch for pipe having inside diameter greater than 42 inches, but not greater than 72 inches; and 1 inch for pipe having inside diameter greater than 72 inches.

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. 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 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 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 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 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 C309 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 of exposed concrete. The pipe shall then be covered with a minimum of 3 inches 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 C171, nominal thickness 0.0015 inches 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 pipe line 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 pipe line 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 Subsection 620.3.2(A) shall be filled with mortar per Subsection 620.2.5. Cracks may be repaired with epoxy materials.

Longitudinal cracks exceeding 0.01 inches in width and 12 inches in length shall be cause for rejection of the pipe. The pipe section or reach in question shall either be removed or 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. 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 the 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.

- End of Section -

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 for Type I, Type IA, II and Type IIA. The external coating and internal lining shall be in accordance with AASHTO M-190 and Section 760.

621.2 MATERIALS:

The types of pipe and fabrication shall be in accordance with Section 760.

All helically-wound corrugated metal pipe shall have a marking system, which shall provide a quick external visual check of diameter variations during and after the manufacturing process.

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 external coating or internal lining 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 approved fiber reinforced bituminous mastic.

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 external coating or internal lining. 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. As determined by the Engineer, pipe that is damaged to such an extent that satisfactory field repairs cannot be made 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 external coating, spelter coating, or internal lining. 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 external coating or internal lining 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 the 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.

- End of Section -

SECTION 625

MANHOLE CONSTRUCTION AND DROP SEWER CONNECTIONS

625.1 DESCRIPTION:

625.1.1 Manholes: Construction shall consist of furnishing all materials and constructing manholes complete in place, as detailed, including foundation walls, manhole frames, covers, and any incidentals thereto, at locations shown on the plans.

625.1.2 Sanitary 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 to the following:

If allowed by the contracting agency, brick may be used for maintenance and adjustment of the existing sanitary sewer manhole or ring and cover. For the use of bricks in manholes, see Section 775.

Cement mortar for manholes Class D, per Section 776.

Concrete for cast in place sanitary sewer manhole bases shall be Class A, for drop sewer connection shall be Class C, per Section 725.

Pipe used in sanitary sewer manholes or drop sewer connections shall comply with pipe requirements of Section 615.

Manhole frame and cover per Section 787 and cast in accordance with standard details.

Manhole steps shall not be used.

625.3 CONSTRUCTION METHODS:

625.3.1 Manholes: Manholes shall be constructed of precast concrete sections, or cast in place concrete. 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 consistent radius as large as the manhole will permit with no angle points. Changes in size and grade of the channels shall be made gradually, evenly, and uniformly throughout the manhole base.

Invert channels may be formed of concrete, half tile laid in concrete, or be constructed by laying full section of sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. The bench of the manhole outside the channels shall be smoothed and shall slope towards the channels.

The excavation shall be in such a manner, access is maintained around the manhole base before, during, and after placement of the manhole.

For cast-in-place manhole bases, a foundation of Class A concrete shall be constructed in accordance with the standard details and Section 505.

No brickwork 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. The brick manholes shall be mortared outside with ½ inch of cement mortar as shown. Inside of the brick wall shall be neatly pointed. The mortar coat shall be cured with a liquid membrane-forming compound conforming with Section 726 immediately

after mortar has been placed and finished.

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 206.

625.3.2 Sanitary Sewer Drop Connections: Drop sewer connections shall be constructed in conformance with standard details.

Backfilling shall be done in accordance with the requirements for trench backfilling as stated in Section 206.

625.4 MEASUREMENT:

Each type of manhole installed, shall be measured as a complete unit, no distinction shall be made based on manhole depth.

625.5 PAYMENT:

Payment will be made at the contract unit price for each accepted manhole, and shall be compensation in full for furnishing and installing the manhole, complete in place, with formed or pre-cast inverts, concrete foundation, sanitary sewer drop connections sheeting and bracing, removal of obstructions 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.

- End of Section -

SECTION 627

PAINTING SANITARY SEWER MANHOLES WITH INSECTICIDE

627.1 GENERAL:

This specification pertains to manholes on sanitary sewer, 27-inch in diameter and smaller pipe, unless otherwise directed by the Engineer.

The interior of all new manholes shall be painted with an insecticide paint.

After the new pipe has been tested, inspected, and accepted for service, and the manhole has been adjusted to final grade, the top eight (8) feet, or from the manhole bench to the finish grade, whichever is less shall be painted. The entire interior circumference shall be covered, including adjusting rings.

The interior of the manhole shall be free from all loose material to provide a clean bonding surface. Refer to manufacturer's specifications for preparation instructions.

New or existing manholes, to which corrosion coatings have been applied, shall also be painted with insecticide.

627.2 INSECTICIDE PAINT:

Product shall be approved by or meet the requirements of the Engineer.

627.3 APPLICATION:

Unless otherwise directed by the Contracting Agency, paint shall be applied to the top eight (8) feet of the manhole cone and barrel sections. Paint must be applied by a State of Arizona Licensed Pest Control Applicator. Cleaning, prep and application shall be in accordance with the manufacturer's recommendations.

Existing manholes, to which a tap or main connection is made, do not require insecticide paint.

Applicator shall be required to submit a project/location specific certification letter to document and warranty the application treatment.

627.4 MEASUREMENT:

If required, measurement shall be made per manhole or per application.

627.5 PAYMENT:

Payment for painting sanitary sewer manholes with insecticide shall either be included in the manhole unit price bid or paid as a separate item if provided for, and shall be considered full compensation for cleaning, surface preparation, materials, application, and any incidentals, thereto, in conformance with plans and specifications.

-End of Section -

SECTION 630

TAPPING SLEEVES, VALVES AND VALVE BOXES ON WATER LINES

630.1 DESCRIPTION:

The installation of all tapping sleeves, valves and valve boxes 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 gate valves, tapping valves, tapping sleeves, curb stop valves, butterfly valves and any 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.

The name of the manufacturer, the 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:

630.3.1 General: All valves shall conform to the latest revisions of AWWA standards supplemented as follows: Valves shall be of the non-rising stem type and shall be counter-clockwise opening (left-hand).

The valve shall be furnished with either low zinc stems conforming to ASTM B98 or ASTM B763 or stainless steel SAE 304, 316, or 431 grade) conforming to either ASTM A276, ASTM A473, or ASTM A582.

Unless otherwise noted, valves shall have a 2-inch square operating nut.

All valves, 2-inch through 54-inch, shall have a working pressure of 250 psi and be in conformance with AWWA C515 or AWWA C509. Valves 2-inch through 16-inch shall also meet the requirements for a UL listing and Factory Mutual Standards 11.20 and 11.30 for gate valves.

Bronze for all interior parts of valves shall contain no more than 6 percent zinc if made from cast bronze, or must conform to Copper Development Association #67600 if made from bar stock material.

All interior and exterior ferrous surfaces exposed to fluid flow shall be epoxy coated to a minimum dry film thickness of 6 mils. Epoxy coatings shall be factory applied by an electrostatic or thermosetting process in accordance with the manufacturer's printed instructions. The epoxy materials used shall be 100% powder epoxy or liquid epoxy that conforms to the requirements of AWWA C550 and NSF/ANSI Standard 61.

Any epoxy coating that is chipped or damaged shall be repaired using the manufacturer's recommended procedure and epoxy system.

Bypass valves are required only when specified. Bypass size shall be per manufacturer's recommendation.

Valves in air release and vacuum relief lines shall be flanged or threaded as shown on the plans.

Valves in fire hydrant lines shall have a flanged joint end on the side towards the main and a restraint or mechanical joint end on the side towards the hydrant.

Gate valves 2-inch through 54-inch shall be resilient wedge style and may be furnished with flange ends, mechanical joint ends, or mechanical joint x flange end.

630.3.2: Specific Valve Size Requirements:

(A) Valves 2-inches through 20-inches:

Valves shall be iron body resilient wedge gate valves in accordance with the latest revision of AWWA C509 or AWWA C515.

The valve shall be designed to work equally well with pressure on either side of the gate. The valve shall be equipped with O-ring packing.

Gearing and bypass not required unless specified.

(B) Valves 24-inches and larger:

Valves shall be resilient wedge gate valves in accordance with AWWA C515.

Valves shall have spur gearing unless the bury is too shallow, in this case bevel gearing is acceptable.

Bypass valves are required only when specified.

630.4 TAPPING SLEEVES AND VALVES:

630.4.1 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 a flange hub-end or mechanical joint on the other.

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.

Once the tap has been completed, the Contractor shall not operate the valve unless under direct supervision of the inspector.

TABLE 630-1	
BY-PASS VALVE SIZES	
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

630.4.2 Tapping sleeves for use on pipelines constructed of cast iron, ductile iron, asbestos cement, and PVC: 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.

Tapping sleeves shall be of the following types:

(A) Mechanical Joint Tapping Sleeves shall conform to the following:

The circumferential joints at both ends of the sleeve shall be sealed by mechanical joints and end gaskets. Mechanical joints shall conform to the requirements set forth in the most recent publication of AWWA C111 as to the dimensions, clearance, and materials. Sleeve body shall be constructed of ASTM A283 Grade C, ASTM A285 Grade C, ASTM A36 steel or equal. The body shall be coated with a corrosion resistant shop coat primer unless otherwise specified by the Utility Owner. A ¾" NPT test port is required on branch of sleeve for field-testing prior to tap.

Flanged outlet shall have dimensions and drilling that complies with ASME B16.1 class 125 and per Manufacturer's Standardization Society (MSS SP-60).

Unless otherwise noted, approved elastomer compounds are SBR, Buna-N, EPDM, and Viton. Elastomer shall be compounded for use with water, salt solutions, mild acids and bases per ASTM D2000.

Bolts to be corrosion resistant low alloy (AWWA C111) unless otherwise specified by the Utility Owner.

Sleeve shall be compliant with the federal requirements of the Drinking Water Standard NSF/ANSI Standard 61 regulating the health effects of drinking water materials, treatment chemicals, and restricting the use of lead-containing materials. Tapping sleeve shall be installed per the manufacturer's recommendations and Detail 340. Coupon extraction shall be available for inspection.

(B) Stainless Steel Tapping Sleeves shall conform to the following:

Stainless Steel, Type 304 ASTM A240, and meets or exceeds applicable AWWA C223 standards. Each weld is to be fully chemically passivated in accordance with ASTM A380. A ¾" NPT test port is required on branch of sleeve for field-testing prior to tap.

Flanged outlets shall be Type 304 Stainless Steel ASTM A240, AWWA C228 Class SD ANSI 150# drilling and recessed for tapping valves per Manufacturer's Standardization Society (MSS-SP 60).

The gasket shall be fully circumferential providing a 360-degree seal. The elastomer compound shall be ¼" thick, have a grid patterned face, and certified to NSF/ANSI Standard 61-G & 372. Unless otherwise noted, approved elastomer compounds are SBR, Buna-N, EPDM, and Viton.

Elastomer shall be compounded for use with water, salt solutions, mild acids and bases per ASTM D2000.

Bolts and Nuts shall be Type 304 Stainless Steel per ASTM A193 or ASTM A194.

Sleeve shall be compliant with the federal requirements of the Drinking Water Standard NSF/ANSI Standard 61 regulating the health effects of drinking water materials, treatment chemicals, and restricting the use of lead-containing materials.

Contractor to verify if size-on-size is acceptable to the Utility Owner.

Tapping sleeve shall be installed per the manufacturer's recommendations and Detail 340. Coupon extraction shall be available for inspection.

(C) Tapping sleeve testing shall comply with the following:

Unless otherwise noted, the tapping sleeve assembly shall be pressure tested utilizing a sanitized hydrostatic pump to 200 psi for a minimum of 30 minutes. The pressure test shall occur prior to tapping the main. A ¾" NPT test port is required on all sleeves for field-testing prior to tap. Original manufacturer's test plug must be properly re-installed after testing is complete. All testing procedures shall comply with the NSF/ANSI Standard 60 and Standard 61 drinking water standard regulating the health effects of drinking water supplies, treatment chemicals, and restricting the use of lead-containing materials.

630.4.3 Tapping sleeves for concrete pressure pipes shall be fabricated tapping sleeves and comply with the following:

Except for meter service connections, taps shall be made by the Agency at prevailing rates or by approved Contractors when allowed or requested by the Contracting Agency. After installation of the tapping sleeve and valve, the Contractor shall provide an excavation sufficient in size to accommodate the tapping operation.

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 services.

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.

630.5 BUTTERFLY VALVES:

(A) 16 inches and larger:

Valves shall be in accordance with AWWA C504 latest revision as modified herein:

(1) Valve body shall be of cast iron or ductile iron with connecting ends one of or a combination of Flanged (Short Body), mechanical joint or ACP Hub End.

(2) Valves shall be Class 150-B unless otherwise specified.

(3) When requested the manufacturer shall furnish records of tests specified in AWWA C504.

(4) Shaft seal may be O-ring seal, V-type packing or pull down packing.

(5) The valve disc may be either cast iron or ductile iron.

(6) Valves and operators shall be for direct burial installation.

(7) Valves to be furnished with manual operators and 2-inch square operating nut. Operator torque rating shall be calculated in accordance with AWWA C504.

(8) Valves shall open when turning the operating nut counter-clockwise.

(9) Valves shall be installed with valve shaft in a horizontal position and the operating shaft vertical.

(10) All interior ferrous surfaces exposed to fluid flow shall be epoxy coated to a minimum dry film thickness of 6 mils. Epoxy coatings shall be factory applied by an electrostatic or thermosetting process in accordance with the manufacturer's printed instructions. The epoxy materials used shall be 100% powder epoxy or liquid epoxy that conforms to the requirements of AWWA C550, and to the prevailing requirements of the Food and Drug Administration and of the Environmental Protection Agency.

(11) All exterior ferrous surfaces, except finished or bearing surfaces, shall be factory coated with two coats of asphaltic varnish conforming to Federal Specification TT-V-51c, or shall be epoxy coated as required above for interior surfaces.

(12) A manufacturer’s affidavit of compliance shall be furnished.

(13) Shop drawings shall be furnished.

(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 or manufacturer's equipment to make it conform to all specific requirements of this specification.

The valves shall be in accordance with AWWA C504, 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 A436, Type 1, or cast iron, ASTM A48, 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 B61 or ASTM B584.

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 C504 for valve class specified above.

All interior ferrous surfaces exposed to fluid flow shall be epoxy coated to a minimum dry film thickness of 6 mils.

Epoxy coatings shall be factory applied by an electrostatic or thermosetting process in accordance with the manufacturer's printed instructions.

The epoxy materials used shall be 100% powder epoxy or liquid epoxy that conforms to the requirements AWWA C550-81, and to the prevailing requirements of the Food and Drug Administration and of the Environmental Protection Agency.

All exterior ferrous surfaces, except finished or bearing surfaces, shall be factory coated with two coats of asphaltic varnish conforming to Federal Specification TT-V-51c, or shall be epoxy coated as required above for interior surfaces.

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 designated on the Agency's approved products list or in the special provisions.

(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. The valves shall be of the same manufacture or may be a combination air and vacuum valve assembly designated on the Agency's approved products list or in the special provisions.

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 valve until 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 contract unit price 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.

- ***End of Section*** -

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 material 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 to Section 754. Polyethylene pipe shall conform to Section 755.

All fittings, pipe and tubing for polyethylene and copper pipe shall be as noted on standard details and as indicated in Section 610.3 Materials.

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 3/4 inch service taps to new meter mains may be made with a saddle, tapped coupling or direct tap in accordance with the following provisions:

The Developer may use heavy tapped couplings for meter service connections on all sizes of pipe including the 3-inch pipe 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 six taps. The minimum distance between taps, saddles, and tapped couplings shall be 3 feet.

631.4 TESTING:

All services, service taps and fittings shall be tested along with the water main in accordance with Section 611.

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.

- ***End of Section*** -

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PART 700

MATERIALS

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SECTION 701

AGGREGATE

701.1 GENERAL:

Coarse and fine aggregates are defined in accordance with ASTM D2487. Material property requirements for specific uses are provided in applicable MAG sections.

Apparent specific gravity shall be at least 2.50, when tested in accordance with ASTM C127.

701.2 COARSE AGGREGATE:

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. Aggregate sources shall include, but not be limited to alluvial deposits, terrace aggregates, quarry stone, or other suitable sources including recycled products that meet all material test requirements as approved by the Engineer. Aggregate classification shall be made by size as noted herein.

701.2.1 Boulders: Particles of rock that will not pass a 12-inch square opening.

701.2.2 Cobbles: Particles of rock that will pass a 12-inch square opening, but are retained on a 3-inch square opening.

701.2.3 Coarse Gravel: Particles of rock that will pass a 3-inch U.S. standard sieve, but are retained on a 3/4-inch U.S. standard sieve.

701.2.4 Fine Gravel: Particles of rock that will pass a 3/4-inch U.S. standard sieve, but are retained on a No. 4 U.S. standard sieve.

701.3 FINE AGGREGATE (SAND):

Fine aggregate (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. Fine aggregates particles shall pass a No. 4 U.S. standard sieve, but are retained on a No. 200 U.S. standard sieve.

701.4 RECLAIMED CONCRETE MATERIAL (RCM):

Reclaimed concrete material (RCM) is defined as an aggregate material that is derived from the crushing, processing and classification of Portland cement concrete construction materials recovered, salvaged, or recycled from roadways, sidewalks, buildings, bridges, and other sources.

In accordance with Section 7 of AASHTO M-319, RCM shall not contain more than five percent by mass of brick or concrete block and shall be substantially free of wood, metal, plaster, and gypsum board, RCM shall be free of all materials that fall under the category of solid waste or hazardous materials as defined by the state or local jurisdiction. With the approval of the Engineer, these respective quantities may be adjusted if the performance of the RCM is not adversely impacted. RCM may be used alone or uniformly blended with other approved aggregate materials to obtain the applicable performance criteria. RCM shall not be used in Portland Cement Concrete without the prior approval of the Engineer.

701.5 RECLAIMED ASPHALT PAVEMENT (RAP):

Reclaimed asphalt pavement (RAP) is defined as all recovered, salvaged or recycled asphalt road waste, large particles or milled material that has been size-reduced, crushed and or screened appropriately, making it reusable. This material shall be of a consistent and relatively clean manner as to not adversely affect the final material usage. RAP may be used alone or uniformly blended with other approved aggregate materials to obtain the applicable performance criteria. RAP shall not be used in Portland Cement Concrete without the prior approval of the Engineer.

701.6 SAMPLING:

Sampling of aggregates shall be performed in accordance with ASTM D75.

- End of Section -

SECTION 702

BASE MATERIALS

702.1 GENERAL:

Base materials shall be as defined in Section 701, consisting of appropriately sized coarse and fine aggregates, Reclaimed Concrete Material (RCM) or Reclaimed Asphalt Pavement (RAP), other inert materials, and/or aggregates that have been treated for plasticity index mitigation, as approved by the Engineer. These materials, whether virgin or reclaimed or a uniform blend of both, shall conform to the end result quality requirements of this section.

When base material without further qualification is specified, the Contractor shall supply materials that meet the gradation and other quality requirements for Aggregate Base Course as defined in Table 702-1. When a particular classification of base material is specified, the Contractor may substitute materials meeting the gradation and other quality requirements for Aggregate Base Course for Select material, when approved by the Engineer.

The Contractor shall provide the Engineer laboratory testing documentation on the source of the base material showing compliance to Table 702-1 at least 10 business days prior to placement except where the base materials are being obtained from a currently approved source from a list maintained by the appropriate Agency or as determined by the Engineer. Included in the documentation shall be the percentage of RCM or RAP, if applicable.

RCM meeting the requirements of Section 701.4 can be utilized in base material at a maximum quantity of 50% and may be used in roadway applications or where otherwise specified by project plans or special provisions.

RAP meeting the requirements of Section 701.5 can be utilized in base material up to 100% and may be used in roadway applications or where otherwise specified by Project plans or special provisions.

702.1.1 Aggregate Base Course is primarily used in roadway applications or where otherwise specified by project plans or special provisions.

702.1.2 Select Material is primarily used, as a sub base in roadways, fill and embankment applications or where otherwise specified by project special provisions.

702.2 PHYSICAL PROPERTIES:

702.2.1 Base material shall meet the physical properties listed in Table 702-1.

Table 702-1			
Sieve Analysis: Test Methods AASHTO T-27, T-11			
Sieve Size	**Accumulative Percentage Passing Sieve, by Weight**		
	Select Material		**Aggregate Base Course**
	Type A	**Type B**	
3 in.	100	- -	- -
1-1/2 in.	- -	100	100
1 in.	- -	- -	90 – 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
Plasticity Index: Test Methods AASHTO T-89 Method A, T-90, T146 Method A			
Maximum allowable value	5	5	5
Fractured Face, One Face: Test Method ARIZ 212, Percent by Weight of the Material Retained on a #4 Sieve			
Minimum required value	50	50	50
Resistance to Degradation and Abrasion by the Los Angeles Abrasion Machine: Test Method AASHTO T-96, Percent Loss by Weight			
Maximum allowable value at 100 revolutions	10	10	10
Maximum allowable value at 500 revolutions	40	40	40

702.2.2: When tested for acceptance, Base material that does not meet Table 702-1 properties for gradation or PI may be approved at the Engineer's discretion if the R-Value is at least 70, when determined by test method AASHTO T-190 (see Table 310-1).

- End of Section -

SECTION 703

RIPRAP

703.1 GENERAL:

Aggregate for grouted and ungrouted riprap shall meet the requirements of Sections 701.2 and 703.2 unless otherwise stated in the project specifications.

Aggregate shall be color-matched with adjacent landscape aggregate if specified on the plans or in the special provisions.

The Contractor shall provide the Engineer, in writing, material information and the source location at least 10 days prior to use of the material unless the material is currently acceptable for use as determined by the Engineer.

703.2 PHYSICAL PROPERTIES:

Riprap shall have the following physical properties:

(A) The maximum aggregate size shall be 150% of the indicated D_{50} size and the minimum aggregate size shall be 50% of the indicated D_{50} size.

(B) Aggregate shall be angular and shall not exceed 3:1 ratio for flat and/or elongated pieces when determined by ASTM D4791. Rounded aggregate shall only be allowed when specified or approved by the Engineer.

(C) The loss by abrasion in the Los Angeles Abrasion Machine, determined as prescribed in ASTM C535, shall not exceed 40 percent (by weight) after 1000 revolutions.

- End of Section -

SECTION 705

PORTLAND CEMENT TREATED BASE:

705.1 GENERAL:

The cement treated base shall consist of aggregate, cement, and water. Use of other types of materials must be approved by the Engineer. The compressive strength requirement shall be determined by the project specifications. The amount of cement used in the mix design shall be determined by the project specifications.

705.2 AGGREGATE FOR CEMENT TREATED BASE:

The aggregate for cement treated base shall conform to the requirements of Section 702.2 Aggregate Base Course.

705.3 PORTLAND CEMENT AND WATER:

Portland cement and water shall conform to the requirements of Section 725.

705.4 CEMENT TREATED BASE MIX DESIGN:

A cement-treated base mix design incorporating the proposed materials shall be completed prior to the start of work. The mix design shall be performed in accordance with Arizona Department of Transportation test methods ARIZ-220, ARIZ-221, and ARIZ-222. Compressive strength specimens shall be tested in accordance with ARIZ-241.

The final report shall include the following elements:

(1) The source and supplier of the aggregate including gradation and plasticity index testing.
(2) The source, supplier, and type of cement.
(3) The cement content required to meet the project specifications. Cement content shall be calculated by the dry weight of the combined aggregate-cement mixture.
(4) The optimum moisture and maximum dry density of the proposed blend at the target cement content as determined by ARIZ-221.
(5) The rock corrected optimum moisture and maximum dry density of the proposed blend at the target cement content as determined by ARIZ-222.
(6) A summary of design compressive strength testing including a graph plotting cement content as the x-axis and compressive strength as the y-axis.

- End of Section -

SECTION 708

ASPHALT PAVEMENT CORE BONDING MATERIALS

708.1 GENERAL:

This specification covers the materials required to bond asphalt pavement cores to the asphalt concrete pavement from which it was originally removed.

708.2 MATERIALS:

Bonding material shall be a single component cementitious, rapid hardening, high strength, waterproof bonding agent conforming to the physical properties shown in Table 708-1.

TABLE 708-1		
Bond Material Properties		
Property	**ASTM Test Method**	**Requirements**
Bond Strength, psi	C882	20 min.
Compressive Strength, psi, (70 degrees F., 30 minute cure)	C109	200 min.

Bonding material shall be impervious to water penetration at the joint after curing.

Bonding material shall, within 30 minutes at minimum ambient temperature of 70 degrees F., allow an 18" diameter core to support a traffic load equivalent to at least three (3) times the AASHTO H-25 standard wheel load.

