

STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

Sponsored and Distributed by:

**Regional Transportation Commission
of Washoe County
Carson City
Churchill County
City of Reno
City of Sparks
City of Yerington
Washoe County**

2016

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FORWARD

To All Proposed Users:

The purpose of this document is to fulfill the need for uniform rules governing public works construction performed in Churchill County, Carson City, the Cities of Reno and Sparks, the City of Yerington, and Washoe County. Uniform specifications help to eliminate conflicts and confusion, lower construction costs, and encourage more competitive bidding by private contractors. The Standard Specifications for Public Works Construction book was first published in 1978 and it has proven to be an invaluable document to its users.

These specifications represent the highest level of professional thinking of representatives from the Public Works Departments. As construction materials and methods are ever changing, however, this document is revised and republished periodically to reflect the changing technology of the industry. A Specifications Revisions Committee has been formed to study and recommend appropriate changes. Interested parties may suggest changes and address questions to the Specifications Revisions Committee, C/O The Regional Transportation Commission of Washoe County. The revisions committee is grateful for the continued support and considerable assistance from local chapters of several organizations, including the American Public Works Association, American Society of Civil Engineers, Associated General Contractors, Builders Association of Northern Nevada, and National Society of Professional Engineers, and other interested parties, including NV Energy and Truckee Meadows Water Authority. The committee also extends special thanks to the Nevada Department of Transportation, for providing information from their Standard Specifications for portions of this document; and to the University of Nevada, Reno College of Engineering, the numerous local consulting engineering and contracting firms, and material manufacturers and suppliers whose representatives have provided extensive technical assistance.

In the interest of uniformity, it is hoped that all user agencies adopt these standards with as few changes as possible. However, it is recognized that because of charter requirements and other reasons, it may be necessary to modify or supplement certain requirements. The final authority for acceptance of all materials covered in these Specifications is the agency involved and will be so noted on the Construction Plans or Project Contract Documents.

The Standard Specifications for Public Works Construction is available online at www rtcwashoe com utilizing the Street and Highway link.

It shall be the sole responsibility of all users of this document to remain current with the latest edition, including any addenda.

100.01 ABBREVIATIONS AND TERMS.

Whenever the following abbreviations or terms, or pronouns in place of them, are used in this document⁽¹⁾ or in any documents or instruments where the Standard Specifications for Public Works Construction govern, the intent and meaning shall be defined⁽²⁾ as follows:

1. Abbreviations and terms will be capitalized and italicized when used as defined in Subsection 100.01 – “Abbreviations and Terms” in this document.
2. All publications defined and referenced herein, including, but not limited to, codes, guides, manuals, specifications and test methods, shall be interpreted to be the *Current* edition unless otherwise noted. The use of other editions shall only be directed or approved by the Engineer, shown on the Plans or specified in the Special Provisions and/or Special Technical Specifications.

100.01.01 ABBREVIATIONS.

| | | |
|--------|---|--|
| AAN | – | American Association of Nurserymen |
| AAP | - | AASHTO Accreditation Program |
| AAR | – | Association of American Railroads |
| AASHTO | – | American Association of State Highway and Transportation Officials |
| ABS | – | Acrylonitrile-Butadiene-Styrene |
| ACEC | - | American Consulting Engineers Council |
| ACI | – | American Concrete Institute |
| ACPA | - | American Concrete Pipe Association |
| ACPPA | - | American Concrete Pressure Pipe Association |
| ADA | - | Americans with Disabilities Act |
| AGC | – | Associated General Contractors of America |
| AIA | – | American Institute of Architects |
| AISC | – | American Institute of Steel Construction |
| AISI | – | American Iron and Steel Institute |
| AMRL | - | AASHTO Material Reference Laboratory |
| ANSI | – | American National Standards Institute |
| APWA | – | American Public Works Association |
| ARA | – | American Railway Association |
| AREMA | – | American Railway Engineering and Maintenance of Way Association |
| ASA | – | American Standards Association |
| ASCE | – | American Society of Civil Engineers |
| ASLA | – | American Society of Landscape Architects |
| ASME | – | American Society of Mechanical Engineers |
| ASTM | – | American Society for Testing and Materials |
| ATPB | - | Asphalt Treated Permeable Base |

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| ATSSA | - | American Traffic Safety Services Association |
| AWG | - | American Wire Gauge |
| AWPA | - | American Wood Preservers Association |
| AWS | - | American Welding Society |
| AWWA | - | American Water Works Association |
| BMP | - | Best Management Practice |
| C | - | Carbon |
| °C | - | Degrees Celsius |
| CBR | - | California Bearing Ratio of Laboratory Compacted Soils |
| CCRL | - | Cement and Concrete Reference Laboratory |
| CE | - | Carbon Equivalency |
| CFR | - | Code of Federal Regulations |
| CHF | - | Cationic High Float |
| CI | - | Cast Iron |
| CIOD | - | Cast Iron Outside Diameter |
| CLSM | - | Controlled Low Strength Material |
| CM | - | Corrugated Metal |
| CMAR | - | Construction Manager at Risk |
| CMS | - | Cationic Medium Setting |
| Code | - | NFPA National Electric Code |
| CQS | - | Cationic Quick Setting |
| Cr | - | Chromium |
| CRS | - | Cationic Rapid Setting |
| CTB | - | Cement Treated Base |
| CTM | - | California Test Method (Published by the California Department of Transportation, Division of Engineering Services) |
| CSS | - | Cationic Slow Setting |
| Cu | - | Copper |
| CY | - | Cubic Yard(s) |
| DBE | - | Disadvantaged Business Enterprise |
| DI | - | Ductile Iron |
| EEI | - | Edison Electrical Institute |
| EIA | - | Electric Industries Association |

| | | |
|--------|---|---|
| EN | - | European Standard |
| EPA | - | Environmental Protection Agency |
| EPD | - | Environmental Product Declaration |
| EPDM | - | Ethylene Propylene Diene Monomer |
| ESAL | - | Equivalent Single Axle Load |
| °F | - | Degrees Fahrenheit |
| FAA | - | Federal Aviation Administration |
| FDIC | - | Federal Deposit Insurance Corporation |
| FHWA | - | Federal Highway Administration, Department of Transportation |
| FL | - | Flow Line |
| FRPM | - | Fiber Reinforced Polymer Mortar |
| FSS | - | Federal Specifications and Standards, General Services Administration |
| HDPE | - | High Density Polyethylene |
| Hg | - | Mercury |
| HMA | - | Hot Mix Asphalt |
| HRWR | - | High Range Water Reducers |
| IAPMO | - | International Association of Plumbing and Mechanical Officials |
| ICBO | - | International Conference of Building Officials |
| ICC-ES | - | International Code Council Evaluation Service |
| ID | - | Inside Diameter |
| IEEE | - | Institute of Electrical and Electronics Engineers |
| IESNA | - | Illumination Engineering Society of North America |
| IFAI | - | Industrial Fabrics Association International |
| IGGA | - | International Grooving and Grinding Association |
| IMSA | - | International Municipal Signal Association |
| IRI | - | International Roughness Index |
| ISA | - | International Society of Arboriculture |
| ISEA | - | International Safety Equipment Association |
| ISO | - | International Organization for Standardization |
| ISSA | - | International Slurry Surfacing Association |
| ISTT | - | International Society for Trenchless Technology |
| ITE | - | Institute of Traffic Engineers |

| | | |
|-------|---|--|
| ITS | - | Intelligent Transportation System |
| JAN | - | Joint Army/Navy Specifications, available from the IHS Global International Standards and Specifications Database |
| JMF | - | Job Mix Formula |
| KSI | - | Kips per Square Inch |
| LB(S) | - | Pound(s) |
| LF | - | Linear Feet |
| LLF | - | Light Loss Factor |
| LM | - | Latex Modified |
| LRFD | - | AASHTO Load and Resistance Factor Design |
| MC | - | Medium Curing |
| MIL | - | Military Specifications and Standards, prepared and/or adopted by the United States Government, Department of Defense, available from the IHS Global International Standards and Specifications Database |
| Mn | - | Manganese |
| Mo | - | Molybdenum |
| MM | - | Millimeter |
| MRI | - | Mean Roughness Index |
| MS | - | Medium Setting |
| MUTCD | - | Manual on Uniform Traffic Control Devices for Streets and Highways (Published by the Federal Highway Administration) |
| NAC | - | Nevada Administrative Code |
| NACE | - | National Association of Corrosion Engineers |
| NAQTC | - | Nevada Alliance for Quality Transportation Construction |
| NASTT | - | North American Society for Trenchless Technology |
| NCLS | - | Notched Constant Ligament Stress |
| NDCBU | - | Neighborhood Delivery Collection Box Unit |
| NDEP | - | Nevada Department of Environmental Protection |
| NDOT | - | Nevada Department of Transportation |
| NEMA | - | National Electrical Manufacturers Association |
| NEPA | - | National Environmental Policy Act |
| Nev. | - | Nevada Test Method (Published by NDOT, Materials Division) |
| NFPA | - | National Fire Protection Association |
| Ni | - | Nickel |

| | | |
|--------|---|---|
| NOI | - | Notice of Intent |
| NOT | - | Notice of Termination |
| NPCA | - | National Precast Concrete Association |
| NPDES | - | National Pollutant Discharge Elimination System |
| NRC | - | Non-Reinforced Concrete |
| NRMCA | - | National Ready Mix Concrete Association |
| NRS | - | Nevada Revised Statutes |
| NSF | - | NSF International: The Public Health and Safety Company |
| OD | - | Outside Diameter |
| OSHA | - | Occupational Safety and Health Administration |
| PCA | - | Portland Cement Association |
| PCC | - | Portland Cement Concrete |
| PCCP | - | Portland Cement Concrete Pavement |
| PCF | - | Pounds per Cubic Foot |
| PE | - | Polyethylene |
| PG | - | Performance Grade |
| PM | - | Polymer Modified |
| PP | - | Polypropylene |
| PROWAG | - | Public Rights-of-Way Accessibility Guidelines |
| PS | - | Pavement Sealant |
| PSF | - | Pounds per Square Foot |
| PSI | - | Pounds per Square Inch |
| PTOE | - | Professional Traffic Operations Engineer |
| PTI | - | Post Tensioning Institute |
| PVC | - | Poly Vinyl Chloride |
| RA | - | Recycling Agent |
| RAP | - | Reclaimed Asphalt Product |
| RC | - | Reinforced Concrete |
| RCC | - | Roller Compacted Concrete |
| REA | - | Rural Electrification Association |
| RFI | - | Request for Information |
| RRFB | - | Rectangular Rapid Flashing Beacon |

| | | |
|-------|---|--|
| RS | - | Rapid Setting |
| RTS | = | Rapid Traffic System |
| RUS | | Rural Utilities Service (formerly REA) |
| SAE | - | Society of Automotive Engineers |
| SC | - | Slow Curing |
| SCC | - | Self Consolidating Concrete |
| SCM | - | Supplemental Cementitious Materials |
| SDR | - | Standard Dimension Ratio |
| SDS | - | Safety Data Sheet (formerly MSDS) |
| SF | - | Square Foot/Feet |
| Si | - | Silicon |
| SI | - | International System of Units |
| SNCA | - | Sierra Nevada Concrete Association |
| SP | - | Structural Plate |
| SS | - | Slow Setting |
| SDS | - | Safety Data Sheet |
| SSD | - | Saturated Surface Dry |
| SSPC | - | Steel Structures Painting Council |
| SWPPP | - | Storm Water Pollution Prevention Plan |
| T & G | - | Tongue and Groove |
| TCS | - | Traffic Control Supervisor |
| TR | - | Tire Rubber |
| UBC | - | <i>ICBO</i> Uniform Building Code |
| ULI | - | Underwriters Laboratories, Incorporated |
| UPC | - | <i>IAPMO</i> Uniform Plumbing Code |
| USA | - | Underground Service Alert |
| USASI | - | United States of America Standards Institute |
| USPS | - | United States Postal Service |
| UV | - | Ultra-Violet |
| V | - | Vanadium |
| VC | - | Vitrified Clay |
| WMA | - | Warm Mix Asphalt |

100.01.02 TERMS.

Acceptance. The written notice indicating that a submittal, plan or element of the *Work* appears to comply with the *Contract Documents*. *Acceptance* shall not shift any risk to the *Agency* or *Engineer*, relieve the *Contractor* of obligation or liability; be construed as a waiver of any non-compliance or breach by the *Contractor*; nor be construed as a warranty that the *Contractor*'s methods will succeed or be the most efficient or economical.

Accredited Laboratory. A testing facility which, at the time of test performance, is actively AASHTO accredited in the applicable test methods or comparable *Agency* approved laboratory accreditation program.

Addendum. A notice provided prior to the opening of bids containing written or visual information which clarifies, corrects or changes the previously issued *Contract Documents*.

Advertisement. The public announcement as required by law, inviting bids for the *Work* to be performed or materials to be furnished.

Agency. The legal entity for which the *Work* is being performed.

Award. The *Acceptance* by the *Agency* of the *Bid Proposal*, including all approved alternates and options, initiating execution of a *Contract*.

Bedrock. The solid rock underlying loose weathered or deposited material.

Bid Bond. The security furnished with a *Bid Proposal* to guarantee that the *Bidder* will enter into the *Contract* if the *Bid Proposal* is accepted.

Bidder. An individual partnership, firm, corporation, or any acceptable combination thereof, or joint venture, submitting a *Bid Proposal* for the advertised *Work*.

Bid Item. An item of *Work* for which a price, either unit or lump sum, is provided.

Bid Item Clarification. The written description of the item of *Work* clarifying the method and unit of measurement.

Bid Proposal. The offer by a *Bidder*, on the approved prepared form, to perform the *Work* and to furnish the labor, materials, equipment, and incidentals at the price(s) quoted.

Blue Book. The Uniform Standard Specifications for Public Works Off-Site Improvements, Clark County Area, Nevada, available at www.rtcsnv.com.

Bole. The stem or trunk of a tree.

Business Day. A *Calendar Day*, excluding Saturday, Sunday and *Holidays*.

Calendar Day. Every day shown on the calendar, beginning and ending at midnight.

Certificate Of Compliance. A written document signed and submitted by a *Supplier* or manufacturer that certifies that the material or manufactured and/or fabricated product supplied conforms to the *Contract Documents*.

Certified Arborist. A professional arborist with a minimum of three years' full-time experience working in the professional tree care industry who has passed an *ISA* or comparable *Agency* approved examination covering all facets of arboriculture.

Change Order. A written order to the *Contractor*, executed by both parties to the *Contract*, which covers changes in the *Plans*, *Specifications* or quantities within the scope of the *Contract*, and establishes the basis of payment and time adjustments for the *Work* affected by the changes.

Conflicting Provisions Order of Precedence. The hierarchy of *Contract Documents* used to resolve conflict or inconsistency between separate provisions of the *Contract Documents*. The person(s) detecting a conflict or inconsistency shall immediately bring the conflict or inconsistency to the attention of the *Engineer*. The *Engineer* shall resolve the conflict or inconsistency by applying the following in decreasing order of precedence:

- A. *Contract Documents*, except *Plans and Specifications*

1. *Contract and Change Order(s)*
2. *Instruction to Bidders*
3. *Addendum*
4. *Special Provisions*
5. *Supplemental General Provisions*
6. Section 100 – “General Provisions”

B. Plans and Specifications

1. *Addendum*
2. *Special Technical Specifications*
3. *Plans*
4. *Technical Report(s)*
5. *Standard Specifications and Details*

Any inconsistencies detected between permit requirements and the remaining *Contract Documents* shall be resolved prior to applying the order of precedence.

Construction Activity (Activities). An item of *Work* performed by the *Contractor* or *Subcontractor* at the *Site of Work* with a requirement for compliance shown on the *Plans* or specified in the *Specifications*.

Contingency Item. An item with a quantity which represents no actual estimate, is nominal only, and may be greatly increased or decreased or reduced to zero. The increase or reduction of this quantity, as compared with that set forth in the *Contract Documents* shall not constitute a basis for claim by the *Contractor* for extra payment or changed conditions. The *Engineer*, however, may negotiate a change in unit cost, should the value of the item meet the criteria for a *Major Item*.

Contract. The written and executed, legally binding agreement between the *Agency* and the *Contractor* including, but not limited to, the *Work*, *Contract Amount* and *Contract Time*.

Contract Amount. The estimated *Contract* cost computed on the basis of the *Bid Proposal* quantities and unit prices, including the *Force Account*, if any.

Contract Documents. The formal compilation of documents setting forth the obligations of the parties therein including, but not limited to, the *Work* and the basis of payment.

The *Contract Documents* consist of written and/or visual material including, but not limited to, the *Notice to Contractors*, *Instruction to Bidders*, *Bid Proposal*, *Contract*, *Bid Bonds*, *Supplemental General Provisions*, *Special Provisions*, *Specifications*, *Bid Item Clarifications*, *Technical Report(s)*, general and detailed *Plans*, any *Addendum* issued during the bid process, *Notice to Proceed*, permits and any *Change Orders* and *Supplemental Agreements* that are required for the *Work*, including authorized extensions and basis of payment thereof, all of which constitute one instrument.

Contract Time. The number of *Working Days* allowed for completion of the *Contract*, including authorized time extensions. In case a *Calendar Date* of completion is shown in the *Contract Documents* in lieu of the number of working or calendar days, the *Work* shall be completed by that date.

Contractor. The individual, partnership, firm, corporation or any acceptable combination thereof, including joint venture, licensed pursuant to the provisions of NRS Chapter 624 and ordinances of the *Agency*, bound by their legal representative's signature on the *Contract* to execute the *Work* under the terms of the *Contract*.

Current. In effect as of the date of *Advertisement* of the *Work*, unless otherwise specified..

Day. One *Calendar Day*.

Emergency. A situation or occurrence posing an immediate risk to health, life, property, or environment that happens unexpectedly and demands immediate action.

Employee. Any person working on the project mentioned in the *Contract* who is under the direction and control of, or receives compensation from, the *Contractor* or *Subcontractor(s)*.

Engineer. The Design Engineer, or other person designated by the *Agency*, acting either directly or through authorized agents.

Engineer of Record. The *Professional Engineer* representing the *Agency*, *Owner* or firm retained by the *Agency* or *Owner* to provide final written documentation that the improvements conform to the *Plans* and *Specifications*.

Engineer, Professional. The individual licensed in the applicable discipline by the *State* in accordance with NRS Chapter 625.

Excavation. As defined by OSHA, any man-made cut, cavity, *Trench* or depression in the earth's surface formed by earth removal.

Extra Work. An item of work not provided for in the *Contract*.

Force Account. The amount included in the *Contract Amount* for work ordered by the *Agency/Owner* and performed with the understanding that the *Contractor* will be compensated by the *Agency/Owner* according to the cost of labor, materials, equipment and incidentals, plus a certain percentage for overhead and profit.

Foundation. The lowest load bearing part of a structure.

Greenbook. The Standard Specifications for Public Works Construction by Public Works Standards, Inc.

Holiday. A formally designated *Day* on which no work shall be performed unless otherwise directed or approved by the *Agency* and shall not be considered a *Working Day*. In the *State*, these occur on:

| | |
|-----------------------------|-------------------------------|
| January 1 | – New Year's Day |
| Third Monday in January | – Martin Luther King, Jr. Day |
| Third Monday in February | – Presidents Day |
| Last Monday in May | – Memorial Day |
| July 4 | – Independence Day |
| First Monday in September | – Labor Day |
| Last Friday in October | – Nevada Day |
| November 11 | – Veteran's Day |
| Fourth Thursday in November | – Thanksgiving Day |
| Day after Thanksgiving | – Family Day |
| December 25 | – Christmas Day |

or on any day that may be appointed by the President of the United States or by the *State* Governor for public fast, thanksgiving or as a legal holiday. If January 1, July 4, November 11, or December 25 falls upon a Sunday, the Monday following shall be observed as a holiday. If January 1, July 4, November 11, or December 25 falls upon a Saturday, the Friday preceding shall be observed as a holiday.

Inspector. An authorized representative of the *Engineer* assigned to make any or all inspections of the work performed and materials furnished by the *Contractor*.

Instruction To Bidders. The detailed instructions describing the *Bid Proposal*, *Award* and *Contract* execution requirements and process.

Lane Foot. The pavement area in square feet divided by 12 feet.

Major Item. Any *Bid Item* having a value of 50,000 dollars or 10 percent of the *Contract Amount*, whichever is less.

Night Time Hours. From one-half hour after sunset to one-half hour before sunrise at the *Site of Work* location. The times shall be obtained at www.calendar-updates.com based on the zip code of the *Site of Work*.

Notice of Award. The written notice from the *Agency* to the successful *Bidder* stating that, upon compliance with the required conditions, the *Agency* will execute a *Contract* with the successful *Bidder*.

Notice of Intent To Award. The written notice from the *Agency* to unsuccessful *Bidders* stating the intent to *Award* to the successful *Bidder*.

Notice To Contractors. The official notice inviting *Bid Proposals* for the proposed *Work*, which includes the means of obtaining the *Contract Documents*.

Notice To Proceed. The written notice from the *Agency* to the *Contractor* to proceed with the *Work* including, when applicable, the date of commencement of *Contract Time*.

Orange Book. This document.

Owner. The title holder of real property.

Performance Bond and Labor And Material Bond. The approved securities furnished by the *Contractor* to guarantee the completion of the *Work* in accordance with the terms of the *Contract* and to guarantee payment for labor and materials purchased by the *Contractor*.

Plans. The visual description or reproductions thereof of the location and characteristics of the *Work* to be done.

Precast. The production of a structural member, especially utilizing *PCC*, which has been cast into form in a reusable form and in a controlled environment before being transported to site of installation.

Quality Assurance. The process of oversight and informational testing provided by the *Agency/Owner* or their designated representative in accordance with *Contract Documents*.

Quality Control. The process of oversight and testing implemented by the *Contractor* to ensure product compliance with *Plans* and *Specifications*.

Rice Relative Compaction. The in-place compaction calculated as a percentage of the *Theoretical Maximum (Rice) Specific Gravity*.

Rock Fill. Fill material containing, by volume, over 30 percent of rock larger than 3/4 inch in greatest dimension.

Scaling. The peeling, popping-out and flaking off of a *PCC* surface.

Silver Book. The Standard Specifications for Road and Bridge Construction, available at www.nevadadot.com.

Site of Work. The physical location(s) where *Construction Activities* are performed, including material sources provided by the *Agency/Owner* and construction staging areas outside the *Work Zone*. Permanent home offices, batch plant establishments, fabrication plants, tool yards or other similar locations of a commercial *Supplier* whose locations and continuance in operation are not dependent on the project and/or were established prior to the submittal of the *Bid Proposal* for the project are not included as the site of work.

Spalling. The peeling, popping-out and flaking off of *PCC* at the joint

Special Provisions. The additions and modifications to the *Standard Specifications* covering conditions specific to an individual project.

Special Technical Specifications. The minute description of directions and requirements for construction not shown on *Plans* including, but not limited to, additions and modifications to the *Standard Specifications*, specific to an individual project.

Specifications. The combined *Special Technical Specifications* and *Standard Specifications*.

Standard Details. The Washoe County Standard Details for Public Works Construction.

Standard Plans. The Standard Plans for Road and Bridge Construction, available at www.nevadadot.com.

Standard Specifications. The general directions, provisions and requirements for construction contained in this document.

Whenever a Section or Subsection is referenced within this document without an associated specification, the intent shall also be interpreted to reference this document.

State. The State of Nevada.

Subcontractor. Any person or entity, licensed pursuant to the provisions of NRS Chapter 624 and ordinances of the *Agency* and not an *Employee* of the *Contractor*, which has a contract with the *Contractor* to perform some portion of the *Work*. Persons providing delivery of materials from a non-specific source that is not in the *Site of Work* and who do not provide performance of *Construction Activities* are not included as subcontractors.

Subgrade. The exposed native or improved soil surface on which a composite section or *Trench* bedding material is placed or upon which the foundation of a structure is built.

Substantial Completion. The completion of the *Work* to the point at which the *Site of Work* can be safely and effectively used by the public without delay, disruption or other impediments.

Superintendent. The *Contractor*'s designated representative who is:

- A. In responsible charge of the work; and
- B. Present on the *Site of Work* at all times during *Construction Activities*.

Supplemental Agreement. A written order to the *Contractor*, executed by both parties to the *Contract*, which covers *Extra Work* not within the scope of the *Contract* and establishes the basis of payment and time adjustments for the *Extra Work*.

Supplemental General Provisions. The additions and modifications to the *Standard Specifications* covering conditions specific to an *Agency*.

Supplier. A person or entity that provides and/or delivers equipment, materials or other goods to the *Contractor* or *Subcontractor* and does not perform the related *Construction Activity* within the *Site of Work*.

Surety. The Corporation, Partnership, or individual, other than the *Contractor*, authorized to conduct business in the *State*, executing a bond furnished by the *Contractor*.

Theoretical Maximum (Rice) Specific Gravity. The specific gravity determined in accordance with ASTM D2041.

Trench. As defined by OSHA, a narrow underground *Excavation* that is deeper than it is wide, and no wider than 15 feet.

Uncontrolled Fill. Any material placed above the native surface that cannot be documented by a *Professional Engineer* to have been placed in controlled compacted lifts in accordance with Section 304 – “Fill, Backfill, Bedding and Riprap” and with inspection and testing in accordance with Section 336 – “Inspection and Testing”.

Work. The execution of the duties and obligations imposed by the *Contract*.

Working Day. A *Day* on which weather and other conditions not under the control of the *Contractor* will permit *Construction Activities* to proceed for at least 5 hours with the normal working force engaged in performing the controlling item(s) of work which would be in progress at that time, exclusive, however, of Saturdays, Sundays, *Holidays*, and any day that is incumbent upon the *Contractor*, by means of a labor union, to observe as a holiday. However, if the *Contractor* elects to work on such days, those days will be considered as a working day.

Work Zone. The area within the project limits as designated on the *Plans*.

100.02 SUBMITTING BID PROPOSALS. *Bid Proposals* to receive consideration shall be submitted in accordance with the *Notice to Contractors*. *Bid Proposals* shall be correctly addressed and delivered in an opaque envelope which is securely sealed. The outside of the envelope shall be plainly marked with the following information:

- A. Project Name;
- B. Contractor's name;
- C. The words "Sealed Bid"; and
- D. The date and time to be opened.

100.03 ORAL OR TELEGRAPHIC BID PROPOSALS OR MODIFICATIONS. Oral or telegraphic *Bid Proposals* or modifications shall not be accepted.

100.04 FORM AND CONTENT OF BID PROPOSALS. *Bid Proposals* to receive consideration shall be made in accordance with the following instructions:

100.04.01 FORM. *Bid Proposals* shall be made upon the separate form provided therefor. All items on the form shall be completed. Dollar amounts shall be stated in figures and the signature of all persons signing shall be in writing. The completed form shall be legible. Interlineations, erasures or alterations shall be acknowledged by the initials of the person making said change.

100.04.02 SUBCONTRACTORS. Each *Bidder* shall submit with the *Bid Proposal*, on the form provided, the name and address of each *Subcontractor* and the portion of the *Work* which each *Subcontractor* will perform. If the *Contractor* fails to name the *Subcontractors* in the *Bid Proposal*, the *Contractor* shall be deemed to have agreed not to subcontract said portion of *Work* without previous permission of the *Engineer*.

100.04.03 SECURITY. *Bid Proposals* shall be accompanied by an unconditional security which is:

- A. In an amount not less than 5 percent of the aggregate of the *Bid Proposal*;
- B. By *Bid Bond* which is written by a *Surety* authorized to do business in the *State* or by certified check which is issued by a bank insured by the *FDIC*; and
- C. Payable to the order of the *Agency*.

Said check or bond shall be a guarantee that the *Bidder*, if awarded the *Work*, will execute the *Contract* within 20 *Calendar Days* after receiving the *Notice of Award*. In case of refusal or failure to enter into said *Contract*, said check or bond shall be forfeited to the *Agency*, the proceeds therefrom being hereby agreed upon as liquidated damages to the said *Agency* on account of the delay in the execution of the *Contract* and required bonds and the performance of the work thereunder, and the necessity of accepting a higher or less desirable *Bid Proposal* resulting from such failure or refusal to execute the *Contract* and bonds as required.

Upon the execution of the *Contract* and the approval on behalf of the *Agency* of the accompanying bonds, upon request by the *Bidder*(s) all checks or bonds that accompanied *Bid Proposals* and that have not theretofore been returned, will be returned each to its maker.

100.05 BIDDER INTERESTED IN MORE THAN ONE BID PROPOSAL. No *Contractor* shall be allowed to prepare or submit, or be interested in, more than one *Bid Proposal* for the same *Work*, unless alternative proposals are invited. A *Subcontractor* or *Supplier* can provide subproposals to multiple *Bidders*.

100.06 EXAMINATION OF CONTRACT DOCUMENTS AND SITE OF WORK.

100.06.01 EXAMINATION OF CONTRACT DOCUMENTS AND SITE OF WORK. Each *Bidder* shall visit the *Site of Work* and become fully acquainted with conditions so that the *Bidder* may fully understand the facilities, difficulties, and restrictions relating to the *Work*. *Bidder* shall thoroughly examine and be familiar with the *Contract Documents*. The failure of any *Bidder* to receive or examine any form, instrument, *Addendum* or other document or to visit the *Site of Work* and become acquainted with conditions there existing, shall, in no way, relieve the *Bidder* of their obligations with respect to the *Bid Proposal* or to the *Contract*.

100.06.01.01 Material Quantities. Material quantities contained in the *Contract Documents* should be considered as approximate only.

100.06.02 TECHNICAL REPORTS. Technical reports are presented for the guidance of *Bidders*. The *Bidder*'s interpretation of the information contained in these reports is the sole responsibility of the *Bidder*.

100.06.02.01 Report of Geotechnical Investigation. The data presented is based on isolated locations which were investigated. Presentation of subsurface information does not constitute a guarantee of uniform subsurface conditions.

100.06.03 INTERPRETATIONS OF CONTRACT DOCUMENTS. Should a *Bidder* find inconsistency in, or omissions from, the *Contract Documents*, or be in doubt as to their meaning, the *Bidder* shall immediately notify the *Engineer* and, should it be found that the point in question is not clearly and fully set forth, an *Addendum* will be issued. The *Engineer* shall not issue any oral instructions.