The bonding material is required to securely bond the asphalt concrete core to asphalt concrete pavement and to fill all voids between the core and pavement and within the core.

708.3 TEST REPORT:

Specifications and test results for the bonding material shall be submitted to the Agency for review and approval before use.

- End of Section -

SECTION 710

ASPHALT CONCRETE

710.1 GENERAL:

Asphalt concrete shall be a mixture of asphalt cement and mineral aggregates. Mineral admixture shall be included in the mixture when required by the mix design or by the Engineer. Asphalt concrete shall be produced in accordance with Section 321.

The designation for asphalt concrete mixes shall be based on the nominal maximum aggregate size of the mix. The applicable mix designations are 3/8 inch, 1/2 inch, 3/4 inch. Each mix shall be designed using Marshall or Gyratory compaction methods.

The following table (Table 710-1) displays the recommended range for lift thickness for various asphalt concrete mix designations found within Section 710. Please note that the minimum lift thicknesses are based on each mix designation's "Nominal Aggregate Size" and the relative coarseness of its gradation. The compacted thickness of layers placed shall not exceed the Maximum Lift Thickness of Table 710-1 except as otherwise provided in the plans and specifications, or if approved in writing by the Engineer.

TABLE 710-1

RECOMMENDED LIFT THICKNESS FOR ASPHALT CONCRETE MIXES

Asphalt Concrete Mix Designation (inches)	Minimum Lift Thickness Marshall Mixes	Maximum Lift Thickness Marshall Mixes	Minimum Lift Thickness Gyratory Mixes	Maximum Lift Thickness Gyratory Mixes
3/8"	1.0 inches	2.0 inches	1.5 inches	3.0 inches
1/2"	1.5 inches	3.0 inches	2.0 inches	3.0 inches
3/4"	2.5 inches	4.0 inches	3.0 inches	4.0 inches

710.2 MATERIAL:

710.2.1 Asphalt Binder: The asphalt binder specified in this section has been developed for use in desert climate conditions. When used in other climates, consideration should be given to adjustments in the asphalt binder selection. The asphalt binder shall be Performance Grade Asphalt conforming to the requirements of Section 711 for PG 70-10, unless otherwise approved by the Engineer or specified differently in the plans or special provisions.

710.2.2 Aggregate: Coarse and Fine aggregates shall conform to the applicable requirements of this section. Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Coarse aggregate for hot mix asphalt is material retained on or above the No. 4 sieve and Fine aggregate is material passing the No. 4 sieve. Aggregates shall be relatively free of deleterious materials, clay balls, and adhering films or other material that prevent coating with the asphalt binder. Coarse and Fine aggregates shall conform to the following requirements when tested in accordance with the applicable test methods.

TABLE 710-2		
COARSE/FINE AGGREGATE REQUIREMENTS		
Characteristics	Test Method	Requirements
Fractured Faces, % (Coarse Aggregate Only)	Arizona 212	85, 1 or more 80, 2 or more
Uncompacted Voids, % Min.	AASHTO T-304, Method A	45
Flat & Elongated Pieces, % 5:1 Ratio	ASTM D4791	10.0 Max.
Sand Equivalent, %	AASHTO T-176	50 Min.
Plasticity Index	AASHTO T-90	Non-plastic
L.A. Abrasion, % Loss	AASHTO T-96	9 max. @ 100 Rev. 40 max. @ 500 Rev
Combined Bulk Specific Gravity	AI MS-2/SP-2	2.35-2.85
Combined Water Absorption	AI MS-2/SP-2	0-2.5%

Tests on aggregates used in asphalt concrete outlined above, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation.

Blend sand (naturally occurring or crushed fines) shall be clean, hard and sound material, which will readily accept asphalt binder coating. The blend sand grading shall be such that, when it is mixed with the other mineral aggregates, the combined product shall meet the requirements of Table 710-2.

The natural sand shall not exceed 20 percent for the Marshall mixes and 15 percent for the Gyratory mixes by weight of the total aggregate for a mix.

710.2.3 Reclaimed Asphalt Pavement (RAP): When allowed by the Engineer, Reclaimed Asphalt Pavement (RAP), as defined in Section 701.5, may be used in asphalt concrete provided all requirements of Section 710 are met. References to use of RAP in Section 710 apply only if RAP is used as part of the mixture.

When RAP is used in asphalt concrete, it shall be of a consistent gradation, asphalt content, and properties. When RAP is fed into the plant, the maximum RAP particle size shall not exceed 1 1/2 in. The percentage of asphalt in the RAP shall be established in the mix design. The percentage of RAP binder shall be established in the mix design.

When RAP is used in base and intermediate courses, the amount of RAP aggregate and RAP binder should not exceed 30% contribution; Surface courses should be limited to 20% RAP aggregate and RAP binder contribution.

In addition to the requirements of Section 710.3.1, the job mix formula shall indicate the percent of asphalt RAP and the percent and performance grade of virgin (added) asphalt binder.

When less than or equal to 15% RAP binder is used by weight of total binder in the mix, the added virgin binder shall meet the requirements for PG 70-10 as shown in Section 711. When greater than 15% RAP is used by weight of the total binder in the mix, the added virgin binder will be dropped one grade for low and high temperature properties to a PG 64-16, unless testing indicates that the blend of the recovered RAP binder and virgin binder meets the requirements for PG 70-10 as shown in Section 711. The virgin asphalt binder shall not be more than one standard asphalt material grades different than the specified mix design binder grade.

710.2.4 Mineral Admixture: Mineral admixture when used as an anti-stripping agent in asphalt concrete shall conform to the requirements of AASHTO M-17. Mineral admixture used in asphalt concrete shall be dry hydrated lime, conforming to the requirements of ASTM C1097 or Portland cement conforming to ASTM C150 Type II or ASTM C595 Type IP. The amount

of hydrated lime or Portland cement used shall be determined by the mix design. The minimum mineral admixture content within a mix will be 1.00 percent, by weight of total aggregate.

710.3 MIX DESIGN REQUIREMENTS:

710.3.1 General: The mix design for asphalt concrete shall be prepared by a laboratory that is accredited through the AASHTO Accreditation Program (AAP) in Hot Mix Asphalt Aggregates and Hot Mix Asphalt. The laboratory shall be under the direct supervision of a Civil Engineer, registered by the State of Arizona, and who is listed by ADOT as a "Qualified Asphaltic Concrete Mix Design Engineer" within ADOT's latest list of approved laboratories. The latest list of approved laboratories is available on ADOT's web page www.azdot.gov. The date of the design shall not be older than two years from the date of submittal, unless supportive documentation is provided and approved by the Engineer.

The mix design report shall include the following elements as a minimum.

(1) The name and address of the testing organization and the person responsible for the mix design report.

(2) The mix plant identification and/or location, as well as the supplier or producer name.

(3) A description of all products that are incorporated in the asphalt concrete along with the sources of all products, including admixtures and asphalt binder, and their method of introduction.

(4) The supplier and grade of asphalt binder, the source and type of mineral aggregate, and the percentage of asphalt binder and mineral admixture used.

(5) The percentage of RAP and RAP Binder being contributed to the total mix shall be included in the mix design report.

(6) The mix design report shall state whether it is Gyratory or Marshall, and the size designation.

(7) The results of all testing, determinations, etc., such as: specific gravity and gradation of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, Tensile Strength Ratio (ASTM D4867), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources. The submittal should include a plot of the gradation on the Federal Highway Administration's 0.45 Power Gradation Chart, plots of the compaction curves and the results of moisture sensitivity testing.

(8) The laboratory mixing and compaction temperature ranges for the supplier and grade of asphalt binder used within the mix design.

(9) A specific recommendation for design asphalt binder content and any limiting conditions that may be associated with the use of the design, such as minimum percentages of crushed or washed fine aggregate.

(10) The supplier's product code, the laboratory Engineer's seal (signed and dated), and the date the design was performed.

(11) If a Warm Mix Technology or additive is used, the following shall be included:

- Technology type and supporting manufacturer information; including instructions pertaining to laboratory mixture temperatures and curing.
- Amount (%) of additive (technology) used in the mixture.
- Attached copy of the ADOT approved product list, showing additive/technology
- Minimum plant production temperature shall not fall below manufacturer's recommendation.
- Minimum field compaction temperature shall be identified.
- Identify any special mixing or compaction temperatures or special methods to be used when conducting Quality Assurance or Quality Control testing of field collected samples. Example: if the field collected samples of warm mix asphalt can be treated as conventional hot asphalt mix, provide the equivalent conventional hot asphalt mix compaction temperature.

The mix design shall be submitted to the Agency or Engineer by the Contractor/Supplier for which it was developed as part of his project submittals. Once the mix design has been approved by the agency or Engineer, the Contractor and/or his supplier shall not change plants nor use additional mixing plants without prior approval of the Engineer. Any changes in the plant operation, the producer's pit, the asphalt binder, including modifiers in the asphalt binder, or any other item that will cause an adjustment in the mix, shall be justification for a new mix design to be submitted.

710.3.2 Mix Design Criteria: The mix design shall be performed by one of two methods, Marshall Mix Design or Gyratory Mix Design. The method shall be specified on the plans, special provisions, or by the Engineer. A minimum of 4 points will be used to establish the mix design results. The oven aging period for both Marshall and Gyratory mix design samples shall be 2 hours.

710.3.2.1 Marshall Mix Design: The Marshall Mix Design shall be performed in accordance with the requirements of the latest edition of the Asphalt Institute's Manual, MS-2 "Mix Design Methods for Asphalt Concrete." The mix shall use the compactive effort of 75 blows per side of specimen. The mix shall comply with the criteria in Table 710-3.

TABLE 710-3

MARSHALL MIX DESIGN CRITERIA

Criteria	Requirements			
	3/8" Mix	1/2" Mix	3/4" Mix	Designated Test
1.Voids in Mineral Aggregate: %, min	15.0	14.0	13.0	AI MS-2
2.Effective Voids: %, Range	4.0±0.2	4.0 ±0.2	4.0 ±0.2	AI MS-2
3.Absorbed asphalt: %, Range*	0-1.0	0-1.0	0-1.0	AI MS-2
4.Dust to Eff. Asphalt Ratio, Range **	0.6-1.4	0.6-1.4	0.6-1.4	AI MS-2
5.Tensile Strength Ratio: % Min.	65	65	65	ASTM D4867
6.Dry Tensile Strength: psi, Min.	100	100	100	ASTM D4867
7.Stability: pounds, Minimum	2,000	2,500	2,500	AASHTO T-245
8.Flow: 0.01-inch, Range	8-16	8-16	8-16	AASHTO T-245
9.Mineral Aggregate Grading Limits				AASHTO T-27

		Percent Passing with Admix	
Sieve Size	3/8 inch Mix	1/2 inch Mix	3/4 inch Mix
1-1/4 inch			
1 inch			100
3/4 inch		100	90 – 100
1/2 inch	100	85 – 100	---
3/8 inch	90-100	62 – 85	62 – 77
No. 8	45-60	40 – 50	35 – 47
No. 40	10-22	10 – 20	10 – 20
No. 200	2.0 – 10.0	2.0 – 10.0	2.0 – 8.0

* Unless otherwise approved by the Engineer.

** The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be within the indicated range.

710.3.2.2 Gyratory Mix Design: Gyratory Mix Designs shall be performed in accordance with the requirements of latest edition of the Asphalt Institute's SP-2 manual. Mix design laboratory compacted specimens shall be prepared using a gyratory compactor in accordance with AASHTO T-312.

The mix design shall be formulated in a manner described for volumetric mix designs in the current edition of the Asphalt Institute Manual SP-2, except the number of trial blend gradations necessary will be determined by the mix design laboratory. Duplicate gyratory samples shall be prepared at a minimum of four (4) binder contents to select the recommended binder content. The gyratory specimens shall be compacted to 160 gyrations. Volumetric data for the design number of gyrations, N_{des}, and the initial number of gyrations, N_{ini}, are then back calculated based on the bulk specific gravity, G_{mb}, of the N_{max} specimens and the height data generated during the compaction process of those same specimens.

TABLE 710-4	
Number of Gyrations	
N_{ini}	8
N_{des}	100
N_{max}	160

The corrected density of the specimens shall be less than 89.0 percent of maximum theoretical density at N_{ini}. The corrected density of the specimens shall be less than 98.0 percent of maximum theoretical density at N_{max}. The Gyratory mix shall comply with the criteria in Table 710-5.

TABLE 710-5				
GYRATORY MIX DESIGN CRITERIA				
Criteria	**Requirements**			**Designated Test**
	3/8" Mix	**1/2" Mix**	**3/4" Mix**	**Method**
1. Voids in Mineral Aggregate: %, Min.	15.0	14.0	13.0	AI SP-2
2. Effective Voids: %, Range	4.0 ± 0.2	4.0 ± 0.2	4.0 ± 0.2	AI SP-2
3. Absorbed Asphalt: %, Range *	0 - 1.0	0 - 1.0	0 - 1.0	AI SP-2
4. Dust to Eff. Asphalt Ratio, Range **	0.6 – 1.4	0.6 – 1.4	0.6 – 1.4	AI SP-2
5. Tensile Strength Ratio: %, Min.	75	75	75	ASTM D4867
6. Dry Tensile Strength: psi, Min.	75	75	75	ASTM D4867
7. Mineral Aggregate Grading Limits				AASHTO T-27
	Percent Passing with Admix			
Sieve Size	**3/8 inch Mix**	**1/2 inch Mix**	**3/4 inch Mix**	
1 inch			100	
3/4 inch		100	90-100	
1/2 inch	100	90-100	43-89	
3/8 inch	90-100	53-89	-	
No. 8	32-47	29-40	24-36	
No. 40	2-24	3-20	3-18	
No. 200	2.0-8.0	2.0-7.5	2.0-6.5	

* Unless otherwise approved by the Engineer.

** The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be within the indicated range.

710.3.2.3 Moisture Sensitivity Testing: Moisture sensitivity testing will be performed in accordance with ASTM D4867 for both Marshall and Gyratory mix designs, without the freeze/thaw cycles. The minimum required Tensile Strength Ratio is indicated in the tables above.

- End of Section -

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.

Polymer modified asphalt cement shall be produced from crude asphalt petroleum and a polymer or blend of polymers mixed to produce a homogeneous material 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 the Performance Grading System and shall conform to the requirements set forth in Table 711-1 and AASHTO M-320 with the PAV temperature changes noted in the table. On all grades, flash point temperature AASHTO T-48: minimum 230 °C and mass loss, maximum 1.00 percent.

TABLE 711-1				
PERFORMANCE GRADING SYSTEM				
	PG 58-22	**PG 64-16**	**PG 70-10**	**PG 76-16**
Original Asphalt				
Viscosity, AASHTO T-316 (Note 1) Max. 3 Pa-s, Test Temp, °C	135	135	135	135
Dynamic Shear AASHTO T-315 (Note 2) G*/Sin δ, Min., 1.0 kPa Test Temp. @ 10 rad/s, °C	58	64	70	76
Tests Using Rolling Thin Film Oven Residue (AASHTO T-240)				
Mass Loss, Maximum %	1.0	1.0	1.0	1.0
Dynamic Shear AASHTO T-315 G*/Sin δ, Min., 2.20 kPa Test Temp. @ 10 rad/s, °C	58	64	70	76
Tests Using Pressure Aging Vessel Residue (AASHTO R-28)				
PAV Aging Temperature, °C (AASHTO R-28)	100	100	110	110
Dynamic Shear AASHTO T-315 G*·Sin δ, Max., 5000 kPa Test Temp. @ 10 rad/s, °C	22	28	34	34
Creep Stiffness, AASHTO T-313 (Note 3) S, Maximum, 300.0 Mpa *m*-value, Minimum, 0.300 Test Temp. @ 60s, °C	-12	-6	0	-6
Direct Tension, AASHTO T-314 (Note 3) Failure Strain, Minimum 1.0% Test Temp. @ 1.0 mm/min. °C	-12	-6	0	-6

NOTES:

(1) This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

(2) For quality control of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be substituted for dynamic shear measurements of G*/sin (d) at test temperatures when the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary or rotational viscometer (AASHTO T-210 or AASHTO T-202).

(3) If the creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. Direct tension test is recommended for polymer modified asphalt binders. The m-value requirement must be satisfied in all cases.

Polymer modified paving asphalt shall be classified by the Performance Grading System and shall conform to the requirements set forth in Table 711-2 and AASHTO M-320 with the PAV temperature changes noted in the table. On all Grades Flash Point Temperature AASHTO T-48: Minimum 230 °C and Mass Loss, Maximum 1.00 percent. P is for Polymer and TR is for Tire Rubber.

TABLE 711-2 PERFORMANCE GRADING SYSTEM				
	PG 64-28P	**PG-76-22P**	**PG76-22TR Type 1 (Note 4)**	**PG76-22TR Type 2 (Note 4)**
Viscosity, AASHTO T-316 (Note 1) Max. 3 Pa-s, Test Temp, °C	135	135	135	135
Dynamic Shear, AASHTO T-315 (Note 2) G*/Sin δ, Min., 1.0 kPa Test Temp. @ 10 rad/s, °C	64	76	76	76
Elastic recovery, ASTM D6084 Procedure "B" @ 10°C	65	65	65	55
Phase Angle, Max	75	75	75	75
Separation test, Texas 540 % Max	4	4	4	4
Solubility in Trichloroethylene, ASTM D2042 or n-propyl bromide, ASTM D7553 % Minimum	–	–	97.5	–
Tests Using Rolling Thin Film Oven Residue (AASHTO T-240)				
Mass Loss, Maximum %	1.0	1.0	1.0	1.0
Dynamic Shear, AASHTO T-315 G*/sin δ, Min., 2.20 kPa Test Temp. @ 10 rad/s, °C	64	76	76	76
Tests Using Pressure Aging Vessel Residue (AASHTO R-28)				
PAV Aging Temperature, °C (AASHTO R-28)	100	110	110	110
Dynamic Shear, AASHTO T-315 G*sin δ, Max., 5000 kPa Test Temp. @ 10 rad/s, °C	22	31	31	31
Mass Loss, AASHTO T-240 Weight % Max	1.0	1.0	1.0	1.0
Creep Stiffness, AASHTO T-313 S, Maximum, 300 Mpa *m*-value, Minimum, 0.300 Test Temp. @ 60s, °C	-18	-12	-12	-12
Direct Tension, AASHTO T-314 (Note 3) Failure Strain, Minimum 1.0% Test Temp. @ 1.0 mm/min. °C	-18	-12	-12	-12

NOTES: (continued on next page.)

(1) This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

(2) For quality control of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be substituted for dynamic shear measurements of G*/Sin δ, at test temperatures when the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary or rotational viscometer (AASHTO T-210 or AASHTO T-202).

(3) If the creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. Direct tension test is recommended for polymer modified asphalt binders. The m-value requirement must be satisfied in all cases.

(4) "TR" binders shall have 9% to 11% reclaimed tire rubber and enough virgin polymer to meet all performance grade criteria specified. The blend percentages shall be listed on the Certificate of Compliance by the manufacturer. Type 1 shall meet solubility limits.

711.3 TEST REPORT AND CERTIFICATION:

Test reports and certifications shall be provided to the Engineer when requested by the Engineer. At the time of delivery of each shipment of asphalt, the supplier supplying the material shall deliver to the purchaser a certified copy of the test report which shall indicate the name of the refinery and 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, that material 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. The certified test reports and the testing required in connection with the reports shall be at no additional cost to the Contracting Agency.

711.4 TEMPERATURES:

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 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 D1250. In converting volume to weight, the computations shall be based on Table 711-3.

TABLE 711-3		
ASPHALT CEMENT QUANTITY CONVERSION		
Grade of Material	**Gals. Per Ton of 60 °F.**	**Lbs. Per Gal at 60 °F.**
PG 58-22	236	8.47
PG 64-16	235	8.51
PG 70-10	235	8.51
PG 64-28P	236	8.47
PG 76-22P,TR	236	8.47
PG 76-16	233	8.58

- End of Section -

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.

The liquid asphalt shall be medium curing product designed by the letters MC, and shall consist of a paving asphalt conforming to the provisions in Section 711, fluxed or blended with a kerosene type 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:

The liquid asphalt shall consist of materials specified above and shall conform to the requirements set forth in Table 712-1.

712.3 TEST REPORTS AND CERTIFICATIONS:

Test reports and certifications will be furnished in accordance with Section 711.

712.4 CONVERSION OF QUANTITIES:

When pay quantities of liquid 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 D1250. In converting volume to weight, the computations shall be based on the data contained in Table 712-2.

TABLE 712-1

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/min, cm.	100	. . .	100	. . .	100	. . .	100	. . .	100	. . .
Solubility in Trichloroethylene, percent	99	. . .	99	. . .	99	. . .	99	. . .	99	

TABLE 712-2		
LIQUID ASPHALT QUANTITY CONVERSION		
Grade of Materials	**Gals. Per Ton at 60 Degrees F.**	**Lbs. Per Gals. at 60 Degrees F.**
70	253	7.90
250	249	8.03
800	245	8.16
2000	241	8.30

- ***End of Section*** -

SECTION 713

EMULSIFIED ASPHALTS MATERIALS

713.1 GENERAL:

Emulsified asphalts shall be composed of a paving asphalt base uniformly emulsified with water and an emulsifying or stabilizing agent, which stabilizes the mixture and provides a charge. The resultant charge is either positive, cationic (C) or negative, anionic. The emulsion shall be homogeneous throughout and if stored, shall show no separation of ingredients within 30 days after delivery. Emulsified asphalt shall be classified by charge, set time, penetration, and viscosity. Paving asphalts may be modified with the use of solid polymer or latex modifiers.

Emulsified asphalt shall be classified as follows:

(A) Charge: Positive charge, cationic (C) or negative charge, anionic.
(B) Modifier: Polymer Modified (PM), Latex Modified (LM)
(C) Set Time: Slow Set (SS), Medium Set (MS), Quick Set (QS), Rapid Set (RS).

713.2 TESTING REQUIREMENTS:

The emulsified asphalt shall conform to the requirements set forth in Table 713-1 or Table 713-2.

713.3 TESTS REPORT AND CERTIFICATION:

Test reports and certifications shall be made in accordance with Section 711.

TABLE 713-1

REQUIREMENTS FOR ANIONIC EMULSIFIED ASPHALT (Specification Designation)

ASTM Test Method	Type	Quick Setting		Rapid-Setting				Medium-Setting						Slow-Setting			
	Grade	QSH		RS-1		RS-2h		MS-1		MS-2		MS-2h		SS-1		SS-1h	
	Laboratory Tests	Min	Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
D7496	**Tests on emulsions:** Viscosity, Saybolt Furol at 77°F (25°C), sec.	20	100	20	100			20	100	100		100		20	100	20	100
D7496	Viscosity, Saybolt Furol at 122°F (50°C), sec.					75	400										
D6936	Demulsibility, 35 ml. 0.02 N. $CaCl_2$, percent			60		60											
D244	Coating ability and water resistance																
	Coating, dry aggregate							good		good		good					
	Coating, after spraying							fair		fair		fair					
	Coating, wet aggregate							fair		fair		fair					
	Coating, after spraying							fair		fair		fair					
D6935	Cement mixing test, percent														2		2
D6933	Sieve test, percent		0.10		0.10		0.10		0.10		0.10		0.10		0.10		0.10
D6997	Residue by distillation, percent	57		55		63		55		65		65		57		57	
D5	**Tests on Residue from Distillation Test:** Penetration 77°F (25°C), 100g, 5 sec.	40	110	100	200	40	90	100	200	100	200	40	90	100	200	40	90
D113	Ductility, 77°F (25°C), 5 cm/min. cm.	40		40		40		40		40		40		40		40	
D2402	Solubility in trichloroethylene, %	98		97.5		97.5		97.5		97.5		97.5		97.5		97.5	

TABLE 713-2

REQUIREMENTS FOR CATIONIC (C) EMULSIFIED ASPHALT
(Specification Designation)

	Type	Quick Setting		Rapid Setting				Medium Setting				Slow Setting				Modified Quick Setting	
ASTM Test Method	Grade	CQSH		CRS-1		CRS-2P		CMS-2		CMS-2h		CSS-1		CSS-1h		PMCQS-1h LMCQS-1h	
	Laboratory Tests	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	Tests on emulsions:																
D7496	Visc., Saybolt Furol at 77°F., sec.	20	100									20	100	20	100	20	100
D7496	Visc., Saybolt Furol at 122°F., sec.			20	100	100	400	50	450	50	450						
D6930	Storage Stability Test, 1 day, %		1		1		1		1		1		1		1		1
D6936	Demulsibility, 35 ml 0.8% sodium dioctyl sulfosuccinate, %			40		40											
D244	**Coating ability and water resistance:**																
	Dry aggregate							Good		Good							
	After spraying							Fair		Fair							
	Wet aggregate							Fair		Fair							
	After spraying							Fair		Fair							
D7402	Particle charge test	Positive		Positive		Positive		Positive		Positive		Positive (1)		Positive (1)		Positive	
D6933	Sieve Test, %		0.10		0.10		0.10		0.10		0.10		0.10		0.10		0.30
D6935	Cement Mixing test, %												2.0		2.0		
D6997	Distillation:																
D6997	Oil distillate, by volume of emulsion, %				3		3		12		12						
D6997	Residue, %	57		60		65		65		65		57		57			
Arizona 512 (2)	Residue by Evaporation, %															60	
	Test on residue from distillation test:															Arizona 504 (3)	
D5	Penetration, 25°C (77°F), 100 g. 5 sec.	40	110	100	250	40	90	100	250	40	90	100	250	40	90	40	90
D113	Ductility, 25°C (77°F.) 5 cm per min, cm. (4)	40		40		40		40		40		40		40		40	
D36	Ring and Ball Softening Point (5)															130	
D6084 (Procedure b)	Elastic Recovery, %					55										55	
D2402	Solubility in trichloroethylene, %	98		98		97.5		98		98		97.5		97.5		97.5	

(1)* If the Particle Charge Test result is inconclusive for CSS-1 or CSS-1h, material having a maximum pH value of 6.7 will be accepted.
(2) Residue by evaporation may be determined in accordance with the requirements of Arizona Test Method 512; however, in case of dispute, ASTM D6934 shall be used.
(3)* If using PMCQS-1h or LMCQS-1h the residue from distillation shall be obtained from ARIZ-504. In case of dispute, testing on residue by distillation at 350° F (ASTM D6997) shall be performed.
(4) When Micro-surfacing emulsion is specified, the ductility shall be a minimum of 60 cm.
(5) When Micro-surfacing emulsion is specified, the softening point shall be a minimum of 140° F.