100.06.04 SECTION COMPLIANCE. The submission of a *Bid Proposal* shall be taken as *prima facie* evidence of compliance with this section.

100.07 ACKNOWLEDGEMENT OF ADDENDUM. An acknowledged copy of any *Addendum* shall be submitted with the *Bid Proposal*.

100.08 WITHDRAWAL OF BID PROPOSALS. *Bid Proposals* may be withdrawn by the *Bidder*.

100.09 OPENING AND COMPARISON OF BID PROPOSALS. *Bid Proposals* will be publicly opened immediately following the time indicated for submittal in the *Notice to Contractors*. *Contractors*, their authorized representatives, and other interested parties are invited to be present.

100.09.01 REJECTION OF BID PROPOSALS. The *Agency* reserves the right to reject any or all *Bid Proposals*. A *Bid Proposal* may be rejected if the unit prices contained in the proposal are obviously unbalanced, either in excess or below the reasonable cost analysis.

The *Agency* reserves the right to waive requirements relating to minor irregularities in the bid form when it is deemed to be in the best interests of the *Agency* to do so.

100.10 AWARD OF CONTRACT. The competency and responsibility of *Bidder*, as evidenced by the information accompanying the *Bid Proposals*, which will be subject to verification, will be considered in making the *Award*. If the *Award* is made, the *Agency* will *Award* the *Contract* to the lowest responsive and responsible *Bidder* or *Bidder* complying the *Instructions to Bidders* within 30 *Calendar Days* after the opening of *Bid Proposals*.

Before any *Contract* is awarded, the *Bidder* may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the the *Work*, together with samples, if required by the *Contract Documents* to determine their quality and fitness for the work.

100.10.01 NOTICE OF INTENT TO AWARD. The *Agency* shall notify the unsucessful *Bidders* by issuing a *Notice of Intent to Award*. The *Notice of Intent to Award* may be hand delivered or sent by mail to the address given in the *Bid Proposal*.

100.10.02 PROTEST PROVISIONS. Any *Bidder* who protests the *Award* for any reason shall file a "Notice of Protest" with the *Agency* within 5 *Business Days* after the *Agency* issues the *Notice of Intent to Award*. The procedure shall be in accordance with *NRS 338.142*.

100.11 CONTRACT. The *Bidder* to whom *Award* is made shall execute a written *Contract* with the *Agency* within 20 *Calendar Days* after the date on which the *Contract* is awarded. The *Contract* shall be made in the form adopted by the *Agency*. A corporation to which an *Award* is made may be required, before the *Contract* is finally executed, to furnish evidence of its corporate existence and evidence that the officer signing the *Contract* and bonds for the corporation is duly authorized so to do.

If the *Bidder* to whom *Award* is made fails to execute the *Contract* as herein provided, the *Award* shall be annulled and an *Award* may be made to the next lowest responsive and responsible *Bidder*, and such *Bidder* shall perform the *Work* as if the next lowest *Bidder* were the party to whom the first *Award* was made.

The *Contractor* shall not assign, transfer, convey or otherwise dispose of the *Contract*, or the right, title or interest therein, or the power to execute such *Contract*, to any other individual, partnership, firm, corporation, or any combination thereof, including joint venture, without previous consent in writing of the *Agency*.

100.11.01 SUBCONTRACTS. If any part of the *Work* is subcontracted, the subcontract shall be in writing and shall provide that all work to be performed thereunder shall be performed in accordance with the terms of the general contract. The *Engineer* may request certified copies of any or all subcontracts be provided for their

review to assure compliance with the subcontract conditions. The subcontracting of any of the work to be done shall, in no way, relieve the *Contractor* of their responsibility under the *Contract*.

The *Bidder* to whom *Award* is made, shall not subcontract more than 50 percent of the total *Contract Amount*.

100.12 SUBCONTRACTORS. *Subcontractors* shall be subject to the provisions of the *Contract*.

The *Contractor* shall report in writing to the *Agency* the name and address of each *Subcontractor* within 5 *Calendar Days* after *Award* of *Contract*.

The *Contractor* shall report in writing to the *State Labor Commissioner* and to the *Agency* the name and address of each *Subcontractor* within 10 *Calendar Days* after the *Subcontractor(s)* have commenced work.

100.13 CONTRACT SECURITY. The successful *Bidder* shall, at the time of signing the *Contract*, furnish the following listed bonds of a *Surety* satisfactory to the *Agency*. The bonds shall be made payable to the *Agency*.

100.13.01 PERFORMANCE BOND. A bond in an amount equal to 100 percent of the full amount of the *Contract*, as surety for the faithful performance of the *Contract*, and for the fulfillment of such other requirements as may be provided by law shall be required. The faithful performance bond shall remain in effect for 1 year after final payment has been accepted by the *Contractor*.

100.13.02 LABOR AND MATERIAL BOND. A bond in an amount equal to 100 percent of the full amount of the *Contract* as surety for the payment of materials and labor costs for which the *Contractor* is obligated, will be required.

100.14 INSURANCE. The *Contractor* shall not commence any work nor permit any *Subcontractor* to commence work on a project until satisfactory proof has been presented to the *Agency* that all insurance requirements as outlined below have been met.

100.14.01 LIABILITY INSURANCE. The *Contractor* shall provide and maintain during the effective life of the *Contract*, Comprehensive General Liability Insurance covering the *Contractor* and the *Agency*. Proof of insurance coverage required shall be by separate policy or Certificate of Comprehensive or commercial general liability insurance furnished to the *Agency* by the *Contractor* within 10 *Calendar Days* of *Notice of Award*.

Notwithstanding any inconsistent statement in the policy or any subsequent endorsement attached thereto, the *Agency* shall be the insured or named as an additional insured covering all operations of the *Contractor*, whether liability is attributable to the *Contractor* or the *Agency*. The general liability policy shall provide protection from claims set forth below:

- A. Products/Completed Operations;
- B. Blanket Contractual;
- C. Independent Contractors;
- D. Broad Form Property Damage;
- E. Personal Injury; and
- F. Automobile Liability.

The policy shall provide the following minimum limits of coverage:

- A. Bodily Injury & Property Damage: 1,000,000 dollars C.S.L. each occurrence; AND
- B. If the policy contains an "Annual Aggregate" or "Policy Aggregate," the minimum aggregate amount shall be 2,000,000.00 dollars.

All liability insurance policies shall bear an endorsement or shall have attached a rider whereby it is provided that, in the event of nonrenewal of such policies for any reason whatsoever, the *Agency* shall be notified by registered mail not less than 30 *Calendar Days* before expiration or cancellation is effective. This policy is the primary policy with respect to the additional insured, and any insurance held by the additional insured shall be secondary or excess. The *Contractor* shall provide insurance at no additional cost to the *Agency*.

Nothing herein contained shall be construed as limiting in any way the extent to which the *Contractor* may be held responsible for payment of damages to persons or property resulting from *Contractor's* operations or the operations of any *Subcontractors*.

100.14.02 INDUSTRIAL INSURANCE. The *Contractor* shall comply with *NRS Chapters 616 and 617*, and within 10 *Calendar Days* of *Notice of Award*, the *Contractor* shall submit written evidence that the *Contractor*

has obtained for the period of the *Contract* full worker's compensation insurance coverage for all *Employees* (as defined in *NRS Chapter 617*) in carrying out the work under this *Contract*. If the *Contractor* fails to make any payment for workers compensation insurance, the *Agency* shall make such payment and subtract the payment amount from any compensation owed to the *Contractor*.

100.14.03 ACCIDENT PREVENTION. The *Contractor* shall at all times exercise reasonable precautions for the safety of *Employees* involved with the *Project* and all other persons at the *Site of Work* and shall comply with all applicable provisions of Federal, *State*, and local safety laws, ordinances, rules, regulations and building and construction codes including providing certificates prepared by the Employers Insurance Company of Nevada (formerly S.I.I.S.) or other insurer that shows compliance with *NRS Sections 616B.627 and 617.210*.

100.14.04 INDEMNITY. The *Contractor* shall indemnify, hold harmless and defend (assuming any and all costs) the *Agency*, *Owner*, and *Engineer*, including their elected officials, officers, employees, and agents from all losses and all claims, demands, payments, suits, actions, recoveries and judgments of every nature and description brought or recovered against the *Contractor* or the *Agency* by reason of any act, omission, or negligence of the said *Contractor*, *Contractor's* agents or *Employees*, in the execution of the *Work* or in the protection of it.

100.15 PATENTS AND PATENT INFRINGEMENTS. All fees or claims for any patented invention, article, arrangement or process that may be used upon or in any manner connected with the *Work* or any part thereof shall be included in the price bid, and the *Contractor* and the *Contractor's* *Sureties* shall protect and hold the *Agency*, together with all of its officers, agents, and employees, harmless against any and all demands made for such fees or claims, against any and all suits and claims brought or made by the holder of any invention or patent, or growing out of an alleged infringement of any invention or patent, and before final payment is made on account of the *Contract*, the *Contractor* shall furnish acceptable proof to the *Agency* of a proper release from such fees or claims.

100.16 COMPLIANCE WITH LAWS, ORDINANCES AND REGULATIONS. The *Contractor* shall conduct the work in compliance with all existing Federal, *State* and municipal laws, ordinances and regulations limiting or controlling the work in any manner.

100.16.01 LABOR DISCRIMINATION. No discrimination shall be made in the employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation and selection for training, including apprenticeship of persons on public works projects because of race, color, creed, national origin or sex, as provided pursuant to *NRS Section 338.125*.

100.16.02 PREFERENTIAL EMPLOYMENT. Pursuant to *NRS 338.130*, in all cases where persons are employed in the construction of public works, preference must be given, the qualifications of the applicants being equal, first to persons who have been honorably discharged from the Army, Navy, Air Force, Marine Corps or Coast Guard of the United States, a reserve component thereof or the National Guard; and are citizens of the *State*, and second to other citizens of the *State*. Any failure or refusal to comply with any of the provisions of this Subsection renders the *Contract* void.

100.16.03 PREVAILING WAGE. All workers employed by the *Contractor* shall be paid a minimum wage at a rate not less than the prevailing wage for the area as determined by the *State* Labor Commissioner pursuant to provisions of *NRS Chapter 338*.

The *Contractor* shall post prevailing wage schedules at the *Site of Work* on a weather proof bulletin board or similar display panel at a location approved by the *Engineer*.

100.16.04 CERTIFIED PAYROLL. The *Contractor* and *Subcontractor(s)* shall submit certified payrolls to the *Agency* for all *Employees* on a weekly basis.

100.17 SCHEDULING OF WORK. After being awarded the *Contract*, the *Contractor* shall prepare and provide to the *Engineer* for review a baseline schedule showing the order in which the *Contractor* proposes to carry out the work within the *Contract Time* and showing the beginning times and completion times for the salient features of the work provided in the *Contract*. The schedule shall outline in sufficient detail the proposed operations, the interrelations of the various operations, and the order of performance so that the progress of the work can be evaluated accurately at any time during the performance of the *Contract*. The schedule shall reflect activity durations in a *Working Day* time frame and the schedule shall not reflect winter shutdown or free time.

In addition to the baseline schedule, the *Contractor* shall provide a detailed weekly work agenda and monthly updates to the baseline schedule.

100.18 COMMENCEMENT OF WORK. The *Contractor* shall commence the *Work* after the *Contract* is fully executed and shall complete the *Work* within the time set forth in the *Contract Documents*.

The *Contractor* shall not commence the *Work*, nor incur any expense in connection therewith, before receiving the *Notice to Proceed* with the *Work*.

The *Contractor* shall give the *Engineer* written notice not less than 2 *Working Days* in advance of the actual date on which the *Work* will be started. The *Contractor* shall be entirely responsible for any delay which may be caused by failure to give such notice.

100.19 PERMITS AND LICENSES. The *Contractor* shall procure and pay for all necessary permits and licenses prior to commencement of work. Cost for obtaining and renewing the permits and licenses shall be included in other items of work, at no additional cost to the *Agency/Owner*. The *Contractor* shall comply with permit requirements, in addition to all applicable Federal, State or local laws and regulations in the performance of the *Work*, and to pay any fines for non-compliance, at no additional cost to the *Agency/Owner*.

100.19.01 STORM WATER POLLUTION PREVENTION. The *Contractor* shall secure coverage under the *NPDES* General Permit and provide for the day-to-day operational control of activities that are necessary to ensure compliance with the requirements for erosion control due to storm water and construction related runoff from construction sites as established under *NRS* and *NAC 445A*.

This work shall include, but is not limited to, filing the *NOI* and the *NOT*; and development and implementation of the *SWPPP*, including furnishing materials; constructing; and maintaining permanent and temporary sediment control measures for the duration of construction activities.

The *SWPPP* shall include *BMP* descriptions and site-specific diagrams indicating proposed locations of erosion control devices. This plan shall include provisions for installation; maintenance, removal, and disposing of erosion control devices and provide for a means of recording all inspections and maintenance actions. A copy of the *NOI*, *SWPPP*, inspection and maintenance records shall be posted at the construction site with other project records and shall be available for public inspection.

100.20 UTILITY SERVICES. The *Contractor* shall procure and pay for utility services required for the *Work* at no additional cost to the *Agency/Owner*. All temporary connections for electricity shall be subject to the approval of the *Engineer*. In the event electricity is made available by the *Agency*, the *Contractor* shall, at no additional cost to the *Agency/Owner*, install a meter to determine the amount of current and such electricity shall be paid by the *Contractor*.

If the *Contractor* desires to use water from fire hydrants during construction, permission for the use of hydrants shall be obtained from the proper *Agency* or owner/operator. The *Contractor* shall use said hydrants in accordance with rules established by the *Agency* for use of fire hydrants. In the event permission is secured to use fire hydrants, the *Contractor* shall install flow control valves on the hydrants to control flow. The hydrant valve shall be either fully open or fully closed to prevent discharge from the drain port which can occur when the valve is in a partial open position. All tank trucks shall have free flow piping into the top of the tank and an air gap suitable to the *Agency* on the fill apparatus to prevent contamination of the water distribution system.

100.21 LOCATION OF WORK. The *Work* is to be installed on property owned by, or rights-of-way obtained by the *Agency*. Limits of rights-of-way are shown on the *Plans*. Where construction easements are indicated, the *Contractor* may use the full width of the construction easement for *Construction Activities* or for storage of material. The use of construction easements is subject to the *Special Provisions*.

Any property outside the limits of easements or right-of-way provided by the *Agency*, that the *Contractor* may require or desire to use, must be acquired by the *Contractor* with no additional cost to the *Agency/Owner*. Should the *Contractor* conclude negotiations for temporary use of private property for access to the *Work Zone*, for storage of material or vehicles, or for other purposes related to the construction operations, the terms of such use shall be specifically detailed in a written agreement between the *Contractor* and the *Owner* of the temporary use private property. Copies of said agreement will, upon request, be furnished to the *Agency/Owner* and the *Agency/Owner* shall be specifically exempted in the agreement from any liability incurred from the use of said private property. Prior to final *Acceptance*, the *Contractor* shall furnish written evidence acceptable to the *Engineer* that the terms of the authorization between the *Contractor* and the *Owner* of the temporary use private property have been satisfied.