713.4 TEMPERATURES:

Unless otherwise specified, the various grades of emulsified asphalt shall be applied at temperatures within the limits specified in Table 713-3 the exact temperature to be determined by the Engineer. Emulsified asphalt shall be reheated if necessary. However, 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 Table 713-3. 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 713-3		
APPLICATION TEMPERATURE OF EMULSIFIED ASPHALT		
Grade of Emulsified Asphalt	**Minimum °F**	**Maximum °F**
RS-1, MS-1, SS-1, SS-Ih, CSS-1, CSS-1h	70° F	140° F
RS-2, MS-2, MS-2h, CRS-1, PMCQS-1h, LMCQS-1h, CRS-1h, CRS-2h, CMS-2, CMS-2h, QSH, CQSH	125° F	185° F

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 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 D1250. In converting volume to weight, the computations shall be based on Table 713-4.

TABLE 713-4		
EMULSIFIED ASPHALTS QUANTITY CONVERSION		
Grade of Material	**Gals Per Ton at 60° F**	**Lbs. Per Gal. at 60° F**
All grades	238	8.40

- ***End of Section*** -

SECTION 714

MICRO-SURFACING MATERIALS

714.1 GENERAL:

Micro-surfacing materials shall consist of a properly proportioned mixture of cationic polymer solids or latex modified asphalt emulsion, mineral aggregates, mineral filler, water, and other additives. Micro-surfacing is designed to provide skid resistant texture, improve surface friction and extend the service life of the existing pavement. Micro-surfacing allows for higher than normal application rates and/or multiple layer applications for rut filling and roadway leveling.

All material sources must be approved prior to their use. The Contractor shall submit a job mix formula, and if requested, pre-qualifications for materials at least seven (7) days prior to start of construction. When requested, additional samples shall be furnished during the construction period at no cost to the Agency. This is a non-pay item.

714.2 AGGREGATE:

714.2.1 Mineral Filler: Mineral filler shall consist of finely divided matter, such as hydrated lime, Portland cement, limestone dust or fly ash, conforming to the requirements of ASTM D242. Mineral filler shall be used only when needed to reduce the setting time, to improve the workability, or to reduce the stripping characteristics of the aggregate emulsion mixture. The minimum amount of the required filler shall be used, and shall be considered as part of the blended aggregate.

A certificate shall be submitted with the job mix formula demonstrating conformance to the requirements of ASTM D242.

714.2.2 Mineral Aggregate: Coarse and fine aggregates shall be per Section 701. Aggregates shall be 100% crushed with no rounded particles. No natural sand shall be allowed. The use of recycled asphalt (RAP) may be used with prior approval of the Engineer. The mineral aggregate shall conform to the requirements of Table 714-1. Historical test data from source aggregate may be used, if tested within the past year.

Type I. This aggregate gradation is used to seal and fill minor surface voids.

Type II. This aggregate gradation is used to fill surface voids, address surface distresses, seal, and provide a durable wearing surface.

Type III. This aggregate gradation provides maximum skid resistance and an improved wearing surface. This type of surface is appropriate for heavily traveled pavements, rut filling, or for placement on highly textured surfaces requiring larger size aggregate to fill voids.

If more than one kind of aggregate is used, the correct amount of each kind of aggregate needed to produce the required gradation shall be proportioned separately in a manner that shall result in a uniform and homogeneous blend. The final blended aggregate shall meet the requirements of Table 714-1.

TABLE 714-1				
MICRO-SURFACING AGGREGATE				
GRADATION TEST METHOD ASTM C136 / C117				
SIEVE SIZE	TYPE I % PASSING	TYPE II % PASSING	TYPE III % PASSING	PRODUCTION TOLERANCES
3/8	100	100	100	
No. 4	100	85-100	70-90	+/- 5%
No. 8	90-100	65-90	45-70	+/- 5%
No. 16	65-90	45-70	28-50	+/- 5%
No. 30	40-60	30-50	19-34	+/- 5%
No. 50	25-42	18-30	12-25	+/- 4%
No. 100	15-30	10-21	7-18	+/- 3%
No. 200	10-20	5-15	5-15	+/- 2%

ASTM TEST METHOD	TEST	REQUIREMENTS
D2419	Sand Equivalent	50, minimum
D5821	Fractured Faces	100%
D4318	Plasticity Index	NP
C131	L.A. Abrasion	35 percent, maximum
Arizona 238	Percent Carbonates	20 percent, maximum

The gradation of the aggregate stockpile shall not vary by more than the production tolerance from the job mix formula gradation (indicated in the table above) while also remaining within the specification gradation band.

714.3 WATER:

Water shall be potable water, free of any injurious impurities. The Contractor shall identify the water source to the Engineer.

714.4 ADDITIVES:

Additives may be used to accelerate or retard the breaking point and set times of the mix, or to improve the resulting finished surface.

The use of additives in the mix shall be supplied in quantities predetermined by the laboratory job mix formula.

714.5 BITUMINOUS MATERIAL:

The asphalt emulsion used for micro-surfacing shall meet the requirements specified in Section 713.

Each tank of emulsion produced shall be certified as to its compliance with these specifications; this certification shall include a certificate of analysis indicating the percent asphalt residue of each tank supplying emulsion to the project. This certificate of analysis shall accompany the placement machine and shall be provided to the Engineer upon request.

When required, the quick setting emulsified asphalt shall be of the cationic quick set type such as PMCQS-1h or LMCQS-1h that shall react to chemically active mineral fillers such as Portland cement in such a way that the applied micro-surfacing mixture can support controlled traffic in 45-60 minutes after application. The amount of chemically active filler shall be determined by job mix formula and field performance.

714.6 MODIFIER TYPE AND CONTENT:

Modified cationic quick setting emulsion (PMCQS-1h or LMCQS-1h) shall be homogeneous and the modifier used shall consist of either a polymer solid milled into the asphalt or latex blended prior to the emulsification process. The PMCQS-1h and LMCQS-1h shall contain a minimum of 4% polymer solids or latex and shall conform to Section 713.

A certification of the polymer solids or latex content and type by the supplier shall be required throughout the duration of the contract. Each tank of emulsion produced shall be certified as to its compliance with these specifications; this certification shall include a certificate of analysis indicating the percent asphalt residue of each tank supplying emulsion to the project. This certificate of analysis shall accompany the placement machine and shall be provided to the Engineer upon request.

Placement of micro-surfacing is temperature dependent and should be tested under field conditions.

714.7 JOB MIX FORMULA:

714.7.1 General: The job mix formula shall be designed to provide a suitable surface for traffic conditions, climate and curing. All materials shall be pre-tested in the laboratory to determine their suitability for use in the micro-surfacing. The job mix formula shall be evaluated using a minimum of three emulsion contents to determine which emulsion content shall yield the optimum emulsion content that meets the requirement of 714-2.

The report must clearly show the theoretical recommended proportion of aggregate, mineral filler (Minimum & Maximum), water (Minimum & Maximum), additive(s), and asphalt based on the dry weight of aggregate.

The Contractor shall provide a job mix formula from an AASHTO re:source accredited laboratory and present certified test results for the Engineer's approval. Compatibility of the aggregate and polymer solids or latex modified emulsion shall be certified by the emulsion manufacturer. All the materials used in the job mix formula shall be representative of the materials proposed by the Contractor for use in the project. The job mix formula shall not be older than one (1) calendar year. A new job mix formula shall be required if any material changes are made to the original design.

All the products used in the construction shall have certifications from the suppliers, and these certifications shall be given to the Engineer upon delivery to the project.

Job mix formula and proportioning shall be approved by the Engineer prior to the start of the project.

714.7.2 Specifications:

The specification limits are shown in Table 714-2.

TABLE 714-2 MICRO-SURFACING JOB MIX FORMULA			
ASTM TEST METHOD	**ISSA TECHNICAL BULLETIN**	**TEST**	**REQUIREMENTS**
D244		Residual Asphalt, % by dry weight of aggregate	6.0 – 11.5
D242		Mineral Filler, % by dry weight of aggregate.	0.1 – 2.0
		Modifier Content, % (see Section 714.6)	4, minimum.
		Additive	As required for mix properties
		Water	As required for mix properties
C136 / C117		Aggregate Grading	Meets requirements of Table 714-1
	TB-106	Consistency, cm.	2.5-3.0
	TB-100	Abrasion Loss (Wet Track Abrasion Test) One Hour Soak, g/ft² Six Day Soak, g/ft²	 50, maximum 75, maximum
	TB-114	Wet Stripping, %	90, minimum
	TB-139	Wet Cohesion Test, at 77° F Set Time Test: (30 minutes), kg-cm Early Rolling Traffic Time: (60 minutes), kg-cm	 12, minimum 20, minimum
	TB-102	Quick Set Emulsion Mix Properties Micro-Surfacing Setting Test, 70-85 ° F. (1-hour cure) Micro-Surfacing Water Resistance Test, 70-85 ° F. (30-minute cure)	 No Brown Stain No More Than Slight Discoloration
	TB-115	Split Consistency Test	Uniform
	TB-113	Mix Time Micro-Surfacing Mixing, 70-85 ° F., Sec.	 120, minimum
	TB-147	Measurement of Stability and Resistance to Compaction, Vertical and Lateral Displacement of Multi-layered Fine Aggregate Cold Mixes	Lateral Displacement 5%, maximum Specific Gravity 2.10, maximum
	TB-109	Loaded Wheel Sand Adhesion	50 g/ft², maximum

714.7.2.1 Bulking Effect (ASTM C29 Modified): The laboratory shall further report the quantitative effects of moisture content in the unit weight of the aggregate (bulking effect).

714.8 TEST CERTIFICATES AND REPORTS:

Test certificates and reports for the bituminous material shall be furnished in accordance with Section 711.

714.9 CONVERSION OF QUANTITIES:

Volumetric conversions shall be accomplished in accordance with Section 713.

- ***End of Section*** -

SECTION 715

SLURRY SEAL MATERIALS

715.1 GENERAL:

Slurry seal shall consist of a properly proportioned mixture of emulsified asphalt, mineral aggregate, mineral fillers, water, and additives (if necessary). Slurry seal is designed to provide skid resistant texture, improve surface friction and extend the service life of the existing pavement. Slurry seal shall be placed as a single layer with a minimum thickness greater than the nominal aggregate size specified in the mix design.

All material sources must be approved prior to their use. The Contractor shall submit a job mix formula and if requested pre-qualifications for materials at least seven (7) days prior to start of construction. When requested, additional samples shall be furnished during the construction period at no cost to the Agency. This is a non-pay item.

715.2 AGGREGATE:

715.2.1 Mineral Filler: Mineral filler shall consist of finely divided matter, such as hydrated lime, Portland cement, limestone dust or fly ash, conforming to the requirements of ASTM D242. Mineral filler shall be used only when needed to reduce the setting time, to improve the workability, or to reduce the stripping characteristics of the aggregate emulsion mixture. The minimum amount of the required filler shall be used, and it shall be considered as part of the blended aggregate.

A certificate shall be submitted with the job mix formula demonstrating conformance to the requirements of ASTM D242.

715.2.2 Mineral Aggregate: Coarse and fine aggregates shall be per Section 701. Mineral aggregates used shall be 100% crushed with no rounded particles. No natural sand shall be allowed. The use of recycled asphalt (RAP) may be used with prior approval of the Engineer. The mineral aggregate without mineral filler shall conform to the requirements specified in Table 715-1. Historical test data from source aggregate may be used, if tested within the past year.

Type I. This aggregate gradation is used to seal and fill minor surface voids.

Type II. This aggregate gradation is used to fill surface voids, address surface distresses, seal, and provide a durable wearing surface.

Type III. This aggregate gradation provides maximum skid resistance and an improved wearing surface. This type of surface is appropriate for heavily traveled pavements, or for placement on highly textured surfaces requiring larger size aggregate to fill voids.

If more than one kind of aggregate is used, the correct amount of each kind of aggregate needed to produce the required gradation shall be proportioned separately in a manner that shall result in a uniform and homogeneous blend. The final blended aggregate shall meet the requirements of Table 715-1.

TABLE 715-1				
SLURRY SEAL AGGREGATE				
GRADATION TEST METHOD ASTM C136 / C117				
SIEVE SIZE	TYPE I % PASSING	TYPE II % PASSING	TYPE III % PASSING	PRODUCTION TOLERANCES
3/8	100	100	100	
No. 4	100	85-100	70-90	+/- 5%
No. 8	90-100	65-90	45-70	+/- 5%
No. 16	65-90	45-70	28-50	+/- 5%
No. 30	40-60	30-50	19-34	+/- 5%
No. 50	25-42	18-30	12-25	+/- 4%
No. 100	15-30	10-21	7-18	+/- 3%
No. 200	10-20	5-15	5-15	+/- 2%

ASTM TEST METHOD	TEST	REQUIREMENTS
D2419	Sand Equivalent	50, minimum
D5821	Fractured Faces	100%
D4318	Plasticity Index	NP
C131	L.A. Abrasion	35 percent, maximum

The gradation of the aggregate stockpile shall not vary by more than the production tolerance from the job mix formula gradation (indicated in the table above) while also remaining within the specification gradation band.

715.3 WATER:

Water shall be potable water, free of any injurious impurities. The Contractor shall identify the water source to the Engineer.

715.4 ADDITIVES:

Additives may be used to accelerate or retard the breaking point and set times of the mix, or to improve the resulting finished surface.

The use of additives in the mix shall be supplied in quantities predetermined by the laboratory job mix formula.

715.5 BITUMINOUS MATERIAL:

The asphalt emulsion used for slurry seal shall meet the requirements specified in Section 713.

Each tank of emulsion produced shall be certified as to its compliance with these specifications; this certification shall include a certificate of analysis indicating the percent asphalt residue of each tank supplying emulsion to the project. This certificate of analysis shall accompany the placement machine and shall be provided to the Engineer upon request.

The quick setting emulsified asphalt shall be of the anionic or cationic quick set type such as QSH, CQSH, PMCQS-1h or LMCQS-1h that shall react to chemically active mineral fillers such as Portland cement in such a way that the applied slurry mixture can support controlled traffic in 45-60 minutes after application. The amount of chemically active filler shall be determined by job mix formula and field performance.

Slow setting emulsion may be used when traffic control is not a critical item.

715.6 MODIFIER TYPE AND CONTENT:

Polymer solids or latex modified cationic quick setting emulsion (PMCQS-1h or LMCQS-1h) may be used when specified or approved by the Engineer.

Modified cationic quick setting emulsion (PMCQS1-h or LMCQS-1h), shall be homogeneous and the modifier used shall consist of either polymer solids milled or latex blended during the emulsification process. The PMCQS-1h or LMCQS-1h shall contain a minimum of 3% polymer solids or latex and shall conform to Section 713.

A certification of the polymer solids or latex content and type by the supplier shall be required throughout the duration of the contract. Each tank of emulsion produced shall be certified as to its compliance with these specifications; this certification shall include a certificate of analysis indicating the percent asphalt residue of each tank supplying emulsion to the project. This certificate of analysis shall accompany the placement machine and shall be provided to the Engineer upon request.

Placement of slurry seal is temperature dependent and should be tested under field conditions.

715.7 JOB MIX FORMULA:

715.7.1 General: The job mix formula shall be designed to provide a suitable surface for traffic conditions, climate and curing. All materials shall be pre-tested in the laboratory to determine their suitability for use in the slurry seal. The job mix formula shall be evaluated using a minimum of three emulsion contents to determine which emulsion content shall yield the optimum emulsion content that meets the requirement of 715-2.

The report must clearly show the theoretical recommended proportion of aggregate, mineral filler (Minimum & Maximum), water (Minimum & Maximum), additive(s), and asphalt based on the dry weight of aggregate.

The Contractor shall provide a job mix formula from an AASHTO re:source accredited laboratory and present certified test results for the Engineer's approval. All the materials used in the job mix formula shall be representative of the materials proposed by the Contractor for use in the project. The job mix formula shall not be older than one (1) calendar year. A new job mix formula shall be required if any material changes are made to the original design.

All the products used in the construction shall have certifications from the suppliers, and these certifications shall be given to the Engineer upon delivery to the project.

Job mix formula and proportioning shall be approved by the Engineer prior to the start of the project.

715.7.2 Specifications:
The specification limits are shown in Table 715-2.

TABLE 715-2 SLURRY SEAL JOB MIX FORMULA			
ASTM TEST METHOD	**ISSA TECHNICAL BULLETIN**	**TEST**	**REQUIREMENTS**
D244		Residual Asphalt, % by dry weight of aggregate: Type I Type II Type III	 10.0 – 16.0 7.5 – 13.0 6.5 – 12.0
D242		Mineral Filler, % by dry weight of aggregate.	0.1 – 2.0
		Modifier Content, % (see Section 715.4), if applicable	3, minimum.
		Additive	As required for mix properties
		Water	As required for mix properties
C136 / C117		Aggregate Grading	Meets requirements of Table 715-1
	TB-106	Consistency, cm.	2.0-3.0
	TB-100	Abrasion Loss (Wet Track Abrasion Test) One Hour Soak, g/ft² Six Day Soak, g/ft²	 75, maximum 75, maximum
	TB-114	Wet Stripping, %	90, minimum
	TB-139	Modified Cohesion Test, at 77° F Set Time Test: (30 minutes), kg-cm Early Rolling Traffic Time: (60 minutes), kg-cm	 12, minimum 20, minimum
	TB-102	Quick Set Emulsion Mix Properties Slurry Seal Setting Test, 70-85 ° F (1-hour cure) Slurry Seal Water Resistance Test, 70-85 ° F (30-minute cure)	 No Brown Stain No More Than Slight Discoloration
	TB-115	Split Consistency Test	Uniform
	TB-113	Mix Time Slurry Seal Mixing, 70-85 ° F, Sec.	 120, minimum
	TB-147	Measurement of Stability and Resistance to Compaction, Vertical and Lateral Displacement of Multi-layered Fine Aggregate Cold Mixes	Lateral Displacement 5%, maximum Specific Gravity 2.10, maximum
	TB-109	Loaded Wheel Sand Adhesion	50 g/ft², maximum

715.7.2.1 Bulking Effect (ASTM C29): The laboratory shall further report the quantitative effects of moisture content in the unit weight of the aggregate (bulking effect).

715.8 TEST CERTIFICATES & REPORTS:

Test certificates and reports for the bituminous material shall be furnished in accordance with Section 711.

715.9 CONVERSION OF QUANTITIES:

Volumetric conversions shall be accomplished in accordance with Section 713.

- ***End of Section*** -

SECTION 716

COVER MATERIAL

716.1 GENERAL:

Cover material "chips" shall consist of precoated or uncoated aggregate spread in conjunction with a bituminous or asphalt-rubber seal coat.

716.2 COVER MATERIAL AGGREGATE:

716.2.1 Properties:

(1) When tested in accordance with AASHTO T-96, the loss shall not exceed 40 percent at 500 revolutions.
(2) When tested in accordance with AASHTO T-104 (Sodium Sulfate Soundness), the loss shall not exceed 12 percent.
(3) When tested in accordance with ARIZ-212, a minimum of 75 percent, by weight, of the material retained on the No. 8 sieve, shall have at least one fractured face.

716.2.3 Gradation: When tested in accordance with AASHTO T-27 and T-11, the gradation shall comply with Table 716-1 and/or Table 716-2.

TABLE 716-1	
COVER MATERIAL (CHIPS) GRADATION For Low Volume Traffic Only	
Sieve Size	Percent Passing
½ inch	100
3/8 inch	97/100
1/4 inch	70/100
#8	0-5
#200	0-2

TABLE 716-2	
COVER MATERIAL (CHIPS) GRADATION For High Volume Traffic	
Sieve Size	Percent Passing
3/4 inch	100
½ inch	97/100
3/8 inch	70/100
1/4 inch	0-10
#8	0-5
#200	0-2

716.3 PRECOATED CHIPS:

When specified, the aggregate shall be heated and precoated with asphalt cement as specified in Section 711. The quantity of bituminous material used shall not be less than 0.30 percent or greater than 0.70 percent of the combined weight of the bituminous material and the aggregate to achieve a "salt and pepper" appearance.

The final percentage of asphalt used for coating shall be as directed by the Engineer. The precoating shall be done in a drum mix hot plant. With approval of the Engineer, a pug mill mixing facility may be used.

716.4 UNCOATED CHIPS:

When liquid or paving grade asphalt is used as the bituminous binder, the uncoated chips shall not contain moisture in excess of a saturated surface dry condition.

When emulsified asphalt is used as the bituminous binder, the uncoated chips shall be surface wet but free from running water.

- ***End of Section*** -

SECTION 717

ASPHALT-RUBBER ASPHALT CONCRETE

717.1 DESCRIPTION:

The work under this section shall consist of furnishing, proportioning and mixing all the ingredients necessary to produce an Asphalt-Rubber Asphalt Concrete (ARAC) material. ARAC mixes may be used for low or high traffic conditions, as determined by the agency. Low traffic conditions are conditions where the asphalt mix will be subject to low volume and low weight vehicle usage. Examples of this condition are residential streets, most parking lots and residential minor collector streets. High traffic conditions are conditions where the asphalt mix will be subject to high volume and/or heavy weight vehicle usage as found on major collector, arterial and commercial streets. Street classifications (i.e. minor collector and major collector) shall be determined by the specifying agency.

717.2 MATERIALS:

717.2.1 Asphalt-Rubber Binder (ARB): The blended ARB shall meet the criteria list below. The ARB may be blended in a dedicated blending and storage unit connected to the hot plant or at the asphalt binder supplier's facility.

717.2.1.1 Asphalt Cement: Asphalt cement shall conform to the requirements of Section 711.

717.2.1.2 Crumb Rubber: Crumb Rubber shall meet the gradation requirements as shown in Table 717-1 below when tested in accordance with Arizona Test Method 714.

TABLE 717-1	
GRADATION REQUIREMENTS OF CRUMB RUBBER	
Sieve Size	**Percent Passing**
2.00 mm (#10)	100
1.18 mm (#16)	65 - 100
600 µm (#30)	20 - 100
300 µm (#50)	0 - 45
75 µm (#200)	0 - 5

The crumb rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of wire or other contaminating materials, and shall contain no more than 0.5 percent fabric. Calcium carbonate, up to four percent by weight of the crumb rubber, may be added to prevent the particles from sticking together.

Crumb rubber shall be derived from processing whole scrap tires or shredded tire materials through a process of mechanical grinding at ambient temperature. Use of crumb rubber granules produced from a cryogenic process is prohibited. The tires from which the crumb rubber is produced shall be from automobiles, trucks, or other equipment owned and operated in the United States.

Upon request, a Certificate of Compliance conforming to the requirements of Section 106.2 shall be submitted that confirms the crumb rubber complies with the gradation and specific gravity of Section 717, and is free of wire or other contaminating materials. The Certificate shall also attest:

- The processing does not produce, as a waste product, casings or other round tire material that can hold water when stored or disposed of above the ground.
- The crumb rubber is produced through a process of mechanical grinding at ambient temperature.
- The tires from which the crumb rubber is produced were from automobiles, trucks, or other equipment owned and operated in the United States.