Unauthorized work outside the *Work Zone* shall not be measured or compensated for. Unauthorized work outside the *Work Zone* may be ordered removed at no additional cost to the *Agency/Owner*.

100.22 RIGHT-OF-ENTRY. The *Contractor* shall not deny right-of-entry onto the *Work Zone* to the *Agency/Owner*, *Engineer*, Federal, State and local jurisdiction representatives, or representatives of utility companies which utilize public right-of-way.

100.23 SUPERVISION. The *Contractor* shall have a thoroughly experienced and qualified *Superintendent* on the project at all times who shall be in direct charge of the work and readily available for consultation with the *Engineer*. Failure to do so may be just cause for the suspension of operations until a qualified *Superintendent* is assigned to the project.

Directions given to the *Superintendent* shall be deemed given to the *Contractor*.

If, at any time, the *Superintendent* proves to be unsatisfactory to the *Engineer*, the *Contractor* shall provide a different acceptable *Superintendent* within 24 hours of receipt of a written request from the *Engineer* to replace the *Superintendent*.

100.24 SANITATION. The *Contractor* shall comply with provisions of Federal, State, and local regulations as relates to sanitation and shall provide sanitary facilities for use of employees.

100.25 PROTECTION OF PERSON AND PROPERTY AND MAINTENANCE OF SERVICES. The *Contractor* shall protect persons and property within the *Work Zone* and maintain normal neighborhood services. The *Contractor* shall be responsible for all damages to persons and property caused by the *Contractor's* operations.

100.25.01 SAFETY. The *Contractor* shall be responsible at all times to exercise reasonable precaution for the safety of the employees involved in the *Construction Activities* and all other persons at the *Site of Work* and within the *Work Zone*.

The *Contractor* shall assume a rightful leadership role and take primary responsibility to establish, coordinate, monitor, manage the overall basic safety program content and structure, and incorporate any special safety rules for unique hazards related to the *Construction Activities*. The *Contractor* shall conduct job-specific hazard assessments and provide safety training, supervision, and personal protective gear for *Employees*. The *Contractor* shall maintain all equipment in a safe operating condition. In addition, the *Contractor* shall comply with all applicable codes and guidelines.

100.25.02 MAINTENANCE OF TRAFFIC. The *Contractor* shall keep road(s) open to all traffic unless otherwise provided for in the *Contract Documents*, during both active construction and temporary suspension periods.

100.25.03 REFUSE COLLECTION. The *Contractor's* operations shall not cause an interruption to refuse collection.

100.25.04 USPS DELIVERY SERVICE. The *Contractor's* operations shall not cause an interruption in *USPS* delivery service.

100.25.05 FENCES. The *Contractor's* operations shall not cause a security breach.

100.25.06 LANDSCAPING. The *Contractor* shall not remove landscaping without authorization of the *Engineer*. The *Contractor* shall comply with all permitting requirements with regard to removal of trees or shrubs. The *Contractor* shall contact the Urban Forester or appropriate authority prior to removing trees and shrubs.

100.26 UTILITIES. The *Contractor* shall contact *USA* at 1-(800) 227-2600 or other appropriate location service, at least 2 *Working Days* prior to start of construction for utility locations. In case it shall be necessary to remove or relocate any telephone, telegraph or electric power transmission poles, gas pipes, water pipes, electrical conduits or underground structures of any character, or any portion thereof, the *Agency* will have arranged with the *Utility* or *Owner* of said facilities for the removal or relocation of conflicting utilities prior to awarding the *Contract*. The *Contractor* shall not interfere with said facilities until the time agreed to for the relocation of said utilities.

In the event that the *Contractor* damages a utility service of any kind, whether inadvertently or intentionally, the *Contractor* shall immediately notify owner of the impacted utility. The *Contractor* shall repair, or arrange to have repaired, the damaged utility, at no cost to the *Agency/Owner*.

In the event that the utility service is unknown or inaccurately marked, the *Contractor* shall submit a request for an increase to the *Contract Amount* in accordance with Subsection 100.36.01 – "Change Orders".

100.27 EXPLOSIVES. When the use of explosives is necessary for the *Work*, the *Contractor* or *Subcontractor* shall be properly licensed and comply with the requirements of OSHA and all applicable codes and regulations. The *Contractor* shall submit to the *Engineer* a work plan for use of explosives, including but not limited to:

- A. Type of explosive;
- B. Site preparation;
- C. Transport and storage of explosives;
- D. Means of detonation; and
- E. Protection of persons and property.

The *Contractor* shall submit all applicable permits with the plan.

The *Contractor* shall ensure that the work plan has been reviewed and accepted by the *Engineer* prior to proceeding with the related Construction Activity.

The *Contractor* shall be held responsible for and required to make restitution, at no additional cost to the *Agency/Owner*, for all damage to persons or property caused by carelessness or neglect on the part of the *Contractor* or *Subcontractor* or the agent, or employees of either, during the progress of the *Work* and until its final *Acceptance*.

100.28 PLANS AND SPECIFICATIONS. The *Contractor* shall keep a copy of the *Plans* and *Specifications* within the *Work Zone* and shall at all times give the *Engineer* access thereto.

The *Engineer* will furnish from time to time such detailed *Plans*, profiles, and information as the *Engineer* may consider necessary for the *Contractor*'s guidance, not otherwise provided in the *Contract Documents*.

Upon written request by the *Agency*, the *Contractor* shall provide as built *Plans* prior to release of retention. The *Agency* may require these plans to be prepared by *Professional Engineer*.

100.29 ENGINEER'S AUTHORITY. The *Engineer* shall decide all questions which arise as to the quality and acceptability of materials furnished, work performed, manner of performance, rates of progress, interpretation of the *Plans* and *Specifications* and acceptable fulfillment of the *Contract*. The *Engineer* shall determine the amount and quality of work performed and materials furnished. The *Engineer*'s estimate shall be "condition precedent" to the right of the *Contractor* to receive money due the *Contractor* under the *Contract*. The *Engineer* may at any time during the progress of the work order *Extra Work* or material not covered by the *Specifications* and determine the value of the *Extra Work* in accordance with Subsection 100.36.01 – "Change Orders". The *Engineer* does not have authority to authorize changes in the *Plans* and *Specifications*, *Change Orders* or *Supplemental Agreements* without prior written approval of the *Agency*.

100.30 INSPECTION AND TESTING. The *Engineer* or designated representative shall inspect and test in accordance with Section 336 – "Inspection and Testing" to provide final written documentation that the improvements conform to the *Plans* and *Specifications*.

All samples requested by the *Engineer* shall be provided by the *Contractor* at no additional cost to the *Agency/Owner*. Sampling and testing may be waived by the *Engineer*.

The *Contractor* shall become fully acquainted with Section 336 – "Inspection and Testing". The *Contractor* shall not perform work nor use materials used without inspection and testing by the *Engineer* or the designated representative. The *Contractor* shall notify the *Engineer* at least 24 hours in of commencement of any *Construction Activity* which requires inspection, at least 48 hours in advance of transport of any material which requires testing and at least 24 hours in advance of completion of any item which requires testing. Unless approved by the *Engineer*, any work done or materials used without inspection and testing, due to the lack of notification by the *Contractor*, shall be removed and replaced at no additional cost to the *Agency/Owner*. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered and such failure shall not obligate the *Engineer* to make final *Acceptance*.

Should the *Engineer* fail to respond to the notification, with approval of the *Agency*, the *Contractor* may elect to secure inspection and testing by an independent *Accredited Laboratory* in order to proceed with the *Work*. The results of these services shall be accepted by the *Engineer* for use in determining the acceptability of the work. The *Contractor* shall be entitled to compensation for the cost of the services.

The *Contractor* shall be responsible for any inspection or testing expenses associated with unacceptable work or materials. The *Agency* reserves the right to deduct these additional costs from money due or which may become due to the *Contractor*.

100.31 MATERIALS. Unless otherwise specified or approved by the *Engineer*, all materials shall be new and must be of the specified quality and equal to approved samples if samples have been submitted.

100.31.01 CERTIFICATE OF COMPLIANCE. The *Contractor* shall submit to the *Engineer* a *Certificate of Compliance* for each material and manufactured and/or fabricated product for which the *Specifications* require that such a certificate be furnished. Unless otherwise specified, the *Contractor* shall submit the certificate at least 30 *Calendar Days* prior to providing the material or product for *Acceptance* by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 14 *Calendar Days* of the submittal. The *Contractor* shall ensure that the certificate has been reviewed and accepted by the *Engineer* prior to transport. Unless approved by the *Engineer*, materials used without acceptance of the certificate by the *Engineer* shall be removed and replaced at no additional cost to the *Agency/Owner*.

All tests associated with the certificate shall be performed by an *Accredited Laboratory* as defined in Subsection 100.01.02 – “Terms”. Unless otherwise specified, the date of each test performance shall be no more than 365 *Calendar Days* prior to the acceptance of the material or product.

100.31.01.01 Required Information. Unless waived by the *Engineer*, the certificate shall include, or have attached, the following information:

- A. The project name;
- B. The legal name, address, and phone number of the material supplier or product manufacturer and/or fabricator;
- C. A description of the material or product;
- D. The specifications being affirmed;
- E. An affirmation that the material or product conforms in all respects to the cited specifications;
- F. The date of the affirmation; and
- G. The name, title, and signature of the individual responsible for the affirmation.

When requested by the *Engineer*, the *Contractor* shall furnish a complete written statement of the origin, compositions and manufacture of any or all materials that are to be used in the work.

100.31.01.02 SDS. A *SDS* shall be available for all applicable materials.

100.31.02 USE OF OTHER MATERIALS. Unless otherwise directed or accepted by the *Engineer*, the *Contractor* shall not use materials and/or installations other than those shown on the *Plans* or specified in the *Specifications*.

100.31.02.01 Materials Specified by Trade Names. Whenever any article or any class of materials is specified by a trade name or by the name of any particular patentee, manufacturer or dealer, it shall be mutually understood to mean and specify the article or class of materials described, or any other equal thereto in quality, finish and durability, and equally as serviceable for the purpose for which it is intended, subject to *Acceptance* of the *Engineer*. If the *Contractor* requests permission to use alternate equipment or materials and its use is permitted, such use will be conditional on the *Contractor* assuming all responsibility to provide any changes to the *Plans* and/or *Specifications* necessary to accommodate the particular equipment or material desired for use at no additional cost to the *Agency/Owner*. The *Contractor* shall, within 10 *Calendar Days* following the *Notice to Proceed*, submit for *Acceptance* a complete list of all materials, articles or equipment which are proposed for substitution as the equal, of materials, articles or equipment which are specified by trade names or by the names of any particular patentee, manufacturer or dealer. Failure to submit such list within that time shall be deemed adequate and reasonable ground for refusal by the *Engineer* to consider any subsequent proposed substitutions. Any items omitted from a duly submitted list may likewise be barred for subsequent consideration.

The *Contractor* shall provide all details of each proposed substitute needed by the *Engineer* to evaluate the substitution.

100.31.02.02 Acceptance. The *Acceptance* shall be in writing; shall state that the *Engineer* has found the proposed substitution to be acceptable; shall list any necessary modifications to the *Specifications*; and shall be stamped and signed by a *Professional Engineer*.

100.31.03 MATERIAL STORAGE. The *Contractor* shall safely and securely store materials and ensure the preservation of their quality. Stored materials shall be located to facilitate inspection.

100.31.04 MATERIAL DISPOSAL. The *Contractor* shall safely and lawfully dispose of unsuitable material, surplus materials and/or materials not designated for reuse at an offsite location.

100.32 SHOP DETAILS. When required by the *Contract Documents*, the *Contractor* shall submit at no additional cost to the *Agency/Owner*, shop details of all fabricated products, equipment, and other appurtenances for the *Engineer's* review and *Acceptance* before such items are manufactured or used on the *Work*. The *Acceptance* of shop details by the *Engineer* shall apply to general design only, and shall in no way relieve the *Contractor* from responsibility for errors or omissions contained therein. The time frames for submittal and required number of copies shall be as specified by the *Engineer*.

100.33 WORKERS, 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 workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any *Employee* of the *Contractor* or *Subcontractor* who, in the opinion of the *Engineer*, is intemperate or disorderly, shall, at the written request of the *Engineer*, be removed forthwith 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*. Should the *Contractor* fail to remove such person or persons as required above the *Engineer* may suspend the work by written notice until such orders are complied with.

When the *Contract* specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are accepted by the *Engineer*. If the *Contractor* desires to use methods or types of equipment other than those specified in the *Contract*, the *Contractor* 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 accepted, it will be on the condition that the *Contractor* will be fully responsible for producing work in conformity with *Contract Documents* at no additional cost to the *Agency/Owner*.

If, after trial use of the substituted methods or equipment, the *Engineer* determines that the work produced does not meet the requirements, 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.

100.34 BASE LINE, BENCH MARKS AND REFERENCE POINTS. Base line, bench marks, and reference points will be established by the *Engineer* sufficient to enable all construction work to be staked out. The *Contractor* shall preserve all such reference lines and points. The *Engineer* will replace lost or destroyed stakes at no additional cost to the *Agency/Owner*. The *Contractor* shall assume full responsibility for dimensions and elevations measured from construction stakes. In all questions arising as to proper location of lines and structures, the *Engineer's* decision will be final.

100.35 CHANGES. The *Agency/Owner* reserves the right to make modifications by addition to, or exclusion from, the *Contract*, *Plans* and/or *Specifications*. Such changes shall in no way have an effect on or make void other portions of the *Contract*. The difference in cost of the work affected by a change will be added to or deducted from the *Contract Amount* by execution of a *Change Order*.

The *Contractor* may submit an *RFI* on any portion of the *Work*. Except under *Emergency* or other extraordinary circumstances, the *Contractor* shall submit the *RFI* in writing to the *Engineer* a minimum of 14 *Calendar Days* prior to the date the information is needed. The *Engineer* shall provide a written response within a maximum of 7 *Calendar Days* of receipt of the request and, if a change is required, initiate a *Change Order* in accordance with this section. Any *Work* that is the subject of an *RFI* performed by the *Contractor* prior to the *Engineer's* written response, shall be at the *Contractor's* sole risk.

The *Contractor* may submit a value engineering proposal in accordance with Subsection 105.19 – “Value Engineering Proposals” of the *Silver Book*. The *Engineer* shall provide a written response within a maximum of 7 *Calendar Days* of receipt of the request and, if accepted, initiate a *Change Order*, in accordance with this section. Any *Work* that is the subject of value engineering proposal performed by the *Contractor* prior to the *Engineer's* written response, shall be at the *Contractor's* sole risk.

100.35.01 CHANGE ORDER. When the change results in increasing or decreasing the original *Contract Amount* of a *Major Item* as calculated from the bid quantities by more than 25 percent in accordance with Subection 100.37 – “Increased or Decreased Quantities”, or if no unit price has been established in the *Contract*, a *Change Order*, acceptable to both parties to the *Contract*, shall be executed. The *Change Order* shall contain fair and reasonable prices, determined in one or more of the following ways:

- A. By the estimate and *Acceptance* of a lump sum price or unit price.
- B. By cost and percentage.
- C. By cost plus a fixed fee.

If none of the above methods are agreed upon, the *Contractor*, provided an order has been received to make said change, shall proceed with the work on a time and materials basis in accordance with Subsection 100.24.01 – “Time and Materials”. In such case and also under cases B and C above, the *Contractor* shall keep and present in such form as the *Engineer* may direct, a record of the correct amount of the net cost of time, labor, equipment, and materials, together with vouchers.

100.35.01.01 Time And Materials. Unless otherwise provided for in the *Special Provisions*, when payment is to be made on a time and materials basis, the *Contractor* shall be compensated as described below, which includes an agreed upon percentage for overhead and profit. The payment of the agreed upon percentage shall be considered full compensation to the *Contractor* for overhead and profit on the work, including all premiums paid on any insurance of any nature which the *Contractor* may be required, or elects, to carry; and any premiums paid on faithful performance and labor and material bonds, whether required for, or in addition to, the original *Contract*.

100.35.01.01.01 Payment. Work specified and performed on a time and materials basis shall be paid for as follows:

100.35.01.01.01.01 Equipment. The *Contractor* will be paid for any machinery or special equipment (other than small tools), which has been authorized by the *Engineer* for use, at a rate no higher than the rental rates applicable to, and listed for, such equipment in the Rental Rate Blue Book for Construction Equipment, regardless of ownership and any rental, or other agreement, entered into by the *Contractor*. If it is deemed necessary by the *Engineer* to use equipment not listed in this publication, a suitable rental rate for such equipment will be established by the *Engineer*. The *Contractor* may furnish any cost data that might assist the *Engineer* in establishment of such rental rate.

The *Contractor*'s compensation for equipment will be calculated based on the amount of documented time that the equipment is in operation, on standby, and in transport related to the *Extra Work*. Payment will be calculated based on the documented time at the appropriate rate for each activity plus an agreed upon increase up to 15 percent of these costs for overhead and profit. If rental equipment is used intermittently and, when not in use, could be returned to its source at less expense to the *Agency* than holding it at the work site, it shall be returned, unless the *Contractor* elects to retain it at the work site at no additional cost to the *Agency/Owner*.

The rental rates paid as provided above shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, and all incidentals.

100.35.01.01.01.02 Labor. The *Contractor* will be paid the cost of the labor classifications at the time of the work for the type of work (including superintendent when authorized by the *Engineer* used in the actual and direct performance of the work. The cost of labor, whether the employer is the *Contractor*, *Subcontractor*, or other forces, will be the sum of the following:

- A. Actual Wages Plus Vacation Pay - The actual wages paid, plus vacation pay, which shall not include any employer payments to, or on behalf of, workers for health and welfare, pension, and similar purposes.
- B. Labor Surcharge -
 - (i) Labor Surcharge: A labor surcharge in the percentage specified by Subsection 109.03(a)2. – “Labor Surcharge” of the *Silver Book* shall be calculated from the actual wages plus vacation pay amount as defined above. This surcharge shall constitute full compensation for all payments imposed by State and Federal laws.
 - (ii) Union Fringe Benefits: All other payments made to, or on behalf of, the workers, as required by collective bargaining agreements will be calculated from the actual wages plus vacation pay amount as defined above.

C. Subsistence and Travel Allowance - Subsistence and travel allowance paid to such workers as required by collective bargaining agreements.

To the sum of the direct costs computed from Subsections A, B and C above, a markup in the percentage specified by Subsection 109.03(a) – “Labor” of the *Silver Book* will be added to calculate the total labor costs.

100.35.01.01.01.03 Subcontractors. Whenever there is a need to perform originally unanticipated work for which the *Contractor* is not properly equipped, the *Contractor* may, upon approval of the *Engineer*, have the work performed by a *Subcontractor* who is proficient in the type of work to be performed. The value of the *Subcontractor*’s work shall be determined in accordance with the methods described for the *Contractor*. The *Contractor* will be compensated for the value of the *Subcontractor*’s work plus a markup in the percentage specified by Subsection 109.03(d) for the *Contractor*’s administrative costs and profit.

When a *Subcontractor* performs work paid for on a time and materials basis, the *Contractor* shall reach agreement with said *Subcontractor* as to the distribution of the payment made for such work. No additional payment will be made by reason of the performance of the work by a *Subcontractor*.

100.35.01.01.01.04 Materials. For materials accepted by the *Engineer* and used for the work, the *Contractor* shall receive the actual cost of such material, plus the percentage specified in Subsection 109.03(b) – “Materials” of the *Silver Book* for overhead and profit. If actual costs are not available, the *Engineer* may establish the cost of an item to be the lowest price which was current at the time of the work. The *Agency* reserves the right to furnish such materials required as it deems expedient, and the *Contractor* shall have no claim for markup of such materials.

100.35.01.01.01.05 Supervision and Tools. No additional allowance shall be made for general supervision, the use of tools having a replacement value of 200.00 dollars or less or other costs for which no specified allowance is herein provided. .

100.35.01.01.01.06 Records. All work shall be recorded daily upon report sheets, furnished to the *Engineer* by the *Contractor* and signed by both parties, which daily reports shall thereafter be considered the true record of work performed. No work shall be performed or change be made except upon a written order from the *Engineer* pursuant to authorization by the *Engineer*, stating that the work or change is authorized, and no claim for an addition to the *Contract Amount* shall be valid unless so ordered.

100.35.01.01.01.06.01 Labor. No payment will be made for labor performed on the work until the *Contractor* furnishes, to the *Engineer*, certified copies of payrolls covering that period when the work was performed.

The certified payrolls shall indicate name, classification, dates, daily hours, and hourly rate for each worker.

100.35.01.01.01.06.02 Equipment, Subcontractors and Materials. Copies of pay vouchers to all vendors for equipment (including transportation charges), subcontracted services, and materials shall be submitted with the *Contractor*’s request for payment. The *Engineer* may request actual invoices if further documentation is required. If materials used on the work are not specifically purchased for such work, but are taken from the *Contractor*’s stock, then in lieu of pay vouchers, an affidavit shall be furnished certifying that such materials were taken from the *Contractor*’s stock, that the quantity claimed was actually used and that the price and transportation claimed represent the actual cost to the *Contractor*.

100.36 INCREASED OR DECREASED QUANTITIES. The *Agency* reserves the right to increase or decrease the quantity of any item of work as given in the *Contract Documents*. Payment for such items shall be at the unit price bid when the revised quantity results in a net increase or decrease of 25 percent or less of the original *Bid Item* quantity for any *Major Item*. In the event the revised quantity results in a net increase or decrease of more than 25 percent of the original *Bid Item* quantity for any *Major Item* a change to the *Contract Amount* shall be determined and a *Change Order* shall be executed in accordance with Subsection 100.35 – “Changes”.

100.37 EXTRA WORK. The *Agency* reserves the right to at any time during the progress of the *Work*, without notice to the sureties on the *Contractor*’s bonds, order *Extra Work* or material not covered by the *Contract Documents*.

The *Contractor* shall perform *Extra Work* and furnish such materials and equipment as may be required, but the *Contractor* shall do no *Extra Work* except upon written order from the *Engineer*. In the absence of such written order the *Contractor* shall not be entitled to payment for extra work. For *Extra Work* a *Supplemental Agreement*, acceptable to both parties to the *Contract*, shall be executed. This *Supplemental Agreement* shall contain fair and reasonable prices, determined as provided for in Subsection 100.35.01 – “*Change Order*”.

100.38 CLIMATIC CONDITIONS. The *Engineer* may order the *Contractor* to stop work that may be subject to damage by climatic conditions.

100.39 DELAYS. The *Contractor* shall be entitled to an extension of *Contract Time* for a delay which is the result of a specific order of the *Engineer* to stop work, or by the performance of *Extra Work* ordered by the *Engineer*, or by the failure of the *Agency* to provide the necessary right-of-way or site for installation. The *Contractor* may be entitled to an extension of *Contract Time* and/or an increase to the *Contract Amount* due to causes beyond the control of the *Contractor*.

The *Contractor* shall submit any request for extension of time in writing to the *Engineer* within 5 *Working Days* from the first day of delay. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

An extension of time shall not release the *Sureties* from their obligations, which shall remain in full force until the discharge of the *Contract*.

100.40 EMERGENCIES. It is possible that *Emergencies* may arise during the progress of the *Work* which may require special treatment or make advisable extra shifts of workers to continue for 16, and even 24, hours per day. These *Emergencies* may be caused by damage or cause possible damage to the work and/or nearby existing structures, utilities and/or property. The *Contractor* shall be prepared to make all necessary repairs and shall promptly execute such work when required by the *Engineer*. In the case of *Emergencies* affecting the safety or protection of persons at the *Site of Work* or adjacent thereto, the *Contractor*, with or without special instruction or authorization from the *Engineer*, shall be act to prevent injury or loss.

The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

100.41 NIGHT WORK. The *Contractor* may be permitted to work at night if the *Agency* and *Engineer* are satisfied of the need in order to maintain the required progress or protect the work from the elements, and that noise impact and safety considerations have been addressed. If permitted to work at night, the *Contractor* shall provide lighting and all other necessary components.

The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Orders*”.

100.42 PROGRESS PAYMENTS. Progress payments shall be made for completed items of *Work*, including any authorized *Change Orders* and/or *Supplemental Agreements*, which have accepted by the *Engineer*. Quantities will be measured and agreed upon by the *Contractor* and *Inspector*. The method of measurement and unit price shall be as described in the *Contract Documents* and/or authorized *Change Orders* and/or *Supplemental Agreements*.

100.42.01 PARTIAL PAYMENT. Partial payment shall be made in accordance with *NRS Section 338*.

100.43 FINAL ACCEPTANCE AND PAYMENT. As soon as practical following completion of the work, the *Contractor* shall make a written request to the *Engineer* for final inspection and *Acceptance* of the work.

100.43.01 FINAL ACCEPTANCE. Upon receipt of written notice to the *Engineer* from the *Contractor* of presumptive completion of the *Work*, the *Engineer* will make an inspection to determine acceptability of same. The *Engineer* shall respond to the notice in accordance with the *Contract Documents* or as follows:

- A. If all work is in conformance with the *Contract Documents*, the *Engineer* will notify the *Contractor* in writing, which notice shall constitute final *Acceptance*.
- B. If the inspection discloses non-conforming work, the *Engineer* shall issue of written notice of non-conformance to the *Contractor*.

All work which has been determined to be non-conforming shall be mitigated, or removed and by the *Contractor* at no additional cost to the *Agency/Owner*. If, within a period of 10 *Calendar Days* after written notice of non-

conformance has been issued, the *Contractor* has not initiated the mitigation, the *Engineer* may, without further notice and without in any way impairing the *Contract*, make such other arrangements as the *Engineer* may deem necessary to have the work completed in a satisfactory manner. The cost of so completing the work shall be deducted from any monies due or which may become due to the *Contractor*.

Upon mitigation or removal and replacement of the non-conforming work, another inspection will be made which will constitute final *Acceptance* provided all work is in conformance with the *Contract Documents*. Corrective action shall continue until all work is in conformance with the *Contract Documents* at which time final *Acceptance* will occur.

The *Contractor* shall be responsible for cost of testing and inspecting the mitigation or removal and replacement of any non-conforming work. Such costs shall be deducted from any monies due or which may become due to the *Contractor*.

Any failure on the part of the *Engineer* to condemn defective work at the time of final *Acceptance* shall not relieve the *Contractor* of the obligation to guarantee the *Work* in accordance with Subsection 100.45 – “Guarantee of Work”.

At the option of the *Agency*, a *Notice of Completion* may be filed with the County Recorder upon final *Acceptance* of the project.

100.43.01 FINAL PAYMENT. Except with respect to payments withheld from a progress payment or retainage reasonably sufficient to pay the expenses *Agency* expects to incur as a result of the failure of the *Contractor* to comply with the *Contract*, applicable billing code, law or regulation, the final payment shall be paid within 30 *Calendar Days* of the occurrence of one or more of the conditions of *NRS Section 338.520*; or

- A. *Contractor* submits evidence satisfactory to *Agency* that all payrolls, bills for material, interest or retention and all other indebtedness connected with the work have been paid; or
- B. No claims, liens or outstanding debts have been filed against the work in response to any *Notice of Completion* which the *Agency* may file with the County Recorder. In the event any claims, liens, or outstanding debts are filed against the work, the parties agree that the *Agency* may continue to hold the retainage until such time as the claims, liens or outstanding debts are resolved.

100.44 PROTECTION OF WORK AND CLEANING UP. The *Contractor* shall be responsible for the care of all work during construction until its completion and final *Acceptance*. The *Contractor* shall replace damaged work or lost material at no additional cost to the *Agency/Owner*.

The *Contractor* shall remove from the site, trash, unused materials, *PCC* forms, sheeting or equipment, belonging to, or used under the *Contractor*'s direction during construction, and in the event of the *Contractor*'s failure to do so, the same may be removed by the *Agency* and the costs shall be deducted from any monies due or which may become due to the *Contractor*.

100.45 GUARANTEE OF WORK. The *Contractor* shall guarantee the work done under this *Contract* against unsatisfactory conditions due to defective equipment, materials or workmanship for a period of 365 *Days* from the date of the *Contractor*'s receipt of the final payment under the *Contract*. The *Contractor* shall repair or replace any work which is not in conformance with the *Contract Documents* and any defects discovered during the guarantee period at no additional cost to the *Agency/Owner*. Should the *Contractor* fail to repair such defects or to make replacement within 5 *Working Days* after written notice of non-conformance from the *Engineer*, the *Agency* may make such other arrangements as the *Engineer* may deem necessary to have the work completed in a satisfactory manner. The cost of so completing the work shall be deducted from any monies due or which may become due to the *Contractor*.

100.46 SUSPENSION OF WORK. The *Agency* reserves the right to suspend the whole or any part of the *Work* if deemed in its interest so to do, without further compensation to the *Contractor* for items not performed. No allowance by way of damages shall be made for any such suspension.

100.47 FAILURE TO PERFORM. In the event the *Contractor* fails to perform any provision of the *Contract*, the *Agency*, after 5 *Working Days* written notice to the *Contractor* may, without prejudice to any other remedy it may have, make good such deficiencies and deduct the cost from the money due or which may become due the *Contractor*.

100.48 FAILURE TO COMPLETE THE WORK IN THE TIME AGREED UPON. In the event the *Contractor* fails to complete the work or any part thereof in the time agreed upon in the *Contract*, the *Contractor* will be subject to the liquidated damages as provided in the *Contract Documents*.

100.49 DEFAULT AND TERMINATION OF CONTRACT. If the *Contractor*:

- A. Fails to begin the *Work* within the time specified in the *Notice to Proceed*; or
- B. Fails to perform the *Work* with sufficient workers 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. Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency; or
- G. Allows any final judgement to stand unsatisfied for a period of 5 *Calendar Days*; or
- H. Makes an assignment for the benefit of creditors; or
- I. For any other cause whatsoever, fails to carry on the *Work* in conformance with the *Contract Documents*, the *Engineer* will give notice in writing to the *Contractor* and the *Contractor's Surety* of such delay, neglect, or default.