717.2.1.3 ARB Proportions and Properties: Ground crumb rubber in ARB shall be a minimum of 18 percent by weight of total binder.

ARB shall be Type 1 unless otherwise specified and conform to the requirements of Table 717-2.

TABLE 717-2			
PHYSICAL PROPERTIES OF ARB			
Property	Requirement		
	Type 1	Type 2	Type 3
Grade of base asphalt cement	PG 64-16	PG 58-22	PG 52-28
Rotational Viscosity*; 350° F, Pascal seconds	1.5-4.0	1.5-4.0	1.5-4.0
Penetration; 39° F (4° C), 200g, 60 sec. (ASTM D5); dmm, min	10	15	25
Softening Point; (ASTM D36); °F, min.	135	130	125
Resilience; 77°F (ASTM D5329); %, min	25	20	15
* The Viscometer used must be a hand held rotational viscometer, such as a Rion (formerly Haake) Model VT – 04, or an equivalent, using Rotor No. 1. The rotor, while in the off position, shall be completely immersed in the binder at a temperature from 350° to 355° F for a minimum heat equilibrium period of 60 seconds, and an average viscosity determined from three separate constant readings (± 0.5 pascal-seconds) taken within a 30 second time frame with the viscotester level during testing and turned off between readings. Continuous rotation of the rotor may cause thinning of the material immediately in contact with the rotor, resulting in erroneous results.			

717.2.1.4 ARB Design: At least two weeks prior to paving, the Contractor shall submit an ARB design prepared by an ADOT approved laboratory. Such design shall meet the requirements specified herein. The design shall show the values obtained from the required tests, along with the following information: percent, grade and source of the asphalt cement used; and percent, gradation and source(s) of the crumb rubber used, as well as the ARB blending location: on-site or at the asphalt binder supplier's facility.

717.2.2 Aggregate: Coarse and fine aggregates shall conform to the applicable requirements of Tables 717-3 and 717-4 below. Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Coarse aggregate is material retained above the Number 8 sieve and fine aggregate is material passing the Number 8 sieve. Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent thorough coating with the asphalt cement. Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

TABLE 717-3		
MIX DESIGN GRADATION REQUIREMENTS WITH MINERAL ADMIXTURE		
Overlay Thickness	1" & 1- ½"	2"
Sieve Size	Percent Passing	Percent Passing
1" (25 mm)	100	100
¾" (19 mm)	100	95-100
½" (12.5 mm)	95-100	78-92
⅜" (9.5 mm)	78-92	61-75
No. 4 (4.75 mm)	28-45	30-40
No. 8 (2.36 mm)	15-25	15-25
No. 30 (600 µm)	5-15	5-15
No. 200 (75 µm)	3.0-7.0	2.0-6.0

The combined aggregate properties shall conform to the requirements of Table 717-4.

TABLE 717-4		
COARSE/FINE AGGREGATE REQUIREMENTS		
Characteristics	**Test Method**	**Requirements**
Fractured Faces, % (Plus No. 8)	ARIZ-212	85, 1 fracture 80, 2 or more
Uncompacted Voids, %	ARIZ-247	45.0 (High Traffic Volume) 42.0 (Low Traffic Volume)
Sand Equivalent (Minus No. 4)	AASHTO T-176	65 minimum
Plasticity Index	AASHTO T-89 & T-90	Non Plastic
L.A. Abrasion, % Loss	AASHTO T-96	9 max. @ 100 Rev. 40 max. @ 500 Rev.
Combined Bulk Specific Gravity	AI MS-2	2.35-2.85
Combined Water Absorption, %	AI MS-2	0-2.5

717.2.3 Mineral Admixture: Mineral admixture used in ARAC shall be dry hydrated lime conforming to the requirements of ASTM C1097 or Portland cement conforming to ASTM C150 for Type II, or ASTM C595 for Type IP. The minimum mineral admixture content will be 1.0percent, by weight of total aggregate.

717.3 MIX DESIGN REQUIREMENT:

717.3.1 General: The mix design for ARAC shall be prepared by a laboratory that is accredited through the AASHTO Accreditation Program (AAP) in Hot Mix Asphalt Aggregates and Hot Mix Asphalt. The laboratory shall be under the direct supervision of a Civil Engineer, registered by the State of Arizona, and who is listed by ADOT as a "Qualified Asphalt Concrete Mix Design Engineer" within ADOT's list of approved laboratories.

The date of the design shall not be older than two years from the date of submittal, unless supportive documentation is provided and approved by the Engineer.

The mix design method used shall be in accordance with the Marshall Mix procedure, 75 blows, as described in Arizona Test Method 832 "Marshall Mix Design Method for Asphaltic Concrete (Asphalt Rubber) [AR-AC]" with the exceptions that:

(1) Mineral admixture shall be considered part of the total weight of aggregate and all combined specific gravity and combined absorption calculations for aggregates and mineral admixture will be done in accordance with Asphalt Institute's Manual MS-2.

(2) Course aggregate shall be separated from the fine aggregate on the #8 sieve.

Mix designs are subject to approval by the Engineer.

717.3.2 Mix Design Criteria: The mix shall comply with the criteria in Table 717-5.

TABLE 717-5 MARSHALL MIX DESIGN CRITERIA		
Criteria	Low Volume Traffic	High Volume Traffic
ARB Content 1" and 1-1/2" Overlay Thickness 2" Overlay Thickness	 8.4% minimum N/A	 8.0% minimum 7.0% minimum
Mixture Air Voids, %	3.5-4.5	4.5-5.5
Voids in Mineral Aggregate, %	19.0 min	19.0 min
Tensile Strength Ratio, ASTM D4867	65% minimum	65% minimum
Marshall Stability, pounds minimum	800	800
Marshall Flow, 0.01 inch minimum	16	16

The mix design report shall include the following elements as a minimum.

(1) The name and address of the testing organization and the person responsible for the mix design report.
(2) The mix plant identification and/or location, as well as the supplier or producer name. The traffic condition (low or high traffic) and lift thickness.
(3) A description of all products that are incorporated in the ARAC along with the sources of all products, including the base asphalt cement, crumb rubber, mineral aggregate, and admixtures.
(4) The results of all testing, determinations, etc., such as: specific gravity and gradation, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, Tensile Strength Ratio (ASTM D4867), Marshall bulk density, stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and mineral admixture content. Historical abrasion values may be supplied on existing sources. The submittal should include a plot of the gradation on the Federal Highway Administration's 0.45 Power Gradation Chart and plots of the compaction curves.
(5) The laboratory mixing and compaction temperature ranges for the ARB used within the mix design.
(6) A specific recommendation for design ARB content and any limiting conditions that may be associated with the use of the design, such as minimum percentages of crushed or washed fine aggregate.
(7) The supplier's product code, the laboratory Engineer's seal (signed and dated), and the date the design was completed.
(8) The ARB design.

The mix design shall be submitted to the Agency or Engineer by the Contractor/Supplier for which it was developed as part of his project submittals. Once the mix design has been approved by the agency or Engineer, the Contractor and/or his supplier shall not change plants nor utilize additional mixing plants without prior approval of the Engineer. Any changes in the plant operation, the producer's pit, the ARB, or any other item that will cause an adjustment in the mix, shall be justification for a new mix design to be submitted.

- ***End of Section*** -

SECTION 718

PRESERVATIVE SEAL FOR ASPHALT CONCRETE

718.1 PRESERVATIVE SEAL:

Asphalt Concrete preservative seal shall be one of the following types or equal, with typical application rates.

TYPE 1 - Asphalt rejuvenating agent shall be an emulsion composed of a petroleum resin oil base uniformly emulsified with water. Each supplier must submit a certified statement from the asphalt rejuvenator manufacturer showing that the asphalt rejuvenating emulsion conforms to the required physical and chemical requirements. They also must provide documentation of tests that determine the acceptable range of application of the product. Typical application rates are 0.07 to 0.18 gallons per square yard.

TYPE 2 - Petroleum Hydrocarbon emulsion. Applied at 0.05 to 0.20 gallons per square yard, diluted.

TYPE 3 - Acrylic polymer modified emulsion Diluted to the manufacture's recommendation and applied at a rate of 0.08 to 0.20 gallons per square yard.

TYPE 4 - Polymer modified rejuvenating emulsion. (PMRE) Diluted to the manufacture's recommendation and applied at a rate of 0.08 to 0.20 gallons per square yard.

718.2 TEST METHODS AND REQUIREMENTS PRESERVATIVE SEAL:

Preservative seal for asphalt concrete material, shall meet type 1, 2, 3 or 4 on Table 718-1 by certification from the manufacturer.

Tests shall be performed by AMRL accredited laboratory, accredited in the specified test being performed.

Table 718-1

PRESERVATIVE SEAL SPECIFICATIONS

Properties	Method	Type-1	Type-2	Type-3	Type-4
Saybolt Viscosity @77°F (sfs)	ASTM D244	15-40	25-150	15-40	50-150
Sieve test %	ASTM D244	0.1 max	0.1 max	0.1 max	0.1 max
Storage Stability, 24 hours, %	ASTM D244				1.0 max
Settlement test, 5 days, %	ASTM D244		2.0 max	5.0 max	
Test on residue by:		**ASTM D244 Evaporation To 138°C**	**ASTM D244 Evaporation To 138°C**	**ASTM D244 Evaporation To 138°C**	**ASTM D244 Distillation To 177°C**
Residue Content, %	ASTM D244	60 min	62 min	53 min	65 min
Oil Distillate, % by volume	ASTM D244				0.5 max
Flash point (Note 2) °F	ASTM D92	400°F	450°F	450°F	
Softening point, °F	ASTM D5			130 min	
Viscosity (Note 3), 60C, Poise	ASTM D2171				5000 max
Elastic Recovery (Note 4), 10C, %	AASHTO T-301				50 min

Table 718-1					
PRESERVATIVE SEAL SPECIFICATIONS					
Properties	**Method**	**Type-1**	**Type-2**	**Type-3**	**Type-4**
Test on residue by:		**ASTM D244 Evaporation To 138°C**	**ASTM D244 Evaporation To 138°C**	**ASTM D244 Evaporation To 138°C**	**ASTM D244 Distillation To 177°C**
Ductility, 25C, 5 cm/min, cm	ASTM D113			20 min	
Penetration, 25C, 100g/5 sec, dmm	ASTM D5			20-80	
Penetration, 4C, 200g/60 sec, dmm	ASTM D5				20-70
Kinematic Viscosity, 140°F, cSt	ASTM D2170	100-200	1,000-9,500		
Accelerated Weathering test (Note 5)	ASTM D4799			Plant certification within 12 months	
Test on		**Evaporative Residue**	**Evaporative Residue**		**Rejuvenating Agent Base**
Asphaltenes, % w	ASTM D2006	1.0 max	10.0 Max.		1.0 max
Maltene Dist. Ratio $(PC+A_1)/(A_2+S)$	ASTM D2006	0.3-0.6	0.2-1.4		
PC/S Ratio	ASTM D2006	0.5 min	0.5 min.		
Saturated Hydrocarbons, S	ASTM D2006	28 max	28 max.		30 max
Kinematic Viscosity, 140°F, cSt	ASTM D2170				50-175
Flash point °F	ASTM D92				375 min
Test on residue from RTFO:	**ASTM D2872**				**Rejuvenating Agent Base**
Mass Change, %,	ASTM D2872				6.5 max
Kinematic Viscosity, 140°F, cSt	ASTM D2170				Report
Kinematic Viscosity, Ratio (Note 6)					3.0 max

Notes:

1. Brookfield viscosity using spindle #27 (ASTM D4402) test temperature at 140˚F temperature equilibrate the sample for a minimum of 20 minutes. Sample test time is at 5 minutes inside the Brookfield viscosity tube.
2. Flash point on residue may be waived by the Engineer during production sampling and testing provided manufacturer submits results performed in the previous 12 months in compliance.
3. Viscosity in poise may be determined using AASHTO T-315 by converting the Complex Dynamic Shear Viscosity to Viscosity in poise.
4. Elastic Recovery molds shall have straight sides as shown in Fig. 1 of AASHTO T-301.
5. Other Accelerated Weathering test procedures may be presented for acceptance by the Engineer prior to project start. These results shall be provided at no additional cost to the agency.
6. Kinematic Viscosity Ratio will be determined by dividing the viscosity of the material after RTFO aging by the original viscosity.

718.3 ASPHALT SURFACE SEALER:

Asphalt Surface Sealer: Asphalt Surface Sealer not diluted, and applied as per the manufacturer's specifications, shall conform to ASTM D8099 noted in Table 718-2 and two additional requirements on the base asphalt used in preservative seal for flash and softening points.

TABLE 718-2		
ASPHALT SURFACE SEALER		
Properties	**Method**	**Asphalt Surface Sealer**
Uniformity	ASTM D2939	No separation, coagulation, or settlement that cannot be overcome by moderate stirring
Wet Film Continuity	ASTM D2939	Uniform homogenous consistency
Density @ 25C (77F) [lbs./gal]	ASTM D2939	Min 1.0 [9] Max 1.5 [12]
Water Content, %	ASTM D95	70% max
Ash content of residue, %	ASTM D2939	10% min 70% max
Drying time, firm set, hours	ASTM D2939	8 hours max
Resistance to heat	ASTM D2939	No blistering, sagging, or slipping
Resistance to water	ASTM D2939	No loss of adhesion and no blistering or tendency to re-emulsify
Flexibility	ASTM D2939	No flaking, cracking, or loss of adhesion to the substrate
Residue by Evaporation	ASTM D2939	30% min
Tests on Base Asphalt Used in Preservative Seal Prior to Emulsification	**Method**	**Asphalt Surface Sealer**
Flash Point (degrees F)	ASTM D92	450° F
Softening Point (degrees F)	ASTM D36	140° F min

- End of Section -

SECTION 719

POLYMER MODIFIED ASPHALT CONCRETE

719.1 DESCRIPTION:
The work under this section shall consist of furnishing, proportioning and mixing all the ingredients necessary to produce a polymer modified asphalt concrete (PMAC) material.

719.2 MATERIALS:

719.2.1 Binder: The binder used in PMAC shall meet the requirements of Table 711-2 as specified by the Engineer.

719.2.2 Aggregate: Coarse and fine aggregates shall conform to the applicable requirements of Tables 719-1 and 719-2 below. Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Coarse aggregate is material retained above the Number 8 sieve and fine aggregate is material passing the Number 8 sieve. Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent thorough coating with the asphalt cement. Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

TABLE 719-1	
MIX DESIGN GRADATION REQUIREMENTS WITH MINERAL ADMIXTURE	
Sieve Size	**Percent Passing**
1" (25 mm)	100
¾" (19 mm)	100
½" (12.5 mm)	90-100
⅜" (9.5 mm)	75-90
No. 8 (2.36 mm)	40-50
No. 40 (425 µm)	10-20
No. 200 (75 µm)	2.0-10.0

The combined aggregate properties shall conform to the requirements of Table 719-2.

719.2.3 Mineral Admixture: Mineral admixture used in PMAC shall be dry hydrated lime conforming to the requirements of ASTM C1097 or Portland cement conforming to ASTM C150 for Type II, or ASTM C595 for Type IP. The minimum mineral admixture content will be 1.0 percent, by weight of total aggregate. Mineral admixture shall be considered part of the total weight of aggregate and all combined specific gravity and combined water absorption calculations for aggregates and mineral admixture will be done in accordance with the latest edition of the Asphalt Institute's Manual MS-2 (AI MS-2).

TABLE 719-2		
COARSE/FINE AGGREGATE REQUIREMENTS		
Characteristics	**Test Method**	**Requirements**
Fractured Faces, % (Plus No. 8)	ARIZ-212	85, 1 fracture 80, 2 or more
Uncompacted Voids, %	AASHTO T-304, Method A	45.0
Sand Equivalent (Minus No. 4)	AASHTO T-176	50 minimum
Plasticity Index	AASHTO T-89 & T-90	Non Plastic
L.A. Abrasion, % Loss	AASHTO T-96	9 max. @ 100 Rev. 40 max. @ 500 Rev.
Combined Bulk Specific Gravity	AI MS-2	2.35-2.85
Combined Water Absorption, %	AI MS-2	0-2.5

719.3 MIX DESIGN REQUIREMENT:

719.3.1 General: The mix design for PMAC shall be prepared by a laboratory that is accredited through the AASHTO Accreditation Program (AAP) in Hot Mix Asphalt Aggregates and Hot Mix Asphalt. The laboratory shall be under the direct supervision of a Civil Engineer, registered by the State of Arizona, and who is listed by ADOT as a "Qualified Asphaltic Concrete Mix Design Engineer" within ADOT's latest list of approved laboratories. The latest list of approved laboratories is available on ADOT's web page www.azdot.gov. The date of the design shall not be older than two years from the date of submittal, unless supportive documentation is provided and approved by the Engineer.

The mix design report shall include the following elements as a minimum.

(1) The name and address of the testing organization and the person responsible for the mix design report.

(2) The mix plant identification and/or location, as well as the supplier or producer name.

(3) A description of all products that are incorporated in the asphalt concrete along with the sources of all products, including admixtures and asphalt binder, and their method of introduction.

(4) The supplier and grade of asphalt binder, the source and type of mineral aggregate, and the percentage of asphalt binder and mineral admixture used.

(5) The mix design report shall identify this as a Marshall 75-blow mix design.

(6) The results of all testing, determinations, etc., such as: specific gravity and gradation of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, Tensile Strength Ratio (ASTM D4867), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources. The submittal should include a plot of the gradation on the Federal Highway Administration's 0.45 Power Gradation Chart, plots of the compaction curves and the results of moisture sensitivity testing.

(7) The laboratory mixing and compaction temperature ranges for the supplier and grade of asphalt binder used within the mix design, and specific gravity at 77°F.

(8) A specific recommendation for design asphalt binder content and any limiting conditions that may be associated with the use of the design, such as minimum percentages of crushed or washed fine aggregate.

(9) The supplier's product code, the laboratory Engineer's seal (signed and dated), and the date the design was performed.

The mix design shall be submitted to the Agency or Engineer by the Contractor/Supplier for which it was developed as part of his project submittals. Once the mix design has been approved by the agency or Engineer, the Contractor and/or his supplier shall not change plants nor use additional mixing plants without prior approval of the Engineer. A new mix design shall be submitted when any changes occur in the plant operation, the producer's pit, the asphalt binder, including modifiers in the asphalt binder, or any other item that will cause an adjustment in the mix.

719.3.2 Mix Design Criteria: The mix design shall be performed by the Marshall Mix Design method. A minimum of 4 points will be used to establish the mix design results. The oven aging period for Marshall Mix Design samples shall be 2 hours.

719.3.2.1 Marshall Mix Design: The Marshall Mix Design shall be performed in accordance with the requirements of the latest edition of the Asphalt Institute's Manual, MS-2 "Mix Design Methods for Asphalt Concrete." The mix shall use the compactive effort of 75 blows per side of specimen, unless specified otherwise by the Engineer. The mix shall comply with the criteria in Table 719-3.

The mix design for PMAC shall be prepared by a laboratory that is accredited through the AASHTO Accreditation Program (AAP) in Hot Mix Asphalt Aggregates and Hot Mix Asphalt. The laboratory shall be under the direct supervision of a Civil Engineer, registered by the State of Arizona, and who is listed by ADOT as a "Qualified Asphalt Concrete Mix Design Engineer" within ADOT's list of approved laboratories.

The date of the design shall not be older than two years from the date of submittal, unless supportive documentation is provided and approved by the Engineer.

Mix designs are subject to approval by the Engineer.

TABLE 719-3		
MARSHALL MIX DESIGN CRITERIA		
Criteria	Requirements 1/2" Mix	Designated Test Method
1. Binder Content, Minimum	6.1%	---
2. Voids in Mineral Aggregate: %, min	14	AI MS-2
3. Effective Voids: %, Range	4.0±0.2	AI MS-2
4. Absorbed asphalt: %, Range*	0-1.0	AI MS-2
5. Dust to Eff. Asphalt Ratio, Range **	0.6-1.4	AI MS-2
6. Tensile Strength Ratio: % Min.	65	ASTM D4867
7. Dry Tensile Strength: psi, Min.	100	ASTM D4867
8. Stability: pounds, Minimum	2,500	ASTM D6926
9. Flow: 0.01-inch, Range, Minimum	8	ASTM D6927
10. Mineral Aggregate Grading	---	AASHTO T-27 & T-11

* Unless otherwise approved by the Engineer.

** The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be within the indicated range

- End of Section -

SECTION 723

PERVIOUS CONCRETE

723.1 GENERAL:

Pervious concrete describes a near-zero-slump, open graded material with sufficient continuous voids to allow water to pass from the surface to underlying layers. The void content will generally range from 15 to 35% and the drainage rate will vary with aggregate size and density of the mixture. Placement of pervious concrete is described in Section 323.

723.2 MATERIALS:

All materials used in the production of pervious concrete shall meet the appropriate requirements of Section 725. Hydration stabilizing and viscosity-modifying admixtures (VMA), if used, shall meet the requirements of ASTM C494.

723.3 MIX DESIGN:

A mix design shall be submitted to the Engineer for approval in accordance with Section 725.6. The minimum cementitious material content shall be 540 pounds per cubic yard. The design shall also show the percent voids, and the intended type of construction. The percent voids shall be tested in accordance with ASTM C1688.

723.4 MIXING:

Pervious concrete mixing shall comply with Section 725.7. Mixing shall continue until the cementitious material and water are thoroughly dispersed throughout the material.

- End of Section -

SECTION 725

PORTLAND CEMENT CONCRETE

725.1 GENERAL:

Portland cement concrete shall be composed of cementitious materials, fine and coarse aggregates, water, and, if specified or allowed, certain chemical admixtures and additives.

TABLE 725-1		
CONCRETE CLASSES - MINIMUM REQUIREMENTS		
Class of Concrete	Minimum Cementitious Materials Content (lbs. per cubic yard)	Minimum Compressive Strength * at 28 Days (psi)
AA	600	4000
A	520	3000
B	470	2500
C	420	2000
* In accordance with Section 725.8		

725.2 CEMENTITIOUS MATERIALS:

Cementitious materials to be used or furnished under this specification shall be:

Portland cement, meeting the requirements of ASTM C150
Type II, low alkali, when no other specific type is specified
Type III, low alkali, for high early strength, when applicable or specified
Type V, low alkali, when specified in the special provisions for applications requiring high sulfate resistance

Portland Pozzolan Cement ASTM C595
Type IP (MS), when no other specific type is specified

Supplementary Cementitious Materials (SCM) shall not be used as an additional cementitious materials replacement in concrete in combination with Portland Pozzolan Cement.

Cementitious materials shall be sampled and tested as prescribed in the applicable ASTM specifications. Upon request, the Contractor shall obtain and deliver to the Engineer a Certification of Analysis or Certificate of Compliance conforming to the requirements of Section 106.2 signed by the material manufacturer, identifying the cementitious material and stating that the cementitious material delivered to the batching site has been tested in accordance with the cited specifications and complies with the cited specifications. The cost of furnishing tested cementitious materials shall be considered as included in the contract 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 cementitious materials, such facilities shall be used. Otherwise, the cementitious material shall be delivered in original unopened sacks that bear the name or brand of the manufacturer. The type of cementitious material, and the weight contained in each sack shall be plainly marked thereon.

Cementitious materials 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 cementitious material be delivered to the site show evidence of contamination, the Engineer may require that such lot be removed from the site.

725.2.1 Supplementary Cementitious Materials (Pozzolans): Supplementary Cementitious Materials to be used in concrete or furnished under this specification shall conform to the appropriate ASTM requirements as follows:

Fly ash or natural pozzolan	ASTM C618 and C311
Silica Fume	ASTM C1240

Up to 25 percent by weight of the Table 725-1 minimum cementitious materials requirements may be an approved fly ash or natural pozzolan. Additional pozzolanic material in excess of the minimum Table 725-1 requirements may be incorporated into a concrete mix design to achieve enhanced performance, upon approval of the Engineer.

Upon request, the Contractor shall obtain and deliver to the Engineer a Certification of Analysis or Certification of Compliance signed by the pozzolan supplier identifying the pozzolanic material and stating the pozzolan delivered to the batching site complies with the appropriate specifications. The cost of furnishing tested pozzolan shall be considered as included in the contract price and no additional allowance will be made therefore.

Pozzolanic materials shall be handled and stored in the same manner as other cementitious materials. When facilities for handling a 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.