If the *Contractor* or *Surety*, within a period of 10 *Working Days* after such notice, does not proceed in accordance therewith, the *Agency* or *Engineer* shall have full power and authority without violating the *Contract*, to take the prosecution of the work out of the hands of the *Contractor*. The *Agency* or *Engineer* may call upon the *Surety* to complete the work in accordance with the terms of the *Contract*, or the *Agency* or *Engineer* may take over the work, including any or all materials and equipment on the project as may be suitable and acceptable, and may complete the *Work* by *Force Account*, or may enter into a new agreement for the completion of said *Contract* according to the terms and provisions thereof, or use such other methods as, in the *Agency's* or *Engineer's* opinion, will be required for the completion of said *Contract* in an acceptable manner.

All costs and charges incurred by the *Agency/Owner* together with the cost of completing the work under the *Contract*, shall be deducted from the money due or which may become due the *Contractor*. In case the expense so incurred by the *Agency* shall be less than the sum which would have been payable under the *Contract* if it had been completed by said *Contractor*, then the *Contractor* shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the *Contract*, then the *Contractor* and the *Contractor's Surety* shall be liable and shall pay to the *Agency* the amount of said excess.

100.50 ARBITRATION. In the event any difference shall arise as to the right or obligation of both parties to the *Contract* which cannot be adjusted amicably between them, the same shall be submitted to a Board of Arbitrators composed of three competent and disinterested persons, one to be chosen by the *Agency/Owner*, one by the *Contractor*, and the third to be selected by the two arbitrators so chosen. Either party to the *Contract* may request that any dispute or difference be arbitrated by appointment of an arbitrator and notifying the other party as to the name of the arbitrator so appointed and requesting that said party appoint their own arbitrator within 10 *Calendar Days* after such notification.

Should the party so notified fail or refuse to appoint an arbitrator within the specified time, then the arbitrator who was first appointed shall alone determine and decide the dispute or difference. Except where one arbitrator alone is acting, a majority of the arbitrators shall constitute the necessary quorum to decide a dispute, and any decision rendered shall be binding and final upon both parties.

The cost of arbitration shall be paid by the party against whom such arbitrator or arbitrators render such decision.

200.01 AGGREGATES FOR BASE COURSES.

200.01.01 DESCRIPTION. This Subsection covers the quality and size of mineral materials used as base courses. PCC or asphalt concrete may be crushed or pulverized and mixed with virgin aggregate or used solely as aggregate base, provided the resulting material complies with the requirements of Subsection 200.01.03 for Type 1, Class A or Type 2, Class B Crushed Aggregate Base. Crushed or pulverized asphalt concrete, not meeting the requirements of Subsection 200.01.03, utilized at the direction of the *Agency* or *Engineer* as aggregate base, shall comply with the requirements of Subsection 200.01.04 for Type 1 or Type 2 Recycled Aggregate Base. If asphalt concrete is to be recycled on-site, it shall be pulverized by approved mechanical methods.

200.01.02 TEST SPECIMEN PREPARATION FOR LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS. Unless otherwise directed or approved by the *Engineer* test specimens for determination of the Liquid Limit, Plastic Limit and Plasticity Index shall be prepared in accordance with the Dry preparation method as described in 10.2 of ASTM D4318.

200.01.03 CRUSHED AGGREGATE BASE. Crushed aggregate base shall conform to the applicable requirements of Tables 200.01.03-I and 200.01.03-II.

TABLE 200.01.03-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|-----------------|
| | Type 1, Class A | Type 2, Class B |
| 2 inch | 100 | |
| 1-1/2 inch | 90 – 100 | |
| 1 inch | 80 – 90 | 100 |
| 3/4 inch | | 90 – 100 |
| No. 4 | 30 – 65 | 35 – 65 |
| No. 16 | 15 – 40 | 15 – 40 |
| No. 200 | 2 – 12 | 2 – 10 |

TABLE 200.01.03-II

| Test | Test Method | Requirements |
|-------------------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.01.03-I |
| Fractured Faces (%) | ASTM D5821 | 35 Minimum |
| Liquid Limit | ASTM D4318 ⁽¹⁾ | 35 Maximum |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 8 Maximum |
| Resistance (R) Value | ASTM D2844 | 70 Minimum |
| Resistance to Degradation (%) | ASTM C131 ⁽²⁾ | 45 Maximum |

1. Dry Method
2. 500 Revolutions

200.01.04 RECYCLED AGGREGATE BASE. Recycled aggregate base shall conform to the applicable requirements of Tables 200.01.04-I and 200.01.04-II.

TABLE 200.01.04-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|------------------------------|
| | Type 1 (Imported) | Type 2 (Recycled On-site) |
| 2 inch | 100 | 100 ⁽¹⁾ |
| ¾ inch | 70 – 100 | |
| No. 4 | 20 – 70 | |
| No. 200 | 0 – 12 | 0 – 12 |

1. Or as directed or approved by the Agency

TABLE 200.01.04-II

| Test | Test Method | Requirements |
|----------------------|--------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.01.04-I |
| Resistance (R) Value | ASTM D2844 | 70 Minimum |

200.01.05 CEMENT TREATED CRUSHED AGGREGATE BASE. Aggregate for cement treated crushed aggregate base shall conform to Subsection 200.01.01 – “Description” and the requirements of Subsection 200.01.03 - “Crushed Aggregate Base” for Type 2, Class B.

200.01.06 CEMENT TREATED RECYCLED AGGREGATE BASE. Aggregate for cement treated recycled aggregate base shall conform to the requirements of Subsection 200.01.04 - “Recycled Aggregate Base”.

200.01.07 SELECT NATURAL BASE. Select natural base shall conform to the applicable requirements of Tables 200.01.07-I and 200.01.07-II.

TABLE 200.01.07-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|------------------|
| | Type 1 (Coarse) | Type 2 (Fine) |
| 1-1/2 inch | 100 | |
| 1 inch | | 100 |
| No. 4 | 55 – 75 | 70 – 100 |
| No. 16 | 30 – 75 | 45 – 90 |
| No. 50 | 15 – 40 | 25 – 60 |
| No. 200 | 3 – 12 | 3 – 15 |

200.01.07 Select Natural Base (Continued)

TABLE 200.01.07-II

| Test | Test Method | Requirements |
|----------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.01.07-I |
| Liquid Limit | ASTM D4318 ⁽¹⁾ | 40 Maximum |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 8 Maximum |
| Resistance (R) Value | ASTM D2844 | 65 Minimum |

1. Dry Method

200.01.08 PIT RUN SUBBASE. Pit run subbase shall conform to the requirements of Tables 200.01.08-I and 200.01.08-II.

TABLE 200.01.08-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 4 inch | 100 |
| 2 inch | 60 – 100 |
| No. 4 | 30 – 60 |
| No.100 | 5 – 20 |
| No. 200 | 3 – 12 |

TABLE 200.01.08-II

| Test | Test Method | Requirements |
|----------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.01.08-I |
| Liquid Limit | ASTM D4318 ⁽¹⁾ | 40 Maximum |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 12 Maximum |
| Resistance (R) Value | ASTM D2844 | 45 Minimum |

1. Dry Method

200.01.09 STRUCTURAL FILL. This Subsection covers the minimum quality and size of mineral materials to be placed beneath buildings, PCC slabs, bituminous pavements and all other components subject to structural loading. Materials used for structural fill shall be free of debris and organic matter. The requirements of Tables 200.01.09-I and 200.01.09-II are intended as a guideline to specify a readily available, pre-qualified material. The *Contractor* shall submit alternate material, if proposed for use, to the *Engineer* for review and *Acceptance* prior to transporting.

200.01.09 Structural Fill (Continued)

TABLE 200.01.09-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 4 inch | 100 |
| 3/4 inch | 70 – 100 |
| No. 40 | 15 – 65 |
| No. 200 | 5 – 20 |

TABLE 200.01.09-II

| Test | Test Method | Requirements |
|----------------------|---------------------------|--------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Above |
| Liquid Limit | ASTM D4318 ⁽¹⁾ | 35 Maximum |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 12 Maximum |
| Resistance (R) Value | ASTM D2844 | 30 Minimum |

1. Dry Method

200.01.10 RECREATIONAL SURFACING AGGREGATE. This Subsection covers the quality and size of mineral materials for uses such as playgrounds, walking paths and parks. Recreational surfacing aggregate shall conform to the requirements of Tables 200.01.10-I and 200.01.10-II.

TABLE 200.01.10-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 3/8 inch | 100 |
| No. 4 | 80 – 100 |
| No. 8 | 55 – 90 |
| No. 16 | 40 – 75 |
| No. 30 | 25 – 50 |
| No. 50 | 15 – 35 |
| No. 100 | 10 – 25 |
| No. 200 | 5 – 20 |

200.01.10 Recreational Surfacing Aggregate (Continued)

TABLE 200.01.10-II

| Test | Test Method | Requirements |
|--------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.01.10-I |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 3 - 15 |

1. Dry Method

200.01.11 SHOULDER MATERIAL. This Subsection covers the quality and size of mineral materials for use in shoulder backing. Shoulder material shall conform to the applicable requirements of Tables 200.01.11-I and 200.01.11-II.

TABLE 200.01.11-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|-----------------------------------|
| | Type 1 | Type 2 (Recycled HMA Pavement) |
| 2 inch | 100 | |
| 1-1/2 Inch | | 100 |
| 1 inch | 75 - 100 | |
| 3/4 inch | 65 - 100 | 70 - 100 |
| No. 4 | 35 - 60 | 30 - 80 |
| No. 30 | 10 - 35 | |
| No. 200 | 5 - 15 | |

TABLE 200.01.10-II

| Test | Test Method | Requirements | |
|------------------------------------|---------------------------|--------------|-----------------------------------|
| | | Type 1 | Type 2 (Recycled HMA Pavement) |
| Sampling Aggregate | ASTM D75 | | - |
| Sieve Analysis | ASTM C136 and C117 | | Table 200.01.10-I |
| Fractured Faces ⁽¹⁾ (%) | ASTM D5821 | | |
| One Face | | 75 Minimum | - |
| Two Faces | | 50 Minimum | - |
| Sand Equivalent | ASTM D2419 | 10 - 35 | 10 Minimum |
| Durability | ASTM D3744 ⁽³⁾ | 25 Minimum | - |

1. Test shall be performed on material retained on the No. 4 sieve.

200.02 AGGREGATES FOR BITUMINOUS COURSES.

200.02.01 DESCRIPTION. This Subsection covers the quality and size of mineral materials used in bituminous courses.

200.02.01.01 RAP. The aggregate shall be the product of crushed, milled, or planed HMA pavement.

200.02.02 TEST SPECIMEN PREPARATION FOR LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS. Unless otherwise directed or approved by the *Engineer* test specimens for determination of the Liquid Limit, Plastic Limit and Plasticity Index shall be prepared in accordance with the Dry preparation method as described in 10.2 of ASTM D4318.

Unless otherwise directed or approved by the *Engineer*, the test specimens shall be obtained from the combined grading materials.

200.02.03 DENSE GRADE PLANTMIX AND ROADMIX AGGREGATE. Dense grade plantmix and roadmix aggregate shall conform to the applicable requirements of Tables 200.02.03-I and 200.02.03-II

TABLE 200.02.03-I

| Sieve Size | Percentage by Weight Passing Sieve | | | |
|------------|---------------------------------------|------------------------|---------|----------|
| | Type 2 | Type 2C ⁽¹⁾ | Type 3C | Type 3 |
| 1 inch | 100 | 100 | | |
| 3/4 inch | 90 – 100 | 88 – 95 | 100 | |
| 1/2 inch | | 70 – 85 | 90 - 99 | 100 |
| 3/8 inch | 63 – 85 | 60 – 78 | 70 – 90 | 85 – 100 |
| No. 4 | 45 – 65 | 43 – 60 | 48 – 65 | 50 – 75 |
| No. 10 | 30 – 44 | 30 – 44 | 32 – 50 | 32 – 52 |
| No. 16 | | | | |
| No. 40 | 12 – 22 | 12 – 22 | 12 - 26 | 12 – 26 |
| No. 200 | 3 – 8 | 3 – 8 | 3 – 8 | 3 – 8 |

1. Unless directed or approved by *Agency* or *Engineer*, Type 2C shall not be used as the final (top) lift of the structural section.

TABLE 200.02.03-II

| Test | Test Method | Requirements |
|-------------------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.02.03-I |
| Fractured Faces (%) | ASTM D5821 | |
| One Face | | 80 Minimum |
| Two Faces | | 50 Minimum |
| Liquid Limit | ASTM D4318 ⁽¹⁾ | 35 Maximum |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 6 Maximum |
| Resistance to Degradation (%) | ASTM C131 ⁽²⁾ | 37 Maximum |
| Soundness (% loss) | ASTM C88 ⁽³⁾ | |
| Coarse Aggregate | | 12 Maximum |
| Fine Aggregate | | 15 Maximum |
| Absorption (%) | ASTM C127 | |
| Coarse Aggregate | | 4 Maximum |

1. Dry Method
2. 500 Revolutions
3. 5 Cycles, Sodium Sulfate

200.02.04 OPEN GRADE AGGREGATE. Open grade aggregate shall conform to the applicable requirements of Tables 200.02.04-I and 200.01.04-II.

TABLE 200.02.04-I

| Sieve Size | Percentage by Weight Passing Sieve | | |
|------------|---------------------------------------|----------------------|----------------------|
| | ATPB ⁽¹⁾ | Type 1 (1/2 Inch) | Type 2 (3/8 Inch) |
| 1 inch | 100 | | |
| 3/4 inch | 90 - 100 | | |
| 1/2 inch | 35 - 65 | 100 | 100 |
| 3/8 inch | 20 - 45 | 90 - 100 | 95 - 100 |
| No. 4 | 0 - 10 | 35 - 55 | 40 - 65 |
| No. 16 | 0 - 5 | 5 - 18 | 12 - 22 |
| No. 200 | 0 - 2 | 0 - 4 | 0 - 5 |

1. Drainage Layer

TABLE 200.02.04-II

| Test | Test Method | Requirements |
|-------------------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.02.04-I |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 6 Maximum |
| Fractured Faces (%) | ASTM D5821 | 90 Minimum |
| Resistance to Degradation (%) | ASTM C131 ⁽²⁾ | 37 Maximum |
| Soundness (% loss) | ASTM C88 ⁽³⁾ | |
| Coarse Aggregate | | 12 Maximum |
| Fine Aggregate | | 15 Maximum |
| Absorption (%) | | |
| Coarse Aggregate | ASTM C127 | 4 Maximum |

1. Dry Method
2. 500 Revolutions
3. 5 Cycles, Sodium Sulfate

200.02.05 CHIP SEAL AGGREGATE. Chip seal aggregate shall conform to the applicable requirements of Tables 200.02.05-I and 200.02.05-II.

TABLE 200.02.05-I

| Sieve Size | Percentage by Weight Passing Sieve | | |
|------------|---------------------------------------|----------------------|--------------------------------|
| | Type 1 (1/2 Inch) | Type 2 (3/8 Inch) | Type 3 (3/8 Inch, Modified) |
| 1/2 inch | 100 | | |
| 3/8 inch | 90 – 100 | 100 | 100 |
| No. 4 | 15 – 35 | 20 – 45 | 95 – 100 |
| No. 8 | | | 30 – 40 |
| No. 16 | 0 – 4 | 0 – 6 | 4 – 10 |
| No. 30 | | | 0 – 5 |
| No. 50 | | | 0 – 4 |
| No. 100 | | | 0 – 3 |
| No. 200 | 0 – 2 | 0 – 2 | 0 – 2 |

TABLE 200.02.05-II

| Test | Test Method | Requirements |
|-------------------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.02.05-I |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | Non Plastic |
| Fractured Faces (%) | ASTM D5821 | 90 Minimum |
| Resistance to Degradation (%) | ASTM C131 ⁽²⁾ | 37 Maximum |
| Stripping Test | Nev. T209 | Satisfactory |

1. Dry Method
2. 500 Revolutions

200.02.06 SLURRY SEAL AND MICRO-SURFACING AGGREGATE. Slurry seal and micro-surfacing aggregate shall conform to the applicable requirements of Tables 200.02.06-I and 200.02.06-II.

TABLE 200.02.06-I

| Sieve Size | Percentage by Weight Passing Sieve | | | |
|------------|---------------------------------------|----------|---------|-----------------------|
| | Type 1 | Type 2 | Type 3 | Type 4 ⁽¹⁾ |
| 1/2 inch | | | | 100 |
| 3/8 inch | | 100 | 100 | 90 – 99 |
| No. 4 | 100 | 90 – 100 | 70 – 90 | 65 – 85 |
| No. 8 | 90 – 100 | 65 – 90 | 45 – 70 | 45 – 70 |
| No. 16 | 65 – 90 | 45 – 70 | 28 – 50 | 28 – 50 |
| No. 30 | 40 – 65 | 30 – 50 | 19 – 34 | 19 – 34 |
| No. 50 | 25 – 42 | 18 – 30 | 12 – 25 | 12 – 25 |
| No. 100 | 15 – 30 | 10 – 21 | 7 – 18 | 7 – 18 |
| No. 200 | 10 – 20 | 5 – 15 | 5 – 15 | 5 – 15 |

1. Unless otherwise directed or approved by the Engineer Type 4 shall be combined with an asphalt emulsion conforming to Micro with LMCQS in Table 201.04-III – “Specifications for Latex Modified Emulsion” and used for rut filling and as a scratch course only.

TABLE 200.02.06-II

| Test | Test Method | Requirements | | | |
|-------------------------------|---------------------------|-------------------|------------|------------|--------|
| | | Type 1 | Type 2 | Type 3 | Type 4 |
| Sampling Aggregate | ASTM D75 | - | | | |
| Sieve Analysis | ASTM C136 and C117 | Table 200.02.06-I | | | |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | Non-Plastic | | | |
| Resistance to Degradation (%) | ASTM C131 ⁽²⁾ | 30 Maximum | | | |
| Soundness (% loss) | ASTM C88 ⁽³⁾ | 10 Maximum | | | |
| Absorption | ASTM C128 | Provide Results | | | |
| Sand Equivalent | ASTM D2419 | 50 Minimum | 60 Minimum | 65 Minimum | |
| Durability Index | ASTM D3744 | 60 Minimum | 70 Minimum | | |

1. Dry Method

2. 500 Revolutions on gradation D

3. 5 Cycles, Sodium Sulfate

200.02.07 SAND SEAL AGGREGATE AND SAND BLOTTER. Sand seal and sand blotter aggregate shall conform to the applicable requirements of Tables 200.02.07-I and 200.02.07-II.

TABLE 200.02.07-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 1/2 inch | 100 |
| No. 4 | 90 – 100 |
| No. 16 | 30 – 75 |
| No. 200 | 0 – 12 |

TABLE 200.02.07-II

| Test | Test Method | Requirements |
|--------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.02.07-I |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | Non-Plastic |
| Organic Impurities | ASTM C40 | Less Than Plate 3 |

1. Dry Method

200.03 AGGREGATES FOR BEDDING AND BACKFILL.

200.03.01 DESCRIPTION. This Subsection covers the quality and size of mineral materials used in the bedding and backfilling of subsurface improvements.

200.03.02 CLASS A BACKFILL. Class A backfill shall conform to the requirements of Tables 200.03.02-I and 200.03.02-II.

TABLE 200.03.02-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 3/8 inch | 100 |
| No. 4 | 90 – 100 |
| No. 50 | 10 – 40 |
| No. 100 | 3 – 20 |
| No. 200 | 0 – 15 |

TABLE 200.03.02-II

| Test | Test Method | Requirements |
|--------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.03.02-I |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 6 Maximum |

1. Dry Method

200.03.03 CLASS B BACKFILL. Class B backfill shall conform to the requirements of Tables 200.03.03-I and 200.03.03-II.

TABLE 200.03.03-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 1/2 inch | 100 |
| No. 4 | 0 – 15 |
| No. 200 | 0 – 3 |

TABLE 200.03.03-II

| Test | Test Method | Requirements |
|-------------------------------|--------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.03.03-I |
| Resistance to Degradation (%) | ASTM C131 ⁽¹⁾ | 37 Maximum |

1. 500 Revolutions

200.03.04 CLASS C BACKFILL. Class C backfill shall conform to the requirements of Tables 200.03.04-I and 200.03.04-II. Class C backfill need not be washed but shall be free of any organic impurities, clay lumps, or unstable substances.

TABLE 200.03.04-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 1 inch | 100 |
| 3/4 inch | 90 – 100 |
| 3/8 inch | 10 – 55 |
| No. 4 | 0 – 10 |

TABLE 200.03.04-II

| Test | Test Method | Requirements |
|-------------------------------|--------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C 117 | Table 200.03.04-I |
| Resistance to Degradation (%) | ASTM C131 ⁽¹⁾ | 37 Maximum |

1. 500 Revolutions

200.03.05 CLASS D BACKFILL. Class D backfill shall conform to the requirements of Tables 200.03.05-I and 200.03.05-II. The material shall be free of any organic impurities, clay lumps or unstable substances.

TABLE 200.03.05-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 2 inch | 100 |
| 1-1/2 inch | 90 – 100 |
| 3/4 inch | 0 – 5 |

TABLE 200.03.05-II

| Test | Test Method | Requirements |
|-------------------------------|--------------------------|-----------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.03.05 |
| Resistance to Degradation (%) | ASTM C535 ⁽¹⁾ | 37 Maximum |

1. 500 Revolutions

200.03.06 CLASS E BACKFILL. Class E Backfill shall conform to the requirements of Tables 200.03.06-I and 200.03.06-II. The material shall be free of any organic matter.

TABLE 200.03.06-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 4 inch | 100 |
| 3/4 inch | 70 – 100 |
| No. 40 | 10 – 50 |
| No. 200 | 0 – 35 |

TABLE 200.03.06-II

| Test | Test Method | Requirements |
|--------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.03.06-I |
| Liquid Limit | ASTM D4318 ⁽¹⁾ | 40 Maximum |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | 12 Maximum |

1. Dry Method

200.03.07 SLURRY BACKFILL. Aggregates for slurry backfill shall conform to the requirements of Tables 200.03.07-I and 200.03.07-II. Mineral materials selected for slurry backfill shall be either commercial quality concrete sand, excavation material, approved imported material, or a combination thereof, which is free of clay, organic material and other deleterious substances.

TABLE 200.03.07-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 1-1/2 inch | 100 |
| 1 inch | 80 – 100 |
| 3/4 inch | 60 – 100 |
| 3/8 inch | 50 – 100 |
| No. 4 | 40 – 100 |
| No. 100 | 2 – 40 |
| No. 200 | 0 – 15 |

TABLE 200.03.07-II

| Test | Test Method | Requirements |
|--------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.03.07-I |
| Plasticity Index | ASTM D4318 ⁽¹⁾ | Non-Plastic |

1. Dry Method

200.04 AGGREGATES FOR MORTAR AND GROUT.

200.04.01 DESCRIPTION. This Subsection covers quality and size of aggregates used in mortar and grout.

200.04.02 MORTAR SAND. Mortar sand shall conform to the requirements of ASTM C144.

200.04.03 COARSE AND FINE AGGREGATE FOR GROUT. Coarse and Fine aggregate for grout shall conform to ASTM C404 specifications and the applicable requirements of Tables 200.04.03-I and 200.04.03-II. The Contractor may elect to utilize Size No. 8 or No.89.

TABLE 200.04.03-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|-------------|
| | Size No. 8 | Size No. 89 |
| 1/2 inch | 100 | 100 |
| 3/8 inch | 85 – 100 | 90 – 100 |
| No. 4 | 10 – 30 | 20 – 55 |
| No. 8 | 0 – 10 | 5 – 30 |
| No. 16 | 0 – 5 | 0 – 10 |
| No. 30 | | 0 – 5 |

TABLE 200.04.03-II

| Test | Test Method | Requirements |
|--------------------|-------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.04.03-I |
| Soundness (% loss) | ASTM C88 ⁽¹⁾ | |
| Coarse Aggregate | | 12 Maximum |

1. 5 Cycles, Sodium Sulfate

200.05 AGGREGATES FOR PCC FLATWORK, CURBS, DITCHES AND SLOPE PAVING AND STRUCTURES.

200.05.01 DESCRIPTION. This Subsection covers the quality and size of mineral materials for use in PCC flatwork, curbs, ditches and slope paving and structures.

200.05.02 QUALITY REQUIREMENTS. Aggregates for PCC shall conform to ASTM C33 for normal weight aggregate or ASTM C330 for lightweight aggregate.

200.05.03 COARSE AGGREGATES. Coarse aggregates for PCC shall conform to the applicable requirements of Tables 200.05.03-I and 200.05.03-II.

TABLE 200.05.03-I

| Sieve Size | Percentage Passing by Weight Passing Sieve | | | | |
|------------|--|----------------------------------|------------------------------|--------------------------------|-------------------------------|
| | Size No. 4 (1-1/2" to 3/4") | Size No. 467 (1 1/2" to No 4) | Size No. 57 (1" to No. 4) | Size No. 67 (3/4" to No. 4) | Size No. 7 (1/2" to No. 4) |
| 2 inch | 100 | 100 | | | |
| 1-1/2 inch | 90 – 100 | 95 – 100 | 100 | | |
| 1 inch | 20 – 55 | | 95 – 100 | 100 | |
| 3/4 inch | 0 – 15 | 35 – 70 | | 90 - 100 | 100 |
| 1/2 inch | | | 25 – 60 | | 90 – 100 |
| 3/8 inch | 0 – 5 | 10 - 30 | | 20 - 55 | 40 - 70 |
| No. 4 | | 0 - 5 | 0 – 10 | 0 - 10 | 0 - 15 |
| No. 8 | | | 0 – 5 | 0 - 5 | 0 - 5 |
| No. 200 | 0 – 1.0 | 0 – 1.0 | 0 – 1.0 | 0 – 1.0 | 0 – 1.0 |

Note: Size No. 467 shall be split into two sizes and furnished in individual stockpiles or bunkers of Size No. 4 and Size No. 67. The combined grading shall comply with the grading requirements of Size No. 467.

TABLE 200.05.03-I (Continued)

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|---------------------------------|
| | Size No. 8 (3/8" to No. 8) | Size No. 89 (3/8" to No. 16) |
| 2 inch | | |
| 1-1/2 inch | | |
| 1 inch | | |
| 3/4 inch | 100 | 100 |
| 3/8 inch | 85 – 100 | 90 – 100 |
| No. 4 | 10 – 30 | 20 – 55 |
| No. 8 | 0 – 10 | 5 – 30 |
| No. 16 | 0 – 5 | 0 – 10 |
| No. 30 | | 0 – 5 |
| No. 200 | 0 – 1.0 | 0 – 1.0 |

200.05.03 Coarse Aggregates (Continued)

TABLE 200.05.03-II

| Test | Test Method | Requirements |
|--------------------------------------|-----------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.05.03-I |
| Resistance to Degradation (%) | ASTM C131 ⁽¹⁾ | 50 Maximum |
| Soundness (% loss) | ASTM C88 ⁽²⁾ | 12 Maximum |
| OR | | |
| Soundness (% loss) | ASTM C88 ⁽³⁾ | 18 Maximum |
| Clay Lumps and Friable Particles (%) | ASTM C142 | 3 Maximum |
| Cleanliness Value | Nev. T228 | 75 Minimum |
| Potential Reactivity (% expansion) | AASHTO T 303 ⁽⁴⁾ | 0.10 Maximum |

1. 500 Revolutions
2. 5 Cycles, Sodium Sulfate
3. 5 Cycles, Magnesium Sulfate
4. Test shall be performed on a yearly basis. Test shall be performed on the aggregates, cementitious materials and admixtures from the proposed sources as shown in the mix design. The cementitious materials and mineral admixtures utilized in the test shall be proportioned at similar rates as the mix design. An individual test may be performed on each aggregate size separately and the results combined mathematically based on the mix design aggregate proportions. The coarse aggregate may be combined with the fine aggregate in similar proportions as the proposed mix design for test performance.

200.05.04 FINE AGGREGATES. Fine aggregates for PCC shall conform to the requirements of Tables 200.05.04-I and 200.05.04-II.

TABLE 200.05.04-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 3/8 inch | 100 |
| No. 4 | 95 – 100 |
| No. 8 | 80 – 100 |
| No. 16 | 50 – 85 |
| No. 30 | 25 – 60 |
| No. 50 | 5 – 30 |
| No. 100 | 0 – 10 |

TABLE 200.05.04-II

| Test | Test Method | Requirements |
|--|-----------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 | Table 200.05.04-I |
| Material Passing No. 200 Sieve (%) | ASTM C117 | |
| Concrete subject to abrasion and/or exposure | | 3.0 Maximum |
| All other concrete | | 5.0 Maximum |
| Soundness (% loss) | ASTM C88 ⁽¹⁾ | 10 Maximum |
| OR | | |
| Soundness (% loss) | ASTM C88 ⁽²⁾ | 15 Maximum |
| Clay Lumps and Friable Particles (%) | ASTM C142 | 3 Maximum |
| Fineness Modulus | ASTM C125 | 2.3 – 3.1 |
| Organic Impurities | ASTM C40 | Less Than Plate 3 |
| Sand Equivalent | ASTM D2419 | 71 Minimum |
| Potential Reactivity (% expansion) | AASHTO T 303 ⁽³⁾ | 0.10 Maximum |

1. 5 Cycles, Sodium Sulfate
2. 5 Cycles, Magnesium Sulfate
3. Test shall be performed on a yearly basis. Test shall be performed on the aggregates, cementitious materials and admixtures from the proposed sources as shown in the mix design. The cementitious materials and mineral admixtures utilized in the test shall be proportioned at similar rates as the mix design. An individual test may be performed on each aggregate size separately and the results combined mathematically based on the mix design aggregate proportions. The fine aggregate may be combined with the coarse aggregate in similar proportions as the proposed mix design for test performance.

200.06 AGGREGATES FOR SPECIFIC USES. This Subsection covers the quality and size of mineral materials for use in PCC for specific uses.

200.06.01 AGGREGATES FOR PCCP. Aggregates for PCCP shall be a blend of coarse and fine aggregates conforming to the applicable requirements of Tables 200.05.03-II and 200.05.04-II, proportioned to conform to the requirements of Tables 200.06.01-I and 200.06.01-II.