725.3 AGGREGATES:

Coarse and fine aggregate shall conform to the applicable requirements of ASTM C33. Coarse aggregate grading requirements shall conform to the appropriate rock size designation in the Grading Requirements for Coarse Aggregate, Table 2. Fine aggregate grading requirements shall conform to the Fine Aggregate Grading section.

The average value of three successive sand equivalent samples shall not be less than 70 when tested in accordance with ASTM D2419. No individual sample shall have a sand equivalent less than 65.

The loss by abrasion in the Los Angeles Abrasion Machine, determined as prescribed in ASTM C131, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

Prior to the delivery of the aggregates and whenever required during concrete production, the Contractor shall make stockpiles available to the Engineer for testing. All required samples shall be furnished at the expense of the Contractor, and the cost of sampling and testing shall be at the expense of the Contracting Agency.

Reclaimed Concrete Materials (RCM) and Reclaimed Asphalt Pavement (RAP) as defined in Section 701 shall not be used in Portland Cement Concrete without the prior approval of the Engineer.

725.4 WATER:

The water used for mixing concrete shall be potable or shall meet the requirements of ASTM C1602, when tested by a qualified independent testing laboratory.

725.5 ADMIXTURES AND ADDITIVES:

Admixtures or additives of any type, except as otherwise specified, shall not be used unless identified in the approved mix design or authorized by the Engineer.

Water reducing admixtures incorporated into the approved concrete mix design shall meet the requirements of ASTM C494 for the appropriate type.

Air entraining admixtures incorporated into the approved concrete mix design shall meet the requirements of ASTM C260.

Pigments incorporated into the approved concrete mix design for integrally colored concrete shall meet the requirements of ASTM C979.

Fibers incorporated into the approved concrete mix shall meet the requirements of ASTM C1116.

Any admixtures used shall be included in the price for that item.

725.6 MIX DESIGN PROPORTIONING:

A concrete mix design carrying the producer's designated mix number for each type of concrete being furnished under these specifications shall be submitted to the Engineer at least once each year for approval. Each design shall utilize the proper proportioning of ingredients to produce a concrete mix that is homogeneous and sufficiently workable to provide a consistent and durable concrete product that meets the specified compressive strength and other properties as required by the application.

A concrete mix design submittal shall include the mix identification number and the applicable proportions, weights, and quantities of individual materials incorporated into the mix including the size and source of concrete aggregates, the type and source of cement and fly ash or SCM, and the brand and designation of chemical admixtures or other additives.

In the event there is a modification to the mix design proportions:

(A) Modifications that do not require a new mix design submittal/approval:

(1) Modifications, which do not result in batch, target weights for the fine aggregate or combined coarse aggregates changing by more than 5 percent from the original approved mix design.
(2) Modifications to the percentage of coarse aggregate fractions that do not change the total coarse aggregate volume.
(3) Modifications to dosages of chemical or air-entraining admixtures, within the manufacturer's recommendations.
(4) The incorporation or elimination of chemical admixtures, which are listed on the mix design to effect a change in the time-of-set (retarders or accelerators).

(B) Modifications that require a new mix design submittal/approval and may require performance verification:

(1) Modification to the class of concrete per Table 725-1.
(2) Modification to the type/class/source of cement, fly ash, natural pozzolan, or silica fume.
(3) Modification to the percentage of fly ash, natural pozzolan, or silica fume.
(4) Modification to a coarse aggregate size designation.
(5) Modification of the type of chemical admixture, or the incorporation or elimination, of an air-entraining admixture.
(6) Modification of coarse or fine aggregate source.

725.7 MIXING:

All proportioning/batching/mixing equipment shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association or National Ready Mixed Concrete Association. The proportioning shall consist of combining the specified sizes of aggregates with cementitious materials, admixtures/additives, and water as herein provided. No method, which may cause the segregation or degradation of materials, shall be used.

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.

Any admixture/additive shall be measured accurately by mechanical means into each batch by equipment or in a method pre-approved by the Engineer.

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. 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. Machine mixing will be required in all cases unless pre-approved by the Engineer. Regardless of the method employed, mixing shall be commenced as soon as possible after the cementitious material is placed in contact with the aggregates or water. 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.

725.7.1 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 or the National Ready Mixed Concrete Association. 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, cementitious materials, admixtures/additives 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.

725.7.2 Transit Mixers: Transit mixers shall meet the requirements of the Truck Mixer Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association or the National Ready Mixed Concrete Association. Ready mix concrete and shall comply with ASTM C94 except as herein specified.

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 rotation speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

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 delivery ticket that 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.
- Time the transit mixer is loaded.
- Amount of water added at the job site at request of receiver, and his signature or initials.
- Suppliers' mix design code number.
- Type and amount of admixture or additive that is not already included in the approved mix design, if any.
- Serial number of the ticket.

Additional water may be added on the jobsite in accordance with ASTM C94 Tolerances in Slump section to adjust slump providing the slump after such water addition does not exceed the maximum allowed by these specifications in Section 725.9

(A) (1) 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 homogeneity of the concrete, shall be cause for rejection of the load. The Contractor shall be responsible for all concrete to which water is added at the job site.

725.7.3 Job Mixed Concrete: All job mixed materials and procedures shall be pre-approved by the Engineer. A prepackaged commercial product shall be used for job mixed concrete placement in accordance with the manufacturer's recommended procedure.

In lieu of the use of a prepackaged commercial product, individual ingredients for concrete placement shall be prepared in a watertight container of suitable volume in batches not to exceed 1/3 cubic yard each. Proportioning of batches shall be in accordance with the applicable required mix design in Table 725-1 and Section 725.6. All mixing shall be done prior to placement in the forms and in accordance with the following procedure:

(A) Mixing shall be done in a mechanical batch mixer of approved type.
(B) The mixer shall be rotated at a speed recommended by the manufacturer.
(C) Mixing shall continue for at least 1-1/2 minutes after all materials are in the mixer, unless a shorter time is shown to be satisfactory by the mixing uniformity tests of ASTM C94.
(D) Materials handling, batching, and mixing shall conform to the applicable provisions of ASTM C94.
(E) Suitable records shall be kept to identify the number of batches, proportions of materials used, and time and date of mixing and placement along with the approximate location in the structure.

725.7.4 Dry Batched Unmixed Concrete: All dry batched unmixed concrete materials and procedures shall be pre-approved by the Engineer. An accurate batch weight shall be provided to record the quantities of cementitious materials, aggregate, admixtures/additives, and water batched into the containers. The date of batching, the container number and the batching certificate number shall be recorded at the time of batching. Copies of the batch weight records shall be submitted to the Engineer upon request.

All dry batched 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/additive added in powder form shall be added to the cement; if 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 cementitious materials, aggregate, water or admixtures/additives 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.

725.7.5 Volumetric Batching and Continuous Mixing Concrete and Equipment: Volumetric-batching and continuous-mixing concrete and equipment may be utilized upon approval of the Engineer for job site concreting applications. Material handling, procedures, and operations shall be in accordance with ACI 304.6R, Guide for the use of Volumetric-Measuring and Continuous-Mixing Concrete Equipment and all concrete produced and all test performed shall be in accordance with ASTM C685, Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing. All equipment shall meet the requirements of the Volumetric Mixer Standards of the Volumetric Mixer Manufacturers Bureau and shall have a suitable copyrighted rating plate furnished by the Bureau and attached to the volumetric mixing equipment.

725.8 TESTS AND TEST METHODS:

725.8.1 Field Sampling and Tests: Concrete shall be sampled in accordance with ASTM C172 for determination of temperature, slump, unit weight and yield (when required) and air content (when required) as well as for fabrication of test cylinders for compressive strength determination at 28 days. Samples shall be of sufficient size to perform all the required tests and fabricate the necessary test cylinders but in no case less than 1 cubic foot. Concrete shall be sampled during discharge of the middle portion of the batch. At the discretion of the Engineer, a sample may be obtained at the beginning of the discharge if the properties of the concrete do not appear to be within the specification limits for slump or temperature.

All sampling and testing shall be done by a certified technician meeting the requirements of the ACI Concrete Field Testing Technician, Grade I or equivalent.

Temperature of the concrete mixture shall be determined in accordance with ASTM C1064.

Slump of the concrete mixture shall be determined in accordance with ASTM C143.

Air content of the concrete mixture (when required) shall be determined in accordance with ASTM C231 or C173, whichever is applicable.

Unit weight and yield of the concrete mixture (when required) shall be determined in accordance with ASTM C138.

All compressive strength test specimens shall be made, cured, handled, protected, and transported in accordance with the requirements of ASTM C31. The contractor shall provide and maintain for the sole use of the testing laboratory/technician adequate facilities for safe storage and proper curing of concrete test cylinders on the project site including sufficient access on weekends and holidays to allow the timely pick-up of cylinders specimens. Any and all deviations from the standard procedure of any test method shall be promptly identified and corrected. Any deviations shall be clearly noted by the testing laboratory on all written reports. Testing results obtained from non-standard testing procedures shall be considered invalid and discarded by Engineer.

Sampling and testing performed for concrete acceptance will be at the expense of the Contracting Agency. Sampling and testing for the Contractor's purposes of quality control or other needs shall be at the Contractor's expense.

725.8.2 Concrete Cylinder Test: A cylinder strength test shall be the average of the strengths of at least two 6 inch by 12 inch cylinders or at least two 4 inch by 8 inch cylinders made from the same sample of concrete and tested at 28 days. An adequate number of cylinder specimens shall be made for each 50 cubic yards or not less than each half-day's placement of each class of concrete. All specimens will be tested in a laboratory approved by the Engineer in accordance with ASTM C39 for concrete acceptance. Should an individual cylinder show evidence of improper sampling, molding, curing, or testing, the results shall be discarded and the compressive strength shall be the result of the average of the remaining cylinder(s). Additional cylinder specimens may be made and tested at other ages to obtain additional compressive strength information and shall not be considered as acceptance tests. Cylinder testing performed for concrete acceptance will be at the expense of the Contracting Agency. Cylinder testing for the Contractor's purposes of quality control or other needs shall be at the Contractor's expense.

725.8.3 Additional Concrete Testing: If the 28-day strength test does not meet the compressive strength requirements, additional concrete testing may be performed to further evaluate the concrete in question for purposes of acceptability or payment. This may involve testing of additional cylinders at later ages, (for example - hold cylinders at 56 days or more), or core testing to determine in-place concrete strengths. This additional testing and all coring repairs shall be pre-approved by the Engineer and at the expense of the Contractor. If core testing is performed, at least three representative cores shall be obtained, conditioned and tested in accordance with ASTM C42 from each concrete member or area of concrete to be tested at locations designated by the Engineer. Cores damaged subsequent to or during removal shall be rejected and additional core samples taken. Cores shall be obtained and delivered to a laboratory acceptable to the Engineer in time to allow complete strength testing within 48 days of original concrete placement. The Contractor may elect to have a representative present during sampling and testing. A core strength test shall be the average of the results of the three cores. Should an individual core show evidence of improper sampling, curing, or testing, the results shall be discarded and the compressive strength shall be the result of the average of the remaining core(s). Results of the core strength testing shall replace the results of the cylinder strength test for that sample.

725.9 ACCEPTANCE:

(A) **Plastic Concrete Properties:**

(1) The slump of the concrete shall meet the requirements of ASTM C94 Tolerances in Slump section. When the approved mix design or project specification requirements for slump are a "maximum" or "not to exceed", the following tolerances apply:

Specified slump:	If 3" or less	If more than 3"
Plus tolerance	0 inch	0 inch
Minus tolerance	1 1/2 inch	2 1/2 inch

When the approved mix design or project specification requirements for slump are not written as a "maximum" or "not to exceed," the following tolerances apply:

For design slump of:	Tolerance
2 inch and less	+/- 1/2 inch
More than 2 through 4 inch	+/- 1 inch
More than 4 inch	+/- 1 1/2 inch

(2) Limit the maximum allowable temperature of the concrete mixture immediately before placement to 90 degrees F unless otherwise specified or unless a higher allowable temperature is pre-approved by the Engineer. At the discretion of the Engineer, recommended practices in ACI 305, Specification for Hot Weather Concreting, can provide good reference information and may be used to modify maximum allowable concrete temperature and acceptance.

Per ACI 306, Specification for Cold Weather Concreting, when the atmospheric temperature at the time of placing concrete is above 30°F the temperature of the concrete, as placed, shall not be less than 60°F. When the atmospheric temperature at the time of placing concrete is between 0°F and 30°F the temperature of the concrete, as placed, shall not be less than 65°F.

(3) Air entrained concrete shall meet the requirements of ASTM C94 Air-Entrained Concrete section. The air content of air-entrained concrete when sampled from the transportation unit at the point of discharge shall be within the approved mix design tolerance or +/- 1.5 % of the specified value. When a representative sample taken prior to discharge shows an air content below the specified level by more than the allowable tolerance, additional air entraining admixture shall be added to the concrete mix to achieve the desired air content level, followed by a minimum of 30 revolutions at mixing speed.

(4) Per ASTM C94 Mixing and Delivery section, discharge of the concrete shall be completed within 1 1/2 hour after the introduction of the mixing water to the cementitious materials or the introduction of the cementitious materials to the aggregates. The Engineer may allow the continuation of concrete placement after the 1 1/2 hour time limit has been reached if the concrete is of such slump or workability that it can be placed without the addition of water to the batch.

Any concrete failing to meet the tolerances for plastic concrete properties in 725.9 (A) (1) through (4) shall be reviewed by the Engineer and is subject to rejection.

(B) **Hardened Concrete Properties – Compressive Strength:**

Compressive strength of concrete shall be determined on the basis of cylinder strength tests obtained in accordance with Section 725.8.2 and shall be acceptable if the tests meet or exceed the minimum specified strength. When the validity of cylinder strength tests are suspect, the strength of concrete in question shall be determined in accordance with Section 725.8.3.

When compressive strength test results are less than the specified minimum, an Engineering Analysis to determine the impact of the strength reduction may be required by the Engineer prior to the decision to accept or reject the concrete. The Engineering Analysis will be at the Contractor's expense. Any concrete that is rejected by the Engineer shall be removed and replaced by the Contractor at the Contractor's expense.

When concrete is accepted by the Engineer on the basis of test results of less than 100% of the required minimum compressive strength, an adjustment in the concrete unit price may be made for the quantity of concrete represented by such strength tests in accordance with Table 725-2.

TABLE 725-2			
Adjustment in Concrete Unit Price Based on Strength Deficiency			
Class AA and Class A		Class B and Class C	
Percent of Specified Minimum 28-day Compressive Strength Attained (Nearest 1%)	Percent of Concrete Unit Price Allowed	Percent of Specified Minimum 28-day Compressive Strength Attained (Nearest 1%)	Percent of Concrete Unit Price Allowed
100% or greater	100	100% or greater	100
98-99	90	95-99	95
96-97	85	90-94	90
95	80	85-89	85

- ***End of Section*** -

SECTION 726

CONCRETE CURING MATERIALS

726.1 GENERAL:

Curing materials shall consist of curing 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) Curing paper, or polyethylene film, shall conform ASTM C171.

(B) Liquid membrane-forming compounds shall conform ASTM C309. Type 1 compound with either a Class A or Class B vehicle shall be used for concrete structures, except bridge decks, approach slabs, and Portland cement concrete pavement. Type 2 white pigmented 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.

- ***End of Section*** -

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 three certified mill test reports or a Certificate 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 in conformance to ASTM A615.

In testing bar reinforcement, only the theoretical cross-sectional area will be used in all computations.

Reinforcing steel shall be furnished in the sizes, shapes, and lengths shown on the plans. Bending of steel shall conform to the requirements of Section 505.5.2.

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 A1064.

727.3 WELDED WIRE REINFORCEMENT:

Welded wire reinforcement shall conform to ASTM A1064. The wire size number and the wire spacing will be specified in the special provisions or shown on the plans. The welded wire 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, and not lighter than 16 gage.

- End of Section -

SECTION 728

CONTROLLED LOW STRENGTH MATERIAL

728.1 GENERAL:

Controlled Low Strength Material (CLSM) is a mixture of cementitious materials, aggregates, admixtures\additives, and water that, as the cementitious materials hydrate, forms a soil replacement. CLSM is a self-compacting, flowable, cementitious material primarily used as a backfill, structural fill, or a replacement for compacted fill or unsuitable native material. Placement and usage of each type of CLSM is described in Section 604.

728.2 MATERIALS:

Cementitious materials shall conform to Section 725.2.

Coarse aggregate shall conform to ASTM C33 grading size No. 57. The size and gradation of fine aggregates (sand) shall conform to ASTM C33. Alternate materials meeting the applicable requirements of Section 701 or 702 such as combinations of other aggregates, Aggregate Base Course (ABC) or Reclaimed Concrete Material (RCM) may be used to replace the required coarse and fine aggregate as long as the approved mix design meets the requirements of Table 728-1 and is approved by the Engineer.

Water shall conform to Section 725.4

728.3 PROPORTIONING OF MIXTURES AND PRODUCTION TOLERANCES:

Proportioning of the mixture shall comply with Section 725.6 and Table 728-1. The CLSM shall have consistency, workability, plasticity, and flow characteristics such that the material when placed is self-compacting. A minimum of 40% coarse aggregate shall be used. A mix design shall be submitted for the Engineer's approval prior to the excavation for which the material is intended for use. Sampling shall be in accordance with ASTM D5971. The flow consistency shall be tested in accordance with ASTM D6103-04. Unit weight (when applicable) shall be obtained by ASTM D6023. Compressive strength shall be tested in accordance with ASTM D4832.

TABLE 728-1	
CONTROLLED LOW STRENGTH MATERIAL REQUIREMENTS	
Portland Cement Content, Sack/cu yd.	Flow, inches
1/2 Sack	9±2
1 Sack	9±2
1 1/2 Sack	9±2
2 Sack	9±2

Notes for Table 728-1:
(1) CLSM mixes meeting the table requirements will not generally be placeable by means of a concrete pump or may not provide the needed workability for certain conditions. When pumpable mixes or increased workability is required, the addition of fly ash or a natural pozzolan in excess of the required Portland Cement Content may be used.
(2) Ready-mixed structural concrete or grout shall not be used in lieu of CLSM without prior approval from the Engineer and shall be subject to rejection.

728.4 MIXING:

CLSM mixing shall comply with Section 725.7 Mixing shall continue until the cementitious material and water are thoroughly dispersed throughout the material. Mixes shall be homogenous, readily placeable and uniformly workable.

- End of Section -

SECTION 729

EXPANSION JOINT FILLER

729.1 PREMOLDED JOINT FILLER:

Expansion joint filler materials shall consist of preformed strips of a durable resilient compound and comply with one of the following as specified by the Contracting Agency or as approved by the Engineer.

(a) ASTM D1751 – Performed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
(b) ASTM D8139 – Semi-Rigid, Closed-Cell Polypropylene Foam, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction
(c) ASTM D1752 – Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
(d) ASTM D2628 – Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.

729.2 POUR TYPE JOINT FILLERS FOR PORTLAND CEMENT CONCRETE PAVING (PCCP):

Pour type joint fillers shall comply with ASTM D3406 or as approved by the Engineer. Joint sealant shall not contain any coal tar materials. The following requirement shall be added to paragraphs 7.1 of ASTM D3406: The minimum ambient temperature during application and ambient temperatures under various storage conditions shall be clearly marked on the container.

729.3 TEST REPORT AND SHIPMENT CERTIFICATE:

When requested by the Engineer, each shipment shall be accompanied by a Certificate of Compliance that the material complies with the above specifications.

- End of Section -

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, and storm and irrigation water.

Except as modified herein, reinforced concrete pipe shall be manufactured and tested in conformance with the requirements of ASTM C76 for circular pipe, ASTM C506 for arch pipe, and ASTM C507 for elliptical pipe.

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 JOINTS:

Bell Reinforcement: All reinforced concrete pipes less than 36 inch inside diameter and the same approximate equivalent size 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.

Rubber gaskets shall be in accordance with ASTM C443.

Cement Mortar Joints for RCP will be in accordance with Subsection 736.3

735.3 FABRICATED SPECIALS – WYES, TEES, CURVES, BENDS AND CLOSURES:

Fabricated pipe 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.

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 3/4 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 other than water, Portland cement, Pozzolanic materials, mineral aggregates and steel shall be used in the manufacturing of the pipe, with the following exceptions:

(A) **Portland Cement:** Portland cement shall comply with ASTM C150, Type II, and 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.

(B) **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.

(C) **Steel Reinforcement:** The pipe manufacturer shall supply three 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.

735.5 MANUFACTURER'S QUALIFICATIONS AND EQUIPMENT REQUIREMENTS:

The manufacturer shall be competent to manufacture the type, size and quality of pipe; in addition, the manufacturer 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, calibrate, and seal the aggregate and cement scales used in the 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 and no later than 8 hours after placing of the concrete. Rate of rise of temperature shall not exceed 30°F 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 the surfaces of the concrete, except joint surfaces that are to be grouted shall be sealed 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 C76, ASTM C506, or ASTM C507, as applicable, including 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 when 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 1/2 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 repair ability 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 1/4 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 the ASTM Standard is elected, acceptance on the basis of material tests and inspection of manufactured pipe for defects and imperfections shall be as stated in the ASTM Standard, 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 three edge bearing method, ASTM C497, 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 the ASTM Standard 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 the design strength requirements table for the type and class of pipe being produced, 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 anyone 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 five. 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 zero, the cylinders shall be made as follows:

Fill the cylinder can in three 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 cylinder 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 C31 where the pipe is manufactured with concrete that has enough slump for the material to be hand rodded. For reinforced concrete pipe made by the centrifugal method, the manufacturer may substitute centrifugally cast test cylinders for standard test cylinders. Centrifugally cast cylinders shall be made in accordance with

AWWA C302 and cured in the same manner as normal test cylinders, except that the net area of the hollow cylinder will be used to determine the compressive strength.

735.8 SANITARY SEWER PIPE:

In addition to the above, sewer pipe shall meet the requirements of ASTM C76, 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 1/2 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.

735.9 ACCEPTANCE MARK:

The Engineer may, at the place of manufacturer, 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.

- ***End of Section*** -

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 C14, 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 C14, with the following exception:

Cement shall conform to ASTM C150, Type II, and 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 weather-tight, 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 rubber gaskets joints. 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 776.3, 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 three days or by using a curing compound.

736.3.2 Rubber Gasket Joints: Rubber gaskets shall be in accordance with ASTM C443 or AASHTO M-315.

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 3/4 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 C14. The test shall be made at the point of manufacturer and shall be made under the presence of the Engineer.

- End of Section -

SECTION 738

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS FOR STORM DRAIN AND SANITARY SEWER

738.1 GENERAL:

This specification covers the requirements of profile-reinforced and corrugated (Type S or Type D) high-density polyethylene (HDPE) pipe manufactured per ASTM F894, AASHTO M-252 or AASHTO M-294 for gravity flow, low pressure storm drain and sanitary sewer systems. When noted on the plans or in the special provisions, gravity flow, low-pressure storm drains and sanitary sewers may be constructed using HDPE pipe. The HDPE pipe will be of the sizes 8-inch diameter through 120-inch diameter. For the purpose of this specification, low pressure is defined as the test pressures of 3.5 psi of air or 4 feet of water as specified in Section 615.11.

All pipe joints shall conform to the controlled pressure test of 10.8 psi of air or 25 feet of water as stipulated in ASTM D3212.

The size and class of the HDPE pipe to be furnished shall be designed by the Engineer and shown on the plans or in the project specifications. At no time will the class designed be less than RSC-63 for profile pipe, or minimum equivalent Pipe Stiffness (PS) for corrugated pipe per the requirements of AASHTO M-252 or AASHTO M-294.

738.2 MATERIALS:

738.2.1 Base Material Composition: Profile pipe base material and fittings shall, in accordance with ASTM F894, be made from a PE plastic compound meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in ASTM D1248 and with established hydrostatic design basis (HDB) of not less than 1250 psi for water at 73.4 degrees Fº as determined in accordance with Method ASTM D2837. Materials meeting the requirements of cell classification PE 334433 C or higher cell classification, in accordance with ASTM D3350 are also suitable. Corrugated pipe base material shall comply with the requirements of AASHTO M-252 (Type S) or AASHTO M-294 (Type S or D) and have a minimum cell classification PE 335420C.

738.2.2 Other Pipe Materials: Materials other than those specified under Base Materials shall comply with ASTM F894, AASHTO M-252 or AASHTO M-294.

738.2.3 Gaskets: Rubber gaskets shall be manufactured from a natural rubber, synthetic elastomer or a blend of both and shall comply in all respects with the physical requirements in ASTM F477.

738.2.4 Water Stops: Water stops shall be manufactured from a natural or synthetic rubber and shall conform to the requirements of ASTM C923. The water stop shall have expansion rings, a tension band, or a take-up device used for mechanically compressing the water stop against the pipe.

738.2.5 Thermal Welding Material: The material used for thermally welding the pipe material shall be compatible with the base material.

738.2.6 Lubricant: The lubricant used for assembly shall comply with manufacturer's recommendations and have no detrimental effect on the gasket or pipe.

738.3 JOINING SYSTEMS:

738.3.1 Gasket Type: Joints for the piping system and fittings shall consist of an integrally formed bell and spigot gasketed joint. The joint shall be designed so that when assembled, the elastomeric gasket located on the spigot is compressed radially on the pipe or fitting bell to form a watertight seal. The joint shall be designed so to prevent displacement of the gasket from the joint during assembly and when in service. The elastomeric gasket shall meet the provision of ASTM F477.

All pipes 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 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 would adversely affect sealability. The assembly of the gasketed joints shall be in accordance with the pipe manufacturer's recommendations.

738.3.2 Thermal Weld Type: The pipe ends shall consist of an integrally formed bell and spigot, with or without the elastomeric centering gasket, which join together to form an interface between bell and spigot, such that it is suitable to seal by thermal weld using the extrusion welding process, in accordance with the manufacturer's recommended procedure.

Thermal welded joints may be effected by welding from inside the pipe or outside, or both.

The assembly of the welded joints shall be in accordance with the manufacturer's recommendations.

Thermal welded joints shall be used only when specified on plans or in specifications.

738.4 FITTINGS:

Fittings for HDPE profile wall or corrugated pipe may include tees, elbows, manhole adapter rings, plugs, caps, adapters and increasers. Fittings shall be joined by gasket type or thermal weld type joints in accordance with Subsection 738.3.

A clamp gasket or approved 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. A non-shrink grout shall be used for grouting.

738.5 CERTIFICATION:

The manufacturer shall furnish an affidavit (certification) that all materials delivered shall comply with the requirements of ASTM F894 or AASHTO M-252.

Pipe and resin producers that manufacture according to AASHTO M-294 shall be certified according to the Plastic Pipe Institute protocol for their Third Party Certification Program.

738.6 DIMENSIONS AND TOLERANCES:

Profile wall HDPE pipe dimensions shall comply with dimensions given in Table 1 of ASTM F894. The "average or nominal inside diameter" of profile wall HDPE pipe shall not deviate from its normal pipe size by more than as specified in Table 1 of ASTM F894. Corrugated HDPE pipe dimensions shall be "nominal inside diameter" dimensions and shall not deviate from its nominal pipe size by more than the minimum and maximum tolerances as described in AASHTO M-252 or AASHTO M-294, Section 7.2.3.

Profile pipe shall have a Ring Stiffness Constant (RSC) or Pipe Stiffness (PS) as shown on the plans. The minimum RSC for profile HDPE pipe shall be RSC-63. The minimum PS for corrugated pipe shall be as shown in AASHTO M-252 (Section 7.5) or AASHTO M-294 (Section 7.4), and tested per ASTM D2412. In no case shall the minimum PS be less than the equivalent PS value for RSC-63.

738.7 CLASSIFICATIONS:

HDPE profile-reinforced pipe products shall be made in four standard Ring Stiffness Constant (RSC) classifications, 40, 63, 100 and 160. These are referred to as RSC-40, RSC-63, RSC-100 and RSC-160. The RSC test shall be conducted in accordance with ASTM D2412 with the exceptions listed in accordance with ASTM F894. HDPE corrugated pipe (Type S or Type D) shall meet the minimum Pipe Stiffness (PS) requirements of AASHTO M-252 or AASHTO M-294. The PS test shall be conducted in accordance with ASTM D2412 with the exceptions listed in accordance with AASHTO M-252 or AASHTO M-294.

738.8 MARKINGS:

Markings on pipe shall be per ASTM F894, AASHTO M-252 or AASHTO M-294. These markings shall be clearly shown on the pipe at intervals of approximately 12 feet and include but not limited to the following: the manufacturer's name or trademark, nominal size, the specification designation, plant designation code, date of manufacture or an appropriate code. All fittings shall be marked with the designation number of the specification and with the manufacturer's identification symbol. In addition, manufacturers of corrugated HDPE, AASHTO M-294, shall print on or affix the appropriate Plastic Pipe Institute Program Mark on each length of pipe produced that meets the requirements of the program.

738.9 CARE OF PIPE AND MATERIALS:

Care of pipe materials shall comply with Subsection 736.5.

HDPE profile reinforced RSC type pipe in shipping or storage shall not be stacked higher than three rows for pipes 21 inches in diameter or less, nor higher than two rows for pipes 24 to 36 inches in diameter inclusive. Pipe shall not be stacked, shipped, or stored with weight on the bells of the pipe.

Corrugated HDPE pipe in shipping and storage shall be stacked per manufacturer's recommendation, but in no case higher than 5 rows for pipe 24 inches or less in diameter, or 3 rows for pipe greater than 24 inches in diameter.

Pipe that is gouged marred or scratched forming a clear depression shall not be installed and shall be removed if damaged in the installation.

- ***End of Section –***

SECTION 739

STEEL REINFORCED POLYETHYLENE PIPE AND FITTINGS FOR STORM DRAIN, IRRIGATION AND SANITARY SEWER

739.1 GENERAL:

This specification covers the requirements of Steel Reinforced Polyethylene (SRPE) pipe manufactured per ASTM F2562 for storm drains, irrigation and sanitary sewer systems. When noted on the plans or in the special provisions, storm drains, irrigation and sanitary sewers may be constructed using SRPE pipe. SRPE pipe shall be designed in accordance with AASHTO LRFD Bridge Design. Specifications, Section 12. Trench excavation, backfilling and compaction for this flexible pipe shall be in accordance with Section 601. Construction and installation shall be in accordance with Section 618 for storm drain and irrigation water or Section 615 for sanitary sewers.

The pipe stiffness class shall be Class 1, per Table 1 of ASTM F2562, unless otherwise specified.

739.2 MATERIALS:

739.2.1 Base Steel Materials: Continuous high strength galvanized ribs shall be cold rolled steel meeting the requirements of either ASTM A1008 or ASTM A1011 with minimum yield strength of 80,000 psi. The steel shall have a galvanized coating meeting the requirements of ASTM A653 with a G60 minimum coating weight. Steel ribs shall be completely encased within the HDPE profile.

739.2.2 HDPE Material Composition: SRPE pipe HDPE material and fittings shall, in accordance with ASTM F2562, be made from HDPE plastic compound meeting the minimum requirements of cell classification 335464C or higher cell classification, in accordance with ASTM D3350.

739.2.3 Gaskets: Elastomeric gaskets shall comply with the requirements in ASTM F477 and be as recommended by the pipe manufacturer.

739.2.4 Water Stops: Elastomeric Water stop gaskets shall conform to the requirements of ASTM C923.

739.2.5 Thermal Welding Material: The material used for thermal welding of the pipe shall be compatible with the pipe's base material.

739.2.6 Lubricant: The lubricant used for assembly shall comply with manufacturer's recommendations and have no detrimental effect on the gasket or pipe.

739.3 JOINING SYSTEMS:

739.3.1 Gasket Type: Steel reinforced bell and spigot joints for the piping system and fittings shall consist of an integrally formed bell and spigot gasketed joint. The joint shall be designed so that when assembled, the elastomeric gasket located on the spigot is compressed radially on the pipe or fitting bell to form a watertight seal. The joint shall be designed so to prevent displacement of the gasket from the joint during assembly and when in service. The elastomeric gasket shall meet the provision of ASTM F477. Gasketed watertight pipe joints shall meet a minimum laboratory test pressure of 10.8 psi when tested in accordance with ASTM D3212.

All pipes shall have a home mark on the spigot end to indicate proper penetration when the joint is made. The bell and spigot configurations for fittings shall be compatible to those used for the pipe.

Joints shall provide a 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 would adversely affect the seal. The assembly of the gasketed joints shall be in accordance with the pipe manufacturer's recommendations.

739.3.2 Thermal Weld Type: Thermal weld joints, when specified, shall utilize plain-ended pipe welded together by internal pressure testable couplers. The internal couplers shall have a minimum wall thickness equal to or greater than the pipe wall

thickness as defined in ASTM F2562. The assembly of the welded joints shall be in accordance with the manufacturer's recommendations. Thermal welded pipe joints shall meet a minimum laboratory test pressure of 10.8 psi when tested in accordance with ASTM D3212.

739.3.3 Pipe to Concrete Structure Connections: An approved flexible connector, mechanical seal or water stop shall be provided at manhole entry or concrete structure connection to reduce infiltration and exfiltration. When grouting is necessary at a water stop connection, non-shrink grout shall be used.

739.4 FITTINGS:

Fittings for SRPE pipe may include tees, elbows, manhole adapter rings, plugs, caps, adapters and increasers. Fittings shall be joined by gasket type or thermal weld type joints in accordance with Subsection 739.3.

739.5 CERTIFICATION:

The manufacturer shall furnish a certification that all delivered materials comply with the requirements of ASTM F2562. The certification shall also identify the steel as galvanized with a G60 minimum coating weight, 80,000 psi yield strength and the cell classification of the HDPE material as 335464C minimum.

739.6 MARKINGS:

Markings on pipe and fittings shall be per ASTM F2562. The markings shall be clearly shown on the pipe, at least, at the end of each length of pipe and spaced at intervals of not more than 10 feet. Markings shall include the following information: ASTM F2562, the nominal pipe size in inches, the pipe stiffness class, the manufacturer's name, trade name or trademark, the manufacturer's production code: identifying plant location, machine, and date of manufacture.

739.7 CARE OF PIPE AND MATERIALS:

All pipe, fittings, gaskets and water stop materials shall be manufactured, handled, loaded, shipped, unloaded, and installed in such a manner as to be undamaged and in sound condition, in the completed work. Particular effort shall be exercised to protect the ends of the pipe. Repairs on damaged pipe shall be made to the satisfaction of the Engineer or removed from the project site. Rubber Elastomeric gaskets shall be covered in a factory applied protective wrap.

- End of Section -

SECTION 740

POLYPROPYLENE PIPE AND FITTINGS FOR STORM DRAIN, IRRIGATION AND SANITARY SEWER

740.1 GENERAL:

This specification covers the requirements of profile wall (both dual wall - Type S and triple wall - Type D) polypropylene (PP) pipe manufactured per ASTM F2881 and AASHTO M-330 for storm drain, or ASTM F2736 or ASTM F2764 for sanitary sewer systems. When noted on the plans or in the special provisions, storm drains, irrigation and sanitary sewers may be constructed using PP pipe. PP pipe approved sizes are 12-inch diameter through 60-inch diameter. Trench excavation, backfilling and compaction for flexible pipe shall be in accordance with Section 601 and manufacturer's installation recommendations. Construction and installation shall be in accordance with Section 618 for storm drain and irrigation water or Section 615 for sanitary sewers.

740.2 MATERIALS:

740.2.1 Base Material Composition: Profile pipe base material and fittings shall meet polypropylene materials requirements as stated in Section 4, Table 1 of ASTM F2736, Section 5, Table 1 of ASTM F2764, ASTM F2881, Section 5 or Section 6, Table 1 of AASHTO M-330.

740.2.2 Gaskets: Elastomeric gaskets shall comply with the requirements in ASTM F477 and be as recommended by the pipe manufacturer.

740.2.3 Water Stops: Elastomeric **w**ater stop gaskets shall conform to the requirements of ASTM C923.

740.2.4 Lubricant: The lubricant used for assembly shall comply with manufacturer's recommendations and have no detrimental effect on the gasket or pipe.

740.3 JOINING SYSTEMS:

740.3.1 Gasket Type: Joints for the piping system and fittings shall consist of an integrally formed bell and spigot gasketed joint. The joint shall be designed so that when assembled, the elastomeric gasket located on the spigot is compressed radially on the pipe or fitting bell to form a watertight seal. The joint shall be designed so to prevent displacement of the gasket from the joint during assembly and when in service. The elastomeric gasket shall meet the provision of ASTM F477. Gasketed watertight joints shall meet laboratory test pressure of 10.8 psi when tested in accordance with ASTM D3212.

All pipes shall have a home mark on the spigot end to indicate proper penetration when the joint is made.

The bell and spigot configurations for fittings shall be compatible to those used for the pipe.

Joints shall provide a 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 would adversely affect the seal. The assembly of the gasketed joints shall be in accordance with the pipe manufacturer's recommendations.

740.3.2 Pipe to Concrete Structure Connections: An approved flexible connection, mechanical seal, or water stop shall be provided at manhole entry or concrete structure connections to reduce infiltration and exfiltration. When grouting is necessary at a water stop connection, non-shrink grout shall be used.

740.4 FITTINGS:

Fittings for PP pipe may include tees, elbows, manhole adapter rings, plugs, caps, adapters and increasers. Fittings shall be joined by gasket type joints in accordance with Subsection 740.3.

The material used for thermally welding the fitting shall be compatible with the base pipe material.

740.5 CERTIFICATION:

The manufacturer shall furnish a certification that all delivered materials comply with the requirements of ASTM F2736, ASTM F2764, ASTM F2881, or AASHTO M-330.

740.6 MARKINGS:

Markings on pipe and fittings shall be per ASTM F2736, ASTM F2764, ASTM F2881, or AASHTO M-330. The markings shall be clearly shown on the pipe, at least, at each end of each length of pipe and spaced at intervals of not more than 10 feet. Markings shall include the following information: the manufacturer's name or trademark, nominal size, the specification designation, plant designation code, date of manufacture or an appropriate code. All fittings shall be marked with the designation number of the specification and with the manufacturer's identification symbol.

740.7 CARE OF PIPE AND MATERIALS:

All pipe, fittings, gaskets, and water stop materials shall be manufactured, handled, loaded, shipped, unloaded, and installed 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 or removed from the project site. At all times, elastomeric gaskets shall be covered in a factory applied protective wrap until ready for use.

- End of Section -

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 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 MATERIALS:

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 gasses and liquids and shall be non-conducive 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 setting 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 ± 0.25 inches in width and shall have each edge beveled prior to application.

Welding strips shall be 1 inch ± 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.

741.3 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 surface 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 forklift.

No pipe with damaged lining will be accepted until and unless the damage has been repaired to the satisfaction of the Engineer.

741.4 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 in minimum of 1 inch.

741.5 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.

- ***End of Section*** -

SECTION 742

PRECAST MANHOLE

742.1 GENERAL:

This specification covers requirements for precast manhole sections. All precast manhole manufacturers shall be NPCA (National Precast Association) certified and shall provide all NPCA certifications upon request. Loading criteria for the precast manholes shall meet or exceed the AASHTO H20 loading requirements. All precast manhole risers shall be monolithically cast to ensure water tightness and have a certified structural design and the manhole shall be cast in a fashion to achieve water tightness. This shall include a monolithic cast manhole or a multi section cast manhole, which also shall have a certified structural design.

742.2 MATERIALS:

742.2.1 Concrete Materials: Concrete materials shall conform to the requirements of Section 725 and Table 725-1 for Class AA.

742.2.2 Precast Sections: Precast sections shall conform to ASTM C478, AASHTO M-199. The design shall be in accordance with ACI 318 and ASTM C890 using traffic load A-16 (HS20-44).

742.2.3 Joints and Connections: Details of proposed joints and connections shall be submitted to the Engineer for approval and shall conform to ASTM C990, C993, or C425 as applicable.

742.3 MANHOLE PENETRATIONS:

The location of penetrations shall be determined by the plans and specifications. Manhole penetrations may be formed or cut out. Cut outs of the precast base shall be done using a mechanical hole saw. After the core is removed from the casting, the precaster shall coat all exposed reinforcing with a corrosion inhibiting epoxy suitable for end use application. The thickness of the epoxy shall be per the epoxy manufacturer's recommendation. Knock outs shall be formed in the location noted on the plans or specifications.

742.4 REINFORCING:

Reinforcing steel shall meet the following specifications:

- Bars ASTM A615 or A706
- Wire and wire fabric ASTM A1064

Design of the reinforcing shall be in accordance with ACI 318 and ASTM C890

742.5 GASKETS:

A flexible pipe to manhole connector shall be used whenever a pipe penetrates into a precast concrete manhole or structure. The design of the connector shall provide a flexible, watertight seal between the pipe and the concrete. The connector shall assure that a seal is made between the structure wall and the pipe by:

- Casting the connector integrally with the structure wall during the manufacturing process in a manner that will not pull out during pipe coupling.
- Compressing the connector against the inside circumference of the structure by means of wedge or toggle style connection, expansion ring or other means approved by the Engineer.

The connector shall be made from materials that conform to the physical and chemical requirements in ASTM C923 or C425 as applicable. The connector shall be sized specifically for the type of pipe being used and shall be installed in accordance with the recommendations of the manufacturer.

The connection hardware shall be constructed of type 316 stainless steel meeting ASTM A480. The hardware shall ensure a watertight connection between the concrete and the pipe material and shall provide an adequate seal enough to withstand the negative air pressure test per ASTM C1244.

742.6 LIFTING POINTS:

Lifting points shall be designed and evaluated by a registered professional engineer and have a minimum safety factor of four. There shall be a minimum of two lifting points on every precast manhole base. After base installation, the lifting holes shall be thoroughly packed with a pre-packaged non-shrink grout. Bent reinforcing steel bars shall not be used as lifting devices. Through lifting holes will not be allowed.

742.7 IMPERFECTIONS:

Any imperfections, which in the opinion of the Engineer may adversely affect the performance of the precast section, shall be cause for rejection.

– End of Section –

SECTION 743

VITRIFIED CLAY PIPE

743.1 GENERAL:

Vitrified clay pipe, 30-inch diameter or less, shall be extra strength in accordance with the requirements set forth in ASTM C700, except as modified herein. Pipe larger than 30 inches shall be of the type specified in the Special Provisions.

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 that 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 herein 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.

When the pipe is subjected to an internal hydrostatic pressure of 10 psi for the time shown in Table 743-1, 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 1 1/2	9
Over 1 1/2 and including 2	12
Over 2 and including 2 1/2	15
Over 2 1/2 and including 3	18
Over 3	21

The loading test shall conform in manner to that specified in ASTM C301 for 3-edge bearing and shall be applied to all specimens selected for testing.

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 couplings shall conform to the requirements of ASTM C425.

- ***End of Section*** -

SECTION 744

PRECAST POLYMER CONCRETE MANHOLE

744.1 GENERAL:

This specification covers requirements for precast polymer concrete manhole structures. Loading criteria for the precast polymer concrete manholes shall meet or exceed the AASHTO M-306 H20 design loads. All precast manhole bases shall be cast to ensure they are watertight and have a certified structural design. This shall include a manhole base with multi-section cast manhole barrels, cones, and flat lids, which also shall have a certified structural design, sealed and stamped by a Professional Engineer. Precast concrete sections with corrosion protective coatings or polymer concrete barrel sections, flat lids, and cones, can also be used on top of concrete cast-in-place bases that are poured in the field.

744.2 MATERIALS:

744.2.1 Polymer Concrete Materials: Polymer concrete materials shall not contain less than 7% resin content of the weight of the sample in accordance with ASTM D6783 for polymer concrete mix design. All aggregates and sand shall be non-reactive and meet the requirements of ASTM C33. Chemical resistance testing shall comply with the latest revision of ASTM C267, D543, F1216 or ASTM C580. This testing is used to determine the physical properties of material specimens used in sewers after exposure to chemical solutions.

All materials shall be tested above 9,000 psi in compression strength according to ASTM C579, and have a tensile strength of not less than 1,500 psi. The modulus of elasticity shall be a minimum of 1,000 psi in accordance with ASTM C78. The density of the material shall not be below 130-155 pounds per cubic foot (PCF) and the water absorption shall not exceed 0.01%. This shall be certified by the manufacturer and provided in the submittal package. No Portland cement shall be permitted in the concrete mix, and all aggregates shall have a minimum acid insoluble content of 95%.

744.2.2 Precast Sections: The dimensional tolerances and related components of precast polymer concrete manhole sections and precast base sections, shall conform to ASTM C478. The material and manufacturing is allowed compositional and dimensional differences required by a polymer concrete product including the reinforcement. The manufacturer shall incorporate steel or fiberglass bar reinforcement in all polymer manhole components. The reinforcement shall be completely encapsulated in the polymer matrix composition, and a professional engineer shall certify the design of the reinforcement as it is related to the structure. The wall thickness design shall meet or exceed the minimum loading requirements as required by AASHTO M-199. The design shall be in accordance with AASHTO M-199 using traffic load A-16 (HS20-44) or greater. Polymer manholes shall be designed based upon live and dead load criteria found in ASTM C857 and ACI 350-05. A unit soil weight of 120 PCF shall be used for calculating the soil density around the structure, which includes the cone and barrel sections. All structures shall be designed to withstand 63 PCF liquid density for an internal liquid pressure. This shall be certified by the manufacturer.

744.2.3 Joints and Connections: Details of proposed joints and connections shall be submitted to the Engineer for approval, and shall conform to ASTM C990 as applicable. With polymer manhole construction, the preferred joint connection shall be per the manufacturer's requirements. In cases where field conditions change and a cast-in-place concrete base is required, the polymer manufacturer shall provide a joint transition mechanism to allow for an interlocking joint system with the cast-in-place concrete base. This transition can be cast with the base or by utilizing transition sections between the materials. This revised joint connection shall only be allowed with the approval of the contracting agency. Water tightness and vacuum testing requirements shall be per contracting agency requirements. Joints shall be sealed in accordance with the manufacturer.

MANHOLE PENETRATIONS:

The location of penetrations shall be determined by the plans and specifications. Manhole penetrations may be formed or cut out. Cut outs of the precast sections shall be done using a mechanical hole saw. For polymer sections with steel reinforcement, after the core is removed from the polymer section, the manufacturer shall coat all exposed steel reinforcement with a corrosion resistant mortar compound suitable for end use application. The thickness of the compound shall be per the compound manufacturer's recommendation.

744.3 PIPE CONNECTIONS:

A flexible pipe to manhole connector shall be used whenever a pipe connects into a precast polymer concrete manhole or structure. The design of the connector shall provide a flexible, watertight seal between the pipe and the structure. The connector shall ensure that a seal is made between the structure wall and the pipe by:

- Casting the connector integrally with the structure wall during the manufacturing process in a manner that shall not pull out during pipe coupling.
- Compressing the connector against the inside circumference of the structure by means of wedge or toggle style connection, expansion ring, or other means approved by the Engineer.

The connector shall be made from materials that conform to the physical and chemical requirements in ASTM C923 or C425, as applicable. The connector shall be sized specifically for the type of pipe being used, and shall be installed in accordance with the recommendations of the manufacturer.

The connection hardware shall be constructed of type 316 stainless steel meeting ASTM A480. The hardware shall ensure a watertight connection between the polymer concrete and the pipe material, and shall withstand the negative air pressure test per ASTM C1244.

Designs are to be submitted to and approved by contracting agency, and certified by the manufacturer.

744.4 REINFORCING:

Fiberglass bar or steel reinforcement shall be required in flat lids, manhole bases, risers, and cones as required by the manufacturer in accordance with the design sealed by a professional engineer. All reinforcement shall be fiberglass or steel bar type reinforcement per ACI 440. Fiberglass rebar shall conform to ASTM D7205; steel shall conform to ASTM A706.

744.5 LIFTING POINTS:

Lifting points shall be designed and evaluated by a professional engineer. There shall be a minimum of two lifting points on every precast manhole base. After base installation, the lifting holes shall be thoroughly packed with a pre-packaged corrosion resistant compound. Bent reinforcing steel bars shall not be used as lifting devices. Through lifting holes will not be allowed.

744.6 IMPERFECTIONS:

Any imperfections, which in the opinion of the contracting agency's Engineer may adversely affect the performance of the precast section, shall be cause for rejection. The manufacturer is to specify acceptable repair procedures, and identify imperfections that may be acceptable during the manufacturing process.

– End of Section –

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 D3034, 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 F477.

745.2.3 Lubricant: The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe.

745.3 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 that could adversely affect sealability.

The assembly of the joints shall be in accordance with the pipe manufacturer's recommendations.

745.4 FITTINGS:

Fittings for PVC pipe may include elbows, wyes, tee wyes, double bell couplings, manhole couplings, manhole adapter rings, plugs, caps, adapters and increasers.

Manholes couplings shall be manufactured from asbestos cement and incorporate an elastomeric gasket moisture barrier.

745.4.1 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.

745.5 CERTIFICATION:

A certificate from the manufacturer shall be furnished certifying that the pipe and fittings meet the requirements of ASTM D3034, SDR-35, F/ΔY 2.5% min. Y = 46 psi at 5% deflection.

745.6 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.

- ***End of Section*** -

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 C101.

Cast iron water pipe may be designed for either 18/40 or 21/45 physicals and shall conform to AWWA C106 or AWWA C108.

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.

Pipe shall be cement mortar lined and seal coated in accordance with AWWA C104.

750.2 DUCTILE IRON WATER PIPE:

All ductile iron water pipe shall be designed in accordance with AWWA C150 and shall be manufactured in accordance with AWWA C151. The class shall be as designated in the plans or special provisions.

Pipe shall be cement mortar lined and seal coated in accordance with AWWA C104.

750.3 JOINT REQUIREMENTS:

Push-on joints for cast iron or ductile iron water pipe shall conform to AWWA C111 and shall include synthetic rubber gaskets and lubricant.

Mechanical joints for cast iron or ductile iron water pipe shall conform to AWWA C111 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.

Restrained Joints:

When noted on plans or approved by the Engineer, joints for push-on or mechanical jointed ductile pipe may be modified to provide a fully restrained joint. These modifications to push-on and mechanical joints, including but not limited to segmented or special glands and split sleeves, shall conform to AWWA C111. The Engineer shall review and/or approve each manufacturer's modifications to the joint. Upon request of the Engineer, the manufacturer of the modified joint shall provide test data showing compliance with AWWA C111.

750.4 FITTINGS:

Iron fittings shall be either Gray-Iron or Ductile Iron conforming to AWWA C110 or AWWA C153 with a minimum pressure rating of 250 psi. Flanged ends shall conform to AWWA C110. Push-on and mechanical joints ends shall conform to AWWA C111.

Fittings shall be cement mortar lined and coal tar coated in accordance with AWWA C104.

- ***End of Section*** -

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 C400, 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 in 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 C400.

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 C400. Certification of all manufacturers' tests in accordance with AWWA C400 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 pipes shall have the Underwriters Laboratory, Inc. seal of approval and certification that all tests were in accordance with AWWA C400.

752.5 FITTINGS:

Fittings shall be cast iron or ductile iron and conform to AWWA C110 or C153 for 250 psi minimum 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 accordance with AWWA C104.

752.6 RUBBER RINGS:

Each coupling shall have two synthetic rubber joint sealing rings conforming to the requirements of ASTM D1869. This paragraph shall also apply to the rings furnished for use with fittings. Neoprene shall not be used.

- ***End of Section*** -

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 A53 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, Pretecto Wrap No. 200, Saft-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 1/4 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 B62.

- ***End of Section*** -

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 B88, 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 coil, 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 shown on standard details.

Service Material containing Brass or Bronze must comply with the current NSF 61-8 Standards at the time the Project begins.

All Brass or Bronze service material must meet the current AWWA C800 Standards.

- ***End of Section*** -

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 620 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 D2239 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.

Service Material containing Brass or Bronze must comply with the current NSF 61-8 Standards at the time the project begins.

All Brass or Bronze service material must meet the current AWWA C800 Standards.

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 D1248, except that the melt index shall be determined under a higher temperature than ASTM D1238. 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 D2239, when measured in accordance with ASTM D2122.

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 five specimens shall be at least equal to 630 psi for water at 73.4°F. Pressures shall be determined in accordance with ASTM D1599.

755.5 SUSTAINED PRESSURE:

In addition to passing the sustained pressures given in ASTM D2239 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 3/4 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 D1598 shall be followed.

755.6 TESTS OF PIPE:

The pipe must be able to meet all tests that are specified in ASTM D2239, and the following test for melt index, as determined in ASTM D1238. 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 pipes that is intended for transporting potable water.

PE 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: 3/4 inch Pipe has I.D. 0.824 inch, O.D. 1.060 inch and 3.328 inch circumference.
3/4 inch Tubing is not acceptable and has I.D. 0.681 inch, O.D. 0.875 inch, 2.747 inch circumference and an SDR-9 if shown.

- ***End of Section*** -

SECTION 756

DRY BARREL/FIRE HYDRANTS

756.1 GENERAL:

Fire Hydrants furnished by the Contractor shall be designed, manufactured, and tested in compliance with the latest edition of the American Water Works Association (AWWA) - C502 Standard for Dry-Barrel Fire Hydrants, 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 hydrant makes and models (and approved alternates) shall be specified by the owner and designated on an approved products list, which will be maintained by the owner. Alternate hydrants by request only to Owner. The diameter of the main valve seat opening shall be not less than 5 inches in diameter. The entire valve assembly shall be effectively sealed against moisture.

All interior ferrous surfaces of the shoe exposed to fluid flow (including the valve plate and cap nut), shall be epoxy coated to a minimum dry thickness of 6 mils. Epoxy coatings shall be factory applied by an electrostatic or thermosetting process in accordance with the manufacturer's printed instructions. The epoxy materials used shall be 100% powder epoxy or liquid epoxy that conforms to the requirements of AWWA C550-81, NSF 61 approved, and to the prevailing requirements of the Food and Drug Administration and of the Environmental Protection Agency.

Style of inlet shoe connections shall be a restrained mechanical joint with accessories, gland, bolts, gaskets and having a 6 inch diameter inlet connection. Solid flange or ring tight "bump in" connections will not be allowed unless through exception by owner. Facing of the main valve against seats shall be rubber or synthetic rubber. 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 streamer 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 15/16 inch to 31/32 inch on side, 1 1/2 inch from point to flat. All barrels above ground shall have a prime coat and painted with two coats of fire hydrant yellow paint or as specified by owner. Hydrants shall be constructed so that the standpipe can be rotated 360 degrees to at least eight different positions.

Hydrants shall be designed for a 250 psi working pressure and factory bench tested to a 500 psi hydrostatic pressure.

Hydrants shall be field tested consistent with the specified pressure ratings for the connecting pipes or as specified by AWWA.

Hydrants shall be of the break flange traffic model type with a replaceable breakable unit immediately above the ground line to minimize repairs necessary due to traffic damage. The breakable stem coupling will be made of a corrosion resistant material such as stainless steel or bronze, or have a permanently applied non-corrosive finish such as nickel plating or fusion bonded epoxy coating.

Hydrants shall be of the compression type; constructed such that the main valve closes with the water pressure to assure no loss of water in the event of damage to the upper portion of the fire hydrant.

Main valve opening shall have a minimum diameter of 5-inches to assure optimum flow. Facing of the main valve against the seats shall be of rubber or synthetic rubber minimum of 1 inch in thickness. Plastic or Neoprene type main valves will not be allowed.

Hydrants shall be of the dry top design with O-ring seals to ensure that the operating threads will be protected from water entry. Dry top design to include factory-lubricated operating mechanism, which allows supplemental lubricant to be added in the field without removal of the upper barrel.

Standard lubricant shall be a NSF 61 approved oil or grease suitable for a temperature range of 20 degrees to 150 degrees F.

Hydrants shall have a cast iron weather shield at the operating nut to protect the clearance area between the top casting and the operating nut.

The operating nut shall be a one-piece bronze casting. Both the operating nut and the nozzle cap nuts shall be National Standard Pentagon in shape and measure 1-1/2 inches from point to flat at the base of the nut.

Hydrants shall have two hose nozzles, 2.5 inches in diameter, and one pumper nozzle approved by the Owner. Rubber gasket nozzle caps shall be provided. Screw threads shall be per owner requirements.

Hydrant nozzle section shall be capable of rotation through 360 degrees to at least 8 points of rotation with respect to the standpipe to allow the positioning of the hose or pumper nozzles

Minimum distance allowable between the centerline of the lowest nozzle and ground / bury line is 18-inches. Bury line shall be visibly marked on lower barrel of hydrant.

Hydrants shall have markings indicating direction of opening right to left (counter-clockwise).

Hydrants shall have permanent markings identifying the manufacturer name, model identification, size of the main valve opening and the year of manufacture.

Hydrants shall have an automatic drain that is operated by the main valve rod. The drain valve is to open as the main valve is closed and close as the main valve is opened. The port and seat of the drain valve shall be bronze. Drain facings shall not be leather.

The outside of the hydrant top section shall be painted a minimum of one coat of non- lead base premium primer and two (2) finished coats of non-lead base premium durable paint. The surface will be properly prepared, smooth, clean, and dry before primer is applied. The primer coat will be applied to a DFT (Dry Film Thickness) of 3-4 mils. The final two coats will be applied to achieve a DFT of 6-8 mils on top of the primer coat. Paint will be a semi-gloss, bright chrome safety yellow in color or as specified by owner. Paint will have high color retention. Paint will be fade and UV resistant, rust resistant, resistant to abrasions and chipping and have flexibility qualities.

Hydrants shall have a bronze valve seat and shall be threaded into a bronze drain ring or shoe bushing to prevent electrolysis between these components

Hydrants shall be designed to permit the use of extension sections.

Hydrants shall be designed to allow all working parts to be removed through the bonnet/dome or upper nozzle section of the hydrant without removal of the entire upper barrel section.

Hydrants shall be suitable for installation in 36-inch to 72-inch trench depth or as specified by owner.

All nuts and bolts of the factory hydrant to be buried below ground will be a minimum of 304 stainless steel and coated for gall protection.

The friction loss must be guaranteed by the manufacturer to match statistics in Table 756-1.

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			
Number of Outlet Nozzles	**Nominal Diameter of Outlet**	**Total Flow From Outlet Nozzles GPM**	**Maximum Permissible Head Loss PSI**
2	2 1/2 inches	500	2.0
1	4 inches	600	2.5

756.5 WARRANTY:

All items shall be warranted by the manufacturer for a minimum period of five (5) years from date of acceptance by the Owner, against defects in material and workmanship. At any time during that period, if a defect should occur in any item, it shall be repaired or replaced by the manufacturer at no obligation to the Owner, except where it would be shown that the defect was caused by misuse and not by fault of manufacturer. The manufacturer shall make necessary repairs within the time frame specified by the owner or reimburse the owner if emergency repairs are required. The manufacturer expressly warrants all items to be new, free from defect in design, materials, and workmanship and to be fit and sufficient for their intended purpose. All warranties shall survive acceptance and payment by the city.

756.6 INSPECTION:

All items shall be inspected before acceptance by an authorized representative of the Owner for workmanship, acceptance and proper functioning of components, and conformance to all requirements of this specification.

Should deficiencies be found, it shall be the responsibility of the supplier to pack the item(s) in question, make necessary corrections, and then return to the Owner for re-inspection and acceptance at no additional expense or obligation to the Owner.

- ***End of Section*** -

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 pipes shall be newly galvanized, standard weight, Schedule 40 conforming to 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 D1785. Schedule 40 or 315 psi pipe shall be used for the continuously pressurized run on the supply side 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 Fitting and Couplings – Steel pipe fittings and couplings shall be galvanized, malleable iron, screwed fittings or couplings, conforming to 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 to 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 D1784, 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 D2564.

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 3/4 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 3/4-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: D638.

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 "Foundation for Cross-Connection Control and Hydraulic Research."

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 1/2 inch 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 D2219 or D2220. 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 controller 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 that 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 capacity. 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.

- ***End of Section*** -

SECTION 758

CONCRETE PRESSURE PIPE – STEEL CYLINDER TYPE

758.1 GENERAL:

These specifications apply to Concrete Pressure Pipe intended for use in water supply pipelines that carry water under pressure. Concrete pressure pipe is specified as follows:

(A) Reinforced concrete pressure pipe-steel cylinder type, pretensioned, shall be designed, manufactured and tested in accordance with AWWA C303. With agreement by the purchaser and the manufacturer, pipe may be manufactured to larger sizes and for higher pressures than indicated herein.

Reinforced concrete pressure pipe may be furnished in pipe diameters of eighteen (18) inches through seventy-two (72) inches.

Pipe shall be designed by the methods described in Appendix A, AWWA C303 to resist the internal pressures and external loading conditions designated on the approved plans or in the project specifications.

(B) Prestressed concrete pressure pipe steel cylinder type, shall be designed, manufactured and tested in accordance with AWWA C301 and AWWA C304.

Prestressed concrete pressure pipe may be furnished in pipe diameters forty-two (42) inches and larger.

Pipe shall be designed by the methods described in AWWA C304 to resist the internal pressures and external loading conditions designated on the approved plans or in the project specifications.

758.2 MANUFACTURE:

The Contractor shall submit design calculations, a tabulated layout schedule, and details of specials and fittings to the Engineer for review and approval.

When specified in the project specifications, the manufacturer shall furnish all samples, test reports, test specimens and perform tests as provided in AWWA C303 or AWWA C301.

An approved rust inhibitor shall be applied on the exposed portions of the steel joint rings.

The Contractor shall submit an affidavit of compliance from the manufacturer that the pipe and fittings furnished comply with all applicable provisions of AWWA C301 or AWWA C303.

The Engineer or his representative shall be allowed access to the manufacturer's plant for the purpose of inspecting the pipe and fittings.

- ***End of Section*** -

SECTION 759

STEEL PIPE

759.1 GENERAL:

These specifications apply to Steel pipe intended for use in water supply pipelines that carry water under pressure. Steel pipe is specified as follows:

- Steel pipe shall be designed, manufactured and tested in accordance with AWWA C200.
- Steel pipe and fittings may be furnished in pipe diameters of six (6) inches and larger.
- Pipe shall be designed by the methods described in AWWA C200 and AWWA Manual M11, to resist the internal pressures and external loading conditions designated on the approved plans or in the project specifications.
- Trench excavation, backfilling and compaction shall be in accordance with Section 601 unless otherwise specified in the plans and specifications. For Steel Pipe with a flexible coating the backfill pipe zone material shall consist of Granular Material, maximum 3/4 inch size.
- As an option, the backfill in the pipe zone may be Controlled low strength material (CLSM) in accordance with Section 728 and placement per Section 604.

759.2 LINING AND COATING OPTIONS:

(A) Cement mortar lining and cement mortar coating shall be in accordance with AWWA C205.

(B) Polyurethane coatings for interior and exterior of steel pipe shall be in accordance with AWWA C222. The MDFT shall be 20 mils. on the interior lining and 25 mils. on the exterior coating.

(C) Polyethylene tape coating shall be in accordance with AWWA C214. The total thickness of the tape coating shall be minimum 50 mils for pipe up to 54 inches diameter and minimum 80 mils for pipe 54 inches diameter and larger.

(D) Liquid-Epoxy coating systems for the interior and exterior of steel water pipelines shall be in accordance with AWWA C210. Interior lining will be applied in one or two coats MDFT of 16 mils.

All linings for potable waterlines shall be NSF approved.

759.3 MANUFACTURE:

The contractor shall submit design calculations, a tabulated layout schedule, and details of specials and fittings to the Engineer for review and approval.

When specified in the project specifications, the manufacturer shall furnish all samples, test reports, test specimens and perform tests as provided in AWWA C200 or AWWA manual M11.

Standard pipe shall be furnished with rolled-groove bell and spigot rubber gasket joints. Restrained joints shall be lap-welded slip joints with the bell formed by cold formed expanded dies.

Unless otherwise specified, fabricated steel pipe shall be manufactured in uniform lengths to fit the pipeline alignment shown on the plans, subject to a maximum length of 40 feet. For Steel Pipe with flexible coatings the pipe length may be 60 foot maximum, subject to the Manufacturer's recommendations. Shorter lengths may be furnished to facilitate special conditions.

The Contractor shall submit an affidavit of compliance from the manufacturer that the pipe and fittings furnished comply with all applicable provisions of AWWA C200 or AWWA Manual M11.

The Engineer or his representative shall be allowed access to the manufacturer's plant for the purpose of inspecting the pipe and fittings.

- End of Section -

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 wall thickness of the pipe to be furnished shall be as specified on the project plans or specifications.

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 Type E.

Type E Pipe - Corrugated Metal Pipe with Smooth Metal Liner: The pipe shall be manufactured as per AASHTO M-36, Type 1A except that the lock seam shall be on the tangent of the helical corrugation. The ends of each pipe shall be reformed with two annular corrugations for joining the pipes with approved band couplers. The minimum thickness of the pipe shell shall be as required to support external load with no credit for load carrying support given to the liner. The minimum thickness for the liner shall be 22 gauge (0.034 inches).

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.

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 project plans or specifications as otherwise specified. Pipe with helical corrugations shall have a continuous lock or weld 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.

Spiral Rib Metal Pipe: The pipe shall be fabricated from flat sheets in coils. The base metal, spelter coating, method of sampling, accepted brands of metal, inspection and rejection, shall meet the requirements of AASHTO M-36. Structures furnished shall be full circle on sizes of 18 inch and above as shown in Table 4 of AASHTO M-36. The pipe shall be fabricated with helical rectangular ribs projecting outwardly from the pipe wall with a continuous lock seam extending from end to end of each length of pipe. Spiral Rib Pipe shall consist of two rectangular ribs and one half-circle rib equally spaced between seams. Rectangular ribs shall be 3/4 inch wide by 1 inch high. The half-circle rib diameter shall be 1/2 inch and shall be midway between the rectangular ribs. Maximum rectangular rib spacing shall be 11 1/2 inches. The thickness (gage) of the metal shall be in accordance with project plans and/or specifications or as otherwise specified.

760.4 COUPLING BANDS:

Watertight joints shall be fabricated for corrugated metal pipe by the use of galvanized couplers or connecting bands, bituminous coated where required, 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. 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 end treatment or may be flat, and shall be fastened with bolts. Dimpled coupling bands shall be 10 1/2 inches wide for diameters 12 through 60 inches, and 17 inches wide for diameters above 60 through 96 inches. The 10 1/2 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 arrangements 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 1/2 inch nominal diameter carriage bolts. Two bolts are required for pipe 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 and spiral rib flange 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 10 1/2 inches wide regardless of pipe diameter and shall be fastened with 2 bolts.

When flanges are provided on the pipe ends, the coupling shall be made by interlocking the flanges with a preformed channel band or other band incorporating a locking channel not less than 3/4 inches in width. The depth of the channel shall be not less than 1/2 inch. The channel band shall have a minimum nominal thickness of 0.079 inches.

760.5 PERMISSIBLE VARIATIONS IN DIMENSION:

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 3/8 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 1/4 inch. The design diameter may vary as above.

- ***End of Section*** -

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.

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.

- ***End of Section*** -

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 A36.

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 specification, 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 A6.

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 three 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, A572, A709 or A992, as specified in the special provisions.

General Purpose Structural Steel: Structural steel shall conform to the requirements of ASTM A36 with a minimum of 0.2 percent copper.

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 A502.

Structural Rivet Steel: The material shall conform to the requirements of ASTM A502, except that the test specimen shall be bent upon itself when performing the bend test.

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 1/4 inch beyond. Washers shall not be furnished unless specified.

Steel bolts shall conform to the requirements of ASTM A307, 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 A36 or A307.

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 A668. 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 E10.

- ***End of Section*** -

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 Table 771-1.

TABLE 771-1		
GALVANIZING SPECIFICATIONS		
Material	**ASTM Spec.**	**Wt. of Coating Oz./Sq. Ft. (Min.)**
Corrugated Metal Pipe	A929	1.80
Flat Steel or Iron Sheets	A653, A924	1.25
Iron or Steel Wire	A116	.80
Chain Link Fabric	A392	1.20
Barbed Wire	A121	.50
Steel Pipe - Rails and Posts	A53	1.8
	F1043 IA	1.8
	F1043 IC Galvanized After Forming	0.9 oz. w/chromate and organic clearcoat
Structural Shapes, Tie Rods, Ornamental Iron Railings, Handrails, Manhole and Catch Basin Steps, and Curb Armor	A123	2.00
Bolts, Nuts, Washers, Anchor Bolts, Packing Spools, Gray Iron and Malleable Iron Castings and Steel Castings	A153	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.

- ***End of Section*** -

SECTION 772

CHAIN LINK FENCE

772.1 GENERAL:

All material shall be new and, upon request, the Contractor shall furnish to the Contracting Agency, a certification of inspection stating that the materials have been manufactured, sampled, tested and inspected so as to meet the requirements for its type as specified below.

772.2 POSTS, RAILS AND BRACES:

Posts, rails and braces shall be constructed of pipe in conformance with types A, B or C below. Unless specifically designated by type in the plans or specifications, the Contractor may utilize any of the three types. The posts and rails in this section will cover fencing up to 12 feet in height with post spacing not to exceed 10 feet. The nominal outside dimensions and minimum weights shall be in accordance with Table 772-1. The manufacturer or his representative shall legibly mark each length of pipe by rolling, stamping or stenciling to identify the product by product name, ASTM standard, etc. and the country of manufacture.

Type A: Shall be manufactured in conformance to ASTM F1043 IA-2 black steel pipe, welded or seamless, hot-dipped zinc coated, plain end, standard weight (schedule 40). The hot-dipped zinc coating (galvanized) shall be applied both inside and outside with not less than 1.8 oz. per square foot ± 0.1 oz.

Type B: Shall be manufactured in conformance to ASTM F1043 IC Galvanized After Forming. Steel used in the manufacturing of the pipe shall be hot-rolled strip steel in compliance with ASTM A1011 having a minimum yield strength of 50,000 psi. The pipe will be manufactured by electric welded cold-formed process per ASTM A500. The exterior surface will be triple coated and the interior surface single coated. The triple coated external surface shall be hot-dipped zinc coated (galvanized) having a weight of not less than 1.0 oz. per square foot ±0.1 oz., followed by a chromate conversion coating, having a weight not less than 1.05 micro ounces per square foot ± 0.353 micro ounces (30 micrograms per square inch ±15 micrograms) and an acrylic coating having a thickness of 0.0005 inches ± 0.0002 inches. The internal surface shall be coated with a zinc base paint having a 90% zinc powder loading and having a minimum thickness of 0.0005 inches.

Type C: Shall be manufactured in conformance to ASTM F1043 IC Galvanized Before Forming. Steel used in the manufacturing of the pipe shall be strip steel in compliance with ASTM A653 Grade D having a minimum yield strength of 50,000 psi. Both sides of the strip shall be hot-dipped zinc coated (galvanized) per ASTM A653 and A-924 having the weight of not less than 1.0 oz. per square inch ± 0.1 oz. The zinc coating will form the first coat of a triple coated external surface and the final coat of the interior surface. The pipe will be manufactured by electric welded cold formed process per ASTM A789. After manufacturing, the final two external coatings shall be a chromate conversion having a weight of not less than 1.05 micro ounces per square inch ± 0.353 micro ounces and an acrylic coating having a thickness of 0.0005 inches ± 0.0002 inches.

772.3 CHAIN LINK FABRIC:

Chain link fabric shall conform to the requirements of ASTM A392 (Zinc-Coated) or ASTM A491 (Aluminum-Coated). The coating process must leave the fabric completely free of barbs, icicles, or other projections that might be hazardous. 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. 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 per ASTM A824. 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 3/16 inch x 3/4 inch.

TABLE 772-1					
FENCE MEMBER SIZES & WEIGHTS					
USE	FENCE FABRIC HEIGHT (Feet)	NPS DESIGNATOR	OUTSIDE DIAMETER (Inches)	WEIGHT (Lb./Lf Minimum)	
				TYPE A Schedule 40	TYPE B and C
FENCE POSTS					
End, corner, slope, pull and strain posts	Less than 6	2	2.375	3.65	3.12
	6 and over but less than 9	2 1/2	2.875	5.79	4.64
	9 and over but not over 12	3 1/2	4.000	9.11	6.56
Line posts	not over 6	1 1/2	1.900	2.72	2.28
	over 6 but less than 9	2	2.375	3.65	3.12
	9 and over but not over 12	2 1/2	2.875	5.79	4.64
GATE POSTS					
Single swing gates 6 feet or less in width or double swing gates 12 feet or less	less than 6	2	2.375	3.65	3.12
	6 and over but not over 12	3 1/2	4.000	9.11	6.56
Single swing gates over 6 feet but not over 13 feet in width or double swing gates over 12 feet but not over 26 feet in width	—	3 1/2	4.000	9.11	6.56
Single swing gates over 13 feet but not over 18 feet in width of double swing gates over 26 feet but not over 36 feet in width	—	6	6.625	18.97	—
Single swing gates over 18 feet in width or double swing gates over 36 feet in width	—	8	8.625	28.55	—
OTHER MEMBERS					
Top rail and braces	—	1 1/4	1.666	2.27	1.84
Frame for gates	—	1 1/2	1.900	2.72	2.28
Stiffeners for gates	—	1 1/4	1.666	2.27	1.84

Notes to Table 772-1:

- 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.
- Top rail shall be furnished in random lengths of approximately 20 feet where required.

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 3/8 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 shall conform to ASTM F626.

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 shall carry 3 wires at approximately 5 1/2 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 12 1/2 gage galvanized steel wire with barbs spaced 5 inches apart and shall conform to ASTM A121.

- ***End of Section*** -

SECTION 775

BRICK AND CONCRETE MASONRY UNITS (BLOCKS)

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.

775.1.1 Manhole Brick: Agency approval is required prior to using brick within manholes. When approved, brick may be used for maintenance and adjustment of the existing manholes or rings and covers.

Manhole brick shall conform to Table 775-1.

TABLE 775-1			
MANHOLE BRICK DIMENSIONS			
Brick	**Inches Depth**	**Inches Width**	**Inches Length**
Standard Size Allowable Variations	2 1/4 ±1/8	3 1/2 ±1/8	7 1/2 ±1/4

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 1 3/4 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 samples, 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.

775.1.2 Building Brick: Building brick shall conform to the requirements of ASTM C62, grade MW.

775.1.3 Facing Brick: Facing brick shall conform to the requirements of ASTM C216, Grade MW, Type FBS. The size, color, and texture shall be as specified on the plans or as approved by the Engineer.

775.2 CONCRETE MASONRY UNITS:

Unless otherwise noted on the plans or special provisions, concrete masonry units shall conform to ASTM C90, Normal Weight, Type I with a minimum compressive strength of 1900 psi.

The units shall be fully cured and shall have been made not less than 28 days prior to delivery.

The moisture content at the time of delivery shall not exceed 30 percent of the minimum absorption value of the units. The Contractor shall provide any protection he deems necessary to maintain the units in this condition until time of use.

The linear change from saturated to cool oven dry shall not exceed 0.0054 inches per linear foot or 0.045 of 1 percent conducted in accordance with test method in ASTM C426.

The units shall be made with normal weight aggregate conforming to ASTM C33.

The nominal size of the units shall be as indicated on the plans. The overall dimensions for width, height and length shall differ by not more than ±1/8 inch from the specified standard dimensions. Standard dimensions of units are the manufacturer's designated dimensions. Nominal dimensions of units are equal to the standard dimensions plus the thickness of one mortar joint.

No less than five samples of the units shall be submitted to the Engineer for approval and to show the full variance of texture and full range of color. Units used in the work shall match the approved samples. These samples may be tested for strength.

All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or would significantly impair the strength or permanence of the construction. When units are to be used in an exposed setting, the face or faces that are to be exposed shall not show chips or cracks, not otherwise permitted, or other imperfections when viewed from a distance of not less than 6 feet under diffused lighting.

Units that are intended to serve as a base for plaster or stucco shall have a sufficiently rough surface to afford a good bond.

- ***End of Section*** -

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±5 percent) are combined in the proportion shown in Table 776-3 and Table 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 C144
A	1	0	1
B	1	0	1 1/2
C	1	0	2
D	1	0	2 1/2
M	1	1/4	2 1/4 to 3
'S	1	1/2	2 1/4 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 C404)	Coarse Aggregate (ASTM C404)
Fine Grout	1	2 1/4 to 3	0
Coarse Grout	1	2 1/2	1 to 2

776.2 PORTLAND CEMENT:

The cement used shall conform to 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.

776.3 AGGREGATE:

All aggregate shall be approved by the Engineer prior to being utilized on the job.

Fine aggregate (sand) to be used in mortar shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances. The size and grading of fine aggregate shall conform to the applicable requirements of ASTM C144.

Fine or coarse aggregate to be used in masonry grout shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances. The size and grading of fine or coarse aggregate shall conform to the applicable requirements of ASTM C404.

The average value of sand equivalent determined on three successive samples shall not be less than 70 when tested in accordance with ASTM D2419. No individual sample shall have a sand equivalent less than 65.

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 C91 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 C207, 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 C780 Annex A-1 and A-6 will be performed. For this area, the penetration of the cone penetrometer correlating to a flow of 110± 5 percent is 40± 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.

- ***End of Section*** -

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 non-showing 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

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.

- ***End of Section*** -

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 four 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 Aresnite (Chemonite)

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 two coats of the same kind of preservative in conformance with AWPA specification. The maximum protection requirement specified therein shall be met in all instances.

- ***End of Section*** -

SECTION 787

GRAY IRON CASTINGS

787.1 GENERAL:

The castings shall be true to pattern in form and dimension and free from pouring faults, spongings, 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 arises 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 A48. 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 A48, 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 A48.

787.3 MANHOLE FRAME AND COVER SETS:

Castings shall conform to ASTM A48, Class 30. The bearing surfaces of the frames and covers shall be machined and the cover shall seat firmly onto the frame without rocking.

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 A48, Class 40.

787.5 ROCKERS, ROCKER PLATE BEARINGS, AND BEARING PLATES FOR BRIDGES:

Castings shall conform to ASTM A48, 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 A48, Class 30.

- ***End of Section*** -

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. Paint containing lead shall comply with Subsection 107.5.2.

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 references 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 D234
Boiled Linseed Oil	ASTM D260
Water-Resistant Spar Varnish	Navy Department Specification 52V20
Alkyd Resin	TT-R-266C
Driers	ASTM D600, Class A or Class B, as applicable
Thinners:	
Xylene	TT-X-916B, Grade A
Turpentine (shall be used in paints used for timber)	ASTM D13, Gum Spirits
Petroleum Spirits (Mineral Spirits)	ASTM D235

(B) **Pigments**	**Specifications:**
Carbonblack	TT-P-343 Form 1, Class B
Lampblack	ASTM D209
Red Lead	ASTM D83
Titanium Dioxide, Non-extended	ASTM D476, Type II, Class II
Titanium Dioxide, Extended (Titanium Calcium, Rutile)	ASTM D476
Titanium Dioxide	TT-P-422B, Type III, Class A
White Lead Basic Carbonate	ASTM D81
Zinc Yellow (Zinc Chromate)	ASTM D478, Type II
Zinc Oxide	ASTM D79
Iron Blue	TT-P-385
Iron Oxide, Yellow	TT-P-458A
Iron Oxide, Orange	ASTM D3721, D3722, D3724
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:

Amphorus Graphite ..... 68.0 percent
Linseed Oil ..... 32.0 percent

(C) **Inert Materials:**	**Specifications:**
Diatomaceous Silica	ASTM D604, Type A
Magnesium Silicate	ASTM D605

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 that 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 that 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.

SECTION 790

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.

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)

- ***End of Section*** -

SECTION 792

DUST PALLIATIVE

792.1 GENERAL:

Dust palliatives shall consist of various chemical dust suppressants, which work by binding together lighter soil particles.

All materials must meet the environmental requirements of Section 792.3 and must be approved by the Engineer prior to their use.

792.2 TYPE OF MATERIALS AND APPLICATION RATES:

Emulsions shall be miscible with water in all proportions as noted in Table 792-1. The dilution ratio will vary based upon the local soil and weather conditions. The ratios shall be proposed by the Contractor and agreed upon by the Engineer.

The rate of application noted in Table 792-1 shall be for the treatment, method and use specified by the Contracting Agency, or as directed by the Engineer. To compensate for local conditions or changes in soil type, the Contractor may adjust the application rate within the ranges specified.

Products specifically formulated as tackifiers, which prevent wind-blown erosion, shall not be acceptable as dust palliatives for vehicular traffic, but may be used for their intended purposes.

TABLE 792-1
DUST PALLIATIVE DILUTION RATIOS AND APPLICATION RATES

Product Type	Use/Treatment (1)	Dilution Ratio (2)		Application Rate (3) (gal/sy)
		Range	Typical	
Acrylic Copolymer And Polymers	Topical - Road or parking Lot Topical - Road Shoulder Surface Course (per inch of depth)	20:1 to 4:1 20:1 to 4:1 20:1 to 4:1	9:1 15:1 9:1	0.20 to 0.15 0.16 to 0.12 0.08 to 0.06
Lignin-Based Type (Lignosulfonate)	Topical - Road or parking Lot Topical - Road Shoulder Surface Course (per inch of depth)	1:1 7:1 to 4:1 1:1	1:1 8:1 1:1	0.10 to 0.05 0.05 to 0.03 0.30 to 0.10
Organic Resin	Topical - All Surface Course (per inch of depth)	10:1 to 2:1 2:1 to 1:1	5:1 1:1	0.25 to 0.15 0.15 to 0.10
Petroleum Resin	Topical - Road or parking Lot Topical - Road Shoulder Surface Course (per inch of depth)	4:1 10:1 to 7:1 4:1	4:1 8:1 4:1	0.15 to 0.10 0.15 to 0.07 0.11 to 0.07
Tall Oil Pitch Emulsion	Topical - Road or parking Lot Topical - Road Shoulder Surface Course (per inch of depth)	20:1 to 5:1 20:1 to 3:1 20:1 to 2:1	5:1 3:1 10:1	0.20 to 0.15 0.16 to 0.12 0.08 to 0.06
Other	As approved by the Engineer			

(1) Topical application rates shown are to obtain 1/2 to 1 inch penetration. Higher rates should be used if greater penetration is anticipated.
(2) The dilution ratio (water: product) is variable and shall be appropriate for the local soil and weather conditions, as proposed by the Contractor and agreed upon by the Engineer.
(3) Application rate of undiluted concentrate.

Contractor shall submit proof of conformance in the form of test reports to verify that the dust palliative product proposed for use meets the minimum material requirements specified in this Section. Testing must be specific to the proposed product and not generic to similar type palliative products. Testing shall be performed by independent AASHTO accredited laboratories, and signed and sealed by Professional Engineers registered in the State of Arizona. The Contractor is responsible for any costs associated with the testing of soil and palliative product prior to the application of as specified herein.

(A) Acrylic Copolymer and Polymer Types:

The material shall be a white or clear emulsion that can penetrate, saturate and bond together treated soils to create a hard, dust-free and water resistant surface. The material shall have the following properties in its undiluted state:

Specification Designation	ASTM Test Method	Requirements
Composition	--	Acrylics, acrylates & acetates
pH	E70	4.0 – 9.5
Residue (active solids content), %	D2834	40 min.
Flash Point	D92	None
Absolute Viscosity (Brookfield), cP, 77°F	--	1500 max.
Specific Gravity, 60/60°F	D1298	1.00 – 1.15

(B) Lignin-Based Types:

Lignin-based dust palliative shall be an aqueous lignosulfonates (a residual co-product of wood pulping by the sulfite process in the manufacturer of cellulose products) that dispersed readily in water to yield a stable, brown-colored solution. The material shall have the following properties in its undiluted state:

Specification Designation	ASTM Test Method	Requirements
Absolute Viscosity (Brookfield), cP, 77°	--	<1000
Residue (total solids content), %	D2834	48 min.
Lignin sulfonate content (% of solids)	D2834	60 min.
pH	E70	5.0 - 7.0
Specific Gravity (liquid), 77/60°F	D1298	1.00 min.

(C) Organic Resinous Types:

The material shall be a tan emulsion designed specifically for dust control of unpaved roads, traffic surfaces, and road shoulders that utilize non-petroleum based organic esters and resins combined with other additives to penetrate, bond and coat treated soils. The material shall have the following properties in its undiluted state:

Specification Designation	ASTM Test Method	Requirements
Absolute Viscosity (Brookfield), cP, 77°	--	50 – 200
pH	E70	3.0 - 9.0
Residue (active solids content), %	D2834	45 min.
Flash Point	D92	None
Specific Gravity, 60/60°F	D1298	1.00 min.

(D) Petroleum Resinous Types:

The materials shall be a light yellow petroleum resinous emulsion suitable for use as agglomerate for soil particles. The material shall have the following properties in its undiluted emulsified state:

Specification Designation	ASTM Test Method	Requirements
Kinematic Viscosity, SFS at 77°F	D244	188 min.
pH	E70	4.0 – 7.0
Residue, % wt (1)	D2834	60 min.
Sieve Test, % wt. Retained (2)	D244	0.1 max.
Particle Charge Test	D244	Positive
Flash Point of base product, CO, °F.	D92	400 min.
Specific Gravity, 60/60°F	D1298	1.00 min.

(1) ASTM test modified by heating 50 g of sample to 300 °F until foaming ceases, then cooling immediately and calculation results.
(2) Replace 2% sodium oleate solution with distilled water in test.

The emulsion shall be stable, i.e., should not break when stored in clean closed containers at temperatures between 35°F and 200 °F for a minimum of 3 months. 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 and not form a skin at the surface or a crusted surface.

(E) Tall Oil Pitch Emulsion:

The material shall be a light brown tree resinous emulsion produced from distilled tall oil and not associated with the use of chlorine-based chemicals to bleach pulp from the production of paper. The product shall be designed specifically for dust control of unpaved roads, traffic surfaces, and road shoulders that can penetrate, saturate and bond together soils to create a hard, dust-free and water repellant surface. The product shall be non-water soluble once cured. The emulsion shall have the following properties in its undiluted state:

Specification Designation	ASTM Test Method	Requirements
pH	E70	2.5 - 9.0
Residue (active solids content), %	D2834	35 min.
Flash Point	D92	None
Specific Gravity, 60/60°F	D1298	0.998 min.

(F) Other Types:

Other types of dust palliative may be approved for use by the Engineer. Test methods, requirements, dilution ratios and application rates shall be as specified by the manufacturer.

792.3 PERFORMANCE STANDARDS AND TEST METHODS:

Product shall be blended at the specified stabilizer content application rate with soil that is either representative of the site soils to be treated or be a local A-7 in accordance with AASHTO M-145 (as determined by the Engineer) and tested in accordance with ASTM D1883. Results of treated soil must show a minimum 25% increase in CBR (California Bearing Ratio) value over the untreated soil for the product to be accepted for either topical dust suppression or soil stabilization.

Testing shall be in accordance with ASTM D1883, as modified herein. Test reporting shall include all the information required by ASTM D1883, Section 10.0 for both treated and untreated CBR samples. In addition, the penetration vs. stress plot for each test shall be included (ASTM D1883, Fig. 2) along with the rate of product application and the percent stabilizer solids. CBR specimens, after molding, shall be left in their mold, on their sides and cured in the laboratory air for 7 days prior to being immersed in water for 96 hours and then tested for CBR. At least three CBR test specimens shall be compacted at the optimum moisture content, both treated and untreated (ASTM D698, method C), with the result reported as the average value. The surcharge weight shall be 10 pounds.

792.4 ENVIRONMENTAL CRITERIA:

Contractor shall submit proof to the Engineer in the form of test reports and certificates to verify that the dust palliative product is in environmental compliance. The Contractor is responsible for any costs associated with the testing of soil and palliative product prior to the application of as specified herein.

Products shall not contain or emit chlorinated fluorocarbons (CFC's or Freon's) and shall not contain or emit volatile organic compounds (VOC's) that exceed Federal, State or Local air quality limitations.

Products and their degradation products shall not be composed of elements, compounds, mixtures or produce runoffs with the characteristics identified under Arizona Revised Statutes 36-2822 of the Arizona Hazardous Waste Management Act, emit or off-gas during placement, use or degradation of any hazardous air pollutant listed under Section 112 of the Federal Clean Air Act [42 U.S.C. § 7412], be a hazardous chemical substance or mixture pursuant to Section 7 of the Federal Toxic Substances Control Act [15 U.S.C.§ 2606], be designated by rule an extremely hazardous chemical substance pursuant to the Arizona Environmental Quality Act, be prohibited for use by the Arizona Department of Environmental Quality, the Environmental Protection Agency, or any applicable law, rule or regulation.

Product runoff and their degradation product runoffs shall not contain concentrations that exceed the parameters designated in Section 2.18 'Table 5' of the National Pollution Discharge Elimination System (NDES) Multi-Sector General Permit for Industrial Activities *(see Note A)*. Adequate proof can be shown by providing one of the following:

(A) Complete aquatic toxicity test for lethal concentration at 50% (LC50).

(B) Provide complete and accurate listing of all individual chemical constituents (including proprietary chemical information) and percentage of each in a given volume of pure chemical product.

(C) Surface water runoff test. This test involves running distilled water over a treated soil area, collecting the test water, and submitting to a certified lab for analysis.

Contractor shall obtain from the dust palliative product manufacturer independent verification and certification of performance and environmental claims by a recognized agency of the United States, Canadian Precertification, Environmental Technology Verification, or EcoLogo Certification programs for chemical dust suppressants.

Products or their components and degradation products shall be tested and certified by the manufacturer not to be substances or composed of substances known to be, or reasonably anticipated to be carcinogenic or toxic by the U.S. Department of Health and Human Services.

Products must have hazardous Materials Identification System (HMIS) ratings equal to or less than the following for each category: H=1; F=1; R=1; PPE=X.

- End of Section -

Note A: Parameter benchmark values shall be provided by the Engineer and based on the Contracting Agency's Requirements.

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 1 1/2%, by dry weight, or organic matter either natural or added. Gradation shall be in accordance with the following:

Sieve Size	Percent Passing
1 inch	100
1/2 inch	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 1/4 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 that are neither root nor pot-bound and are free of kinkled 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 x 4 inches, pointed and at least 18 inches long.

795.8.2 Tree Stakes: Unless otherwise specified, tree stakes shall be 2 x 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 1/2 inch garden hose.

795.8.4 Decomposed Granite: 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 below. If a specific color or type is required, it will be so indicated in the Contracting Agency's specifications.

Sieve Size	Percent Passing
3/4 inch	100%
1/2 inch	60-70
No. 40	5-20

- End of Section -

SECTION 796

GEOSYNTHETICS

796.1 GENERAL:

This section defines the requirements for geosynthetic fabrics, grids and membranes typically used as pavement fabric beneath asphalt concrete overlays, filtration/drainage separation between soil/aggregate layers, erosion control filter/separators for riprap protection, and soil or base reinforcement to improve the stability of weak soils or reinforce aggregate bases.

796.2 MATERIALS AND REQUIREMENTS:

Identification, packaging, delivery, storage and handling of geosynthetic materials shall be in accordance with manufacturer's recommendations and ASTM D4873. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number date of manufacture, and shipping date.

Geosynthetic materials shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties.

Geosynthetic materials shall be packaged with material that will protect the geosythetic (including ends of rolls) from damage due to shipment, water, sunlight and contaminates. During storage, geosynthetic materials shall be elevated off the ground and protected from the following: site construction damage, precipitation, extended ultraviolet radiation, strong acid or strong base chemicals, flames (including welding sparks), temperatures in excess of 160°F, and any other environmental condition that may damage geosynthetic material property values. Protection shall be in accordance with manufacturer's specifications and shall be maintained during periods of shipment and storage.

Materials required for complete and proper installation of geosynthetic materials that are not specifically described herein (such as pins, nails, washers, etc.) shall conform to the manufacturer's recommendations and be as selected and supplied by Contractor subject to final approval by the Engineer.

Requirements represent minimum average roll values in the weaker principal direction. Average of test results from any sampled roll in a lot shall meet or exceed the minimum values noted herein. Lot sampling shall be in accordance with ASTM D4354.

796.2.1 Pavement: Pavement fabric geosynthetics are non-woven polyester or polypropylene fabrics that are field saturated with an asphalt binder and placed as an interlayer beneath a pavement overlay or between pavement layers. When placed, the fabric becomes an integral part of the roadway section, forming a barrier to water infiltration and absorbing stresses to reduce reflective and fatigue cracking of the new pavement surface layer.

Pavement fabric shall be constructed of at least 95 percent (by weight) nonwoven synthetic fibers of polyester or polypropylene, thermally bonded on one side. The fabric material shall additionally conform to the physical properties shown in Table 796-1.

TABLE 796-1

PAVEMENT GEOSYNTHETIC PROPERTIES

Property	Class A	Class B	Test Method
Weight: oz./yd^2	4.1 min.	4.0 min.	ASTM D3776
Grab tensile strength: lbs.	100 min.	90 min.	ASTM D4632
Elongation at break: %	50 min.	50 min.	ASTM D4632
Melting point: degree F	300 min.	300 min.	ASTM D276
Asphalt retention: gal/yd^2	0.25 min.(1)	0.20 min.	ASTM D6140

(1) May be reduced within street intersections, on steep grades or in other zones where vehicle braking is common, but not less than 0.20 gal/yd^2, when approved by the Engineer.

796.2.2 Filtration (Drainage) and Separation: Filtration and separation fabrics are nonwoven or woven polypropylene or polyester fabrics with specified strength characteristics used as permeable separators to restrain soil or other particles subjected

to hydrodynamic forces while allowing the passage of fluids into or across a geotextile and to prevent inter-migration of adjacent soil layers of vastly different particle sizes and particle distributions.

Filtration and separation fabrics shall be nonwoven or woven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed or woven into a stable network such that the filaments retain their relative position to each other. The fabric material shall additionally conform to the physical properties shown in Table 796-2.

TABLE 796-2			
FILTRATION & DRAINAGE GEOSYNTHETIC PROPERTIES			
Property	**Class A (1)**	**Class B (2)**	**Test Method**
Grab tensile strength: lbs.	180 min.	80 min.	ASTM D4632
Seam strength: lbs.	160 min.	70 min.	ASTM D4632
Puncture strength: lbs.	80 min.	25 min.	ASTM D4833
Trapezoidal tear: lbs.	50 min.	25 min.	ASTM D4533
Apparent opening size: US Standard sieve size	>50	>50	ASTM D4751
Ultraviolet Stability: %	50 min.	50 min.	ASTM D4355

(1) Class A - Use where installation stresses are more severe than for Class B application (i.e. very coarse sharp angular aggregate or high compaction requirements).
(2) Class B – Use with smooth graded surface having no sharp angular projections and sharp angular aggregate.

796.2.3 Erosion Control: Erosion control fabrics are used below areas to receive aggregate or riprap slope protection and act as filter/separators to provide sustained permeability while maintaining structural stability.

Erosion control fabrics shall be a woven monofilament fabric or a nonwoven fabric consisting only of long chain polymeric filaments such as polypropylene or polyester formed into a stable network that the filaments retain their relative position to each other. The fabric material shall additionally conform to the physical properties shown in Table 796-3.

TABLE 796-3			
EROSION CONTROL GEOSYNTHETIC PROPERTIES			
Property	**Class A**	**Class B**	**Test Method**
Grab tensile strength: lbs.	270 min.	200 min.	ASTM D4632
Elongation at break: %	45min., 115 max.	15 min., 115 max.	ASTM D4632
Puncture strength: lbs.	110 min	75 min.	ASTM D4833
Burst strength: psi	430 min.	320 min.	ASTM D3786
Trapezoidal tear: lbs.	75 min.	50 min.	ASTM D4533
Permittivity: second^{-1}	0.07 min.	0.07 min.	ARIZ-730 (1)
Apparent opening size: US Standard sieve size	30 – 140	30 - 140	ASTM D4751
Ultraviolet Stability: %	70 min.	70 min.	ASTM D4355

(1) Arizona Department of Transportation test method.

796.2.4 Soil or Base Reinforcement: Geogrid geosynthetic materials are used for improving the stability of weak soils or reinforcing aggregate bases. Geogrids are defined as biaxial or triaxial polymeric grids formed by a regular network of integrally connected polymer tensile elements with apertures of sufficient size to permit significant mechanical interlock with the surrounding soil, aggregate, or other fill materials to function primarily as reinforcement.

The geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport and installation. Geogrids shall be integrally formed and deployed as a single layer; comprised of 100 percent polypropylene or high-density polyethylene. Geogrids shall additionally conform to the physical properties shown in Table 796-4.

TABLE 796-4			
REINFORCEMENT GEOGRID PROPERTIES			
Property	**Type 1**	**Type 2**	**Test Method**
Aperture size: inches	1 min.	1-3/8 min.	ID callipered
Ultimate Tensile Strength: lb./ft.	850 min.	1300 min.	ASTM D4945
Flexural Rigidity: Mg-cm	250,000 min.	750,000 min.	ASTM D1388
Tensile Strength @ 2% Strain: lb./ft. MD (1)	270 min.	410 min.	ASTM D6637
Tensile Strength @ 2% Strain: lb./ft. CMD (2)	380 min.	620 min.	ASTM D6637
Tensile Strength @ 5% Strain: lb./ft. MD (1)	550 min.	810 min.	ASTM D6637
Tensile Strength @ 5% Strain: lb./ft. CMD (2)	720 min.	1340 min.	ASTM D6637
Junction Efficiency: % Ultimate Tensile Strength	75 min.		GRI-GG2 (3)
Ultraviolet Stability: % Retained Strength	70 min.		ASTM D4355

(1) MD = Test in the machine direction along roll length
(2) CMD = Test in the cross-machine (transverse) direction across roll width
(3) Geosynthetic Research Institute test method

796.3 TEST AND CERTIFICATION REQUIREMENTS:

Upon request, a Certificate of Compliance shall be submitted to the Engineer for material to be used. Samples of materials shall be submitted for testing. Each geosynthetic material lot or shipment is to be approved by the Engineer before the material is incorporated into the work.

Testing methods and results shown in the Certificate of Compliance shall conform to the listed specifications for the proposed geosynthetic. Manufacturer's supporting documentation including, but not limited to, product information sheets, installation procedures and recommendations, recommended use, and project references shall be submitted to the Engineer for product evaluation and approval.

- End of Section -

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