TABLE 200.06.01-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 2 inch | 100 |
| 1-1/2 inch | 90 – 100 |
| 1 inch | 50 – 86 |
| 3/4 inch | 45 – 75 |
| 3/8 inch | 38 – 55 |
| No. 4 | 30 – 45 |
| No. 8 | 23 – 38 |
| No. 16 | 15 – 33 |
| No. 30 | 8 – 22 |
| No. 50 | 4 – 13 |
| No. 100 | 1 – 5 |
| No. 200 | 0 – 3 |

TABLE 200.06.01-II

| Test | Test Method | Requirements |
|--------------------|--------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.05.05-I |

200.06.02 AGGREGATES FOR GUNITE. Aggregates used for gunite shall conform to the quality requirements of ASTM C33 or ASTM C330, as applicable, the combined grading requirements of ASTM C1436 and the grading requirements of Tables 200.06.02-I and 200.06.02-II.

TABLE 200.06.02-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|-----------------|
| | Gradation No. 1 | Gradation No. 2 |
| 1/2 inch | | 100 |
| 3/8 inch | 100 | 90 – 100 |
| No. 4 | 95 – 100 | 70 – 85 |
| No. 8 | 80 – 100 | 50 – 70 |
| No. 16 | 50 – 85 | 35 – 55 |
| No. 30 | 25 – 60 | 20 – 35 |
| No. 50 | 10 – 30 | 8 – 20 |
| No. 100 | 2 – 10 | 2 – 10 |

TABLE 200.06.02-II

| Test | Test Method | Requirements |
|--------------------|--------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.06.01-I |

200.06.03 AGGREGATES FOR SHOTCRETE. Aggregates used for shotcrete shall conform to the quality requirements of ASTM C33 and the grading requirements of Tables 200.06.03-I and 200.06.03-II.

TABLE 200.06.03-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|-----------------|
| | Gradation No. 1 | Gradation No. 2 |
| 1/2 inch | | 100 |
| 3/8 inch | 100 | 90 – 100 |
| No. 4 | 95 – 100 | 70 – 85 |
| No. 8 | 80 – 100 | 50 – 70 |
| No. 16 | 50 – 85 | 35 – 55 |
| No. 30 | 25 – 60 | 20 – 35 |
| No. 50 | 10 – 30 | 8 – 20 |
| No. 100 | 2 – 10 | 2 – 10 |

TABLE 200.06.03-II

| Test | Test Method | Requirements |
|--------------------|--------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.06.02-I |

200.06.04 LIGHTWEIGHT COARSE AGGREGATE. Lightweight coarse aggregates for PCC shall conform to ASTM C330 for lightweight aggregate and the applicable requirements of Tables 200.06.03-I and 200.06.03-II.

TABLE 200.06.04-I

| Sieve Size | Percentage Passing by Weight Passing Sieve | | | |
|------------|---|-----------------|-----------------|-------------------|
| | 1 Inch to No. 4 | ¾ Inch to No. 4 | ½ Inch to No. 4 | 3/8 Inch to No. 4 |
| 1 Inch | 95 – 100 | 100 | - | - |
| 3/4 Inch | - | 90 - 100 | 100 | - |
| 1/2 Inch | 25 – 60 | - | 90 – 100 | 100 |
| 3/8 Inch | - | 10 - 50 | 40 – 80 | 80 – 100 |
| No. 4 | 0 – 10 | 0 - 15 | 0 – 20 | 5 – 40 |
| No. 8 | - | - | 0 – 10 | 0 – 20 |
| No. 16 | - | - | - | 0 – 10 |
| No. 200 | 0 - 10 | 0 - 10 | 0 - 10 | 0 – 10 |

TABLE 200.06.04-I (Continued)

| Sieve Size | Coarse and Fine Combined Grading Percentage by Weight Passing Sieve | |
|------------|---|----------------------------------|
| | Size No. 8 (1/2" to No. 200) | Size No. 89 (3/8" to No. 200) |
| 1 Inch | - | - |
| 3/4 Inch | 100 | - |
| 1/2 Inch | 95 – 100 | 100 |
| 3/8 Inch | - | 90 – 100 |
| No. 4 | 50 – 80 | 65 – 90 |
| No. 8 | - | 35 – 65 |
| No. 16 | - | - |
| No. 30 | - | - |
| No. 50 | 5 – 20 | 10 – 25 |
| No. 100 | 2 – 15 | 5 - 15 |
| No. 200 | 0 – 10 | 0 – 10 |

200.06.04 Lightweight Coarse Aggregate (Continued)

TABLE 200.06.04-II

| Test | Test Method | Requirements |
|--------------------------------------|-----------------------------|---|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.06.03-I |
| Organic Impurities | ASTM C40 | Less Than Plate 3 |
| Clay Lumps and Friable Particles (%) | ASTM C142 | 2 Maximum |
| Dry Loose Unit Weight (PCF) | ASTM C29 | 55 Maximum |
| Potential Reactivity (% expansion) | AASHTO T 303 ⁽¹⁾ | 0.10 Maximum if exposed to freeze thaw or wet environment |
| Freeze Thaw Durability | ASTM C666 | Acceptable for Environment |

1. Test shall be performed on a yearly basis. Test shall be performed on the aggregates, cementitious materials and admixtures from the proposed sources as shown in the mix design. The cementitious materials and mineral admixtures utilized in the test shall be proportioned at similar rates as the mix design. An individual test may be performed on each aggregate size separately and the results combined mathematically based on the mix design aggregate proportions. The coarse aggregate may be combined with the fine aggregate in similar proportions as the proposed mix design for test performance.

200.06.05 LIGHTWEIGHT FINE AGGREGATE. Lightweight fine aggregates for PCC shall conform to the requirements of Tables 200.06.05-I and 200.06.05-II.

TABLE 200.06.05-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 3/8 inch | 100 |
| No. 4 | 85 – 100 |
| No. 8 | - |
| No. 16 | 40 – 80 |
| No. 30 | - |
| No. 50 | 10 – 35 |
| No. 100 | 5 – 25 |
| No. 200 | - |

TABLE 200.06.05-II

| Test | Test Method | Requirements |
|---|-----------------------------|---|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.06.03-I |
| Organic Impurities | ASTM C40 | Less Than Plate 3 |
| Clay Lumps and Friable Particles (%) | ASTM C142 | 2 Maximum |
| Dry Loose Unit Weight (PCF) | ASTM C29 | 70 Maximum |
| Coarse and fine Dry Loose Unit Weight (PCF) | ASTM C29 | 65 Maximum |
| Potential Reactivity (% expansion) | AASHTO T 303 ⁽¹⁾ | 0.10 Maximum if exposed to freeze thaw or wet environment |
| Freeze Thaw Durability | ASTM C666 | Acceptable for Environment |

1. Test shall be performed on a yearly basis. Test shall be performed on the aggregates, cementitious materials and admixtures from the proposed sources as shown in the mix design. The cementitious materials and mineral admixtures utilized in the test shall be proportioned at similar rates as the mix design. An individual test may be performed on each aggregate size separately and the results combined mathematically based on the mix design aggregate proportions. The fine aggregate may be combined with the coarse aggregate in similar proportions as the proposed mix design for test performance.

200.06.06 AGGREGATES FOR RCC. Aggregates used for RCC shall conform to the quality requirements of ASTM C33 and the grading requirements of Tables 200.06.06-I and 200.06.06-II.

TABLE 200.06.06-I

| Sieve Size | Percentage by Weight Passing Sieve | |
|------------|---------------------------------------|-----------------|
| | Gradation No. 1 | Gradation No. 2 |
| 1 Inch | 100 | |
| 3/4 Inch | 93-100 | 100 |
| 1/2 Inch | 70-95 | 81-100 |
| 3/8 Inch | 60-85 | 71-91 |
| No. 4 | 40-60 | 49-70 |
| No. 8 | 30-50 | 33-54 |
| No. 16 | 20-40 | 24-40 |
| No. 30 | 15-30 | 15-30 |
| No. 50 | 10-25 | 10-25 |
| No. 100 | 2-16 | 2-16 |
| No. 200 | 0-8 | 0-8 |

200.06.06 Aggregates for RCC (Continued)

TABLE 200.06.03-II

| Test | Test Method | Requirements |
|---------------------------------|---------------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.06.02-I |
| Liquid Limit ⁽¹⁾ | ASTM D4318 ⁽¹⁾ | 20 Maximum |
| Plasticity Index ⁽¹⁾ | ASTM D4318 ⁽¹⁾ | 5 Maximum |

1. Material passing the No. 40 sieve.

200.07 RIPRAP.

200.07.01 DESCRIPTION. This Subsection covers the quality and size of mineral materials used for riprap.

200.07.02 GENERAL. Stone for riprap shall be angular fractured stone or rounded cobblestone, except that cobblestone shall not be used on slopes steeper than 1 vertical to 2 horizontal or, unless directed by the *Engineer*, where exposed to hydraulic conditions. Stone shall be of such shape to form a stable protection structure for the required section. Flat or elongated shapes will not be accepted unless the thickness of the individual pieces is at least 1/3 of the length.

Stones shall be sound, durable, hard, resistant to abrasion and free from laminations, weak cleavage planes, and the undesirable effects of weathering. It shall be of such character that it will not disintegrate from the action of air, water, or the conditions experienced during handling and placing. All material shall be clean and free from deleterious impurities, including alkali, earth, clay, refuse, and adherent coatings.

Unless otherwise directed or approved by the *Engineer*, for application greater than 200 tons, design parameters, including filter, foundation, and gradation with supporting calculations by a *Professional Engineer*, shall be submitted to the *Engineer* for review at least 30 *Calendar Days* prior to application.

207.07.02.01 Visual Evaluation. Visual evaluation of the source, suitable tests and service records may be used to determine the acceptability of the stone. The *Contractor* shall notify the *Engineer* in writing at least 30 *Calendar Days* prior to use.

200.07.03 LOOSE RIPRAP AND RIPRAP BEDDING GRADING AND QUALITY REQUIREMENTS BY SIZE. Loose stone for riprap designated by size shall conform to the requirements of Tables 200.07.03-I and 200.07.03-II.

TABLE 200.07.03-I

| % by Size Passing | Class 150 Bedding | Size (Inches) | | | | | |
|--------------------------------|-------------------|---------------------------------|---------------------------------|-----------------------------|-----------|-----------|-----------|
| | | Class 150/Class 300/400 Bedding | Class 300/Class 550/700 Bedding | Class 400/Class 900 Bedding | Class 550 | Class 700 | Class 900 |
| 100 | 4 | 10 | 20 | 30 | 40 | 48 | 60 |
| 70 - 85 | | 9 | 18 | 27 | 36 | 45 | 54 |
| 30 - 50 | 1 | 6 | 12 | 18 | 24 | 30 | 36 |
| 5 - 15 | ¾ | 2 | 5 | 7 | 12 | 18 | 24 |
| 0 - 5 | #4 | 1 | 2 | 3 | 6 | 8 | 12 |
| D ₅₀ ⁽¹⁾ | | 6 | 12 | 16 | 22 | 28 | 35 |

1. Mean Stone Size

200.07 Riprap (Continued)

TABLE 200.07.03-II

| Test | Test Method | Requirements |
|-------------------------------|-------------------------------------|----------------------------|
| Resistance to Degradation (%) | ASTM C131 or C535 ⁽¹⁾⁽³⁾ | 45 Maximum |
| Absorption (%) | ASTM C127 ⁽³⁾ | 4 Maximum |
| Apparent Specific Gravity | ASTM C127 ⁽³⁾ | 2.5 Minimum ⁽²⁾ |
| Durability | ASTM D3744 ⁽³⁾ | 52 Minimum |

1. 500 Revolutions
2. Riprap with a specific gravity of less than 2.5 may be provided for use outside of channels and major drainage facilities if approved by the Agency or Engineer.
3. Tests performed on a processed sample of the parent rock.

200.07.04 SLOPE PROTECTION.

200.07.04.01 Color Requirements. Unless otherwise directed or approved by the Agency, stone for riprap used for slope protection shall have an earth tone which blends with the surrounding environment. Staining shall be used only with approval of the Agency. The Contractor shall submit representative samples from source to the Agency at least 30 *Calendar Days* prior to use for determination of acceptability of the color.

200.08 TOPSOIL.

200.08.01 DESCRIPTION. This Subsection covers the quality and size of materials used for turf and wildflower establishment, sodding or planting.

200.08.02 GENERAL. Topsoil shall be free of refuse, constituents toxic or otherwise deleterious to plant growth, woody vegetation, stumps or roots, and brush. Sod and herbaceous growth such as grass need not be removed, but shall be thoroughly broken up and mixed with the soil.

200.08.03 GRADING AND QUALITY REQUIREMENTS. Unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, topsoil shall conform to the requirements of Tables 200.08.03-I and 200.08.03-II.

TABLE 200.08.03-I

| Sieve Size | Percentage by Weight Passing Sieve |
|------------|---------------------------------------|
| 1 inch | 100 |
| 3/8 inch | 85 - 100 |
| No. 8 | 50 - 80 |
| No. 200 | 0 - 20 |

TABLE 200.08.03-II

| Test | Test Method | Requirements |
|--------------------|--------------------|-------------------|
| Sampling Aggregate | ASTM D75 | - |
| Sieve Analysis | ASTM C136 and C117 | Table 200.08.03-I |
| Organic Content | AASHTO T 194 | 2 - 20 |
| PH | ASTM E70 | 5.5 - 7.4 |

201.01 GENERAL.

201.01.01 DESCRIPTION. This section covers the quality of asphalt cement, liquid asphalt, emulsified asphalt and additives.

201.02 ASPHALT CEMENTS. These specifications cover performance grades *PG 64-22*, *PG 64-28NV*, *PG 76-22NV*, *PG 64-28NVTR*, *PG 70-22TR* and *PG 76-22NVTR*. Performance grades shall conform to the applicable requirements of Tables 201.02-III through 201.02-V. Performance grades containing tire rubber shall conform to the applicable requirements of Tables 202.02-VI through 202.02-VIII.

Asphalt cement shall be prepared by the distillation of crude petroleum. The asphalt shall be homogeneous, free from water, and shall not foam when heated to 347 degrees Fahrenheit. Polymer modified asphalts shall be blended at the source of supply (refinery or terminal) and delivered as a finished mixture to the contractors hot plant asphalt storage tank. If asphalt is pumped directly from a tanker truck into the contractors hot mix plant, no in-line blending of polymer will be allowed.

201.03 CUTBACK ASPHALTS. These specifications cover medium and slow curing liquid asphalts. Medium curing liquid asphalt are designated by the letters *MC* and shall conform to the requirements of Table 202.03-I. Slow curing liquid asphalts are designated by the letters *SC* and shall conform to the requirements of Table 202.03-II.

Liquid asphalts shall be produced by fluxing or blending an asphalt base with suitable petroleum distillates.

201.04 EMULSIFIED ASPHALTS. These specifications cover cationic, anionic and latex modified emulsified asphalts. Emulsified asphalts shall conform to the applicable requirements of Tables 201.04-I, 201.04-II, 201.04-III, 201.04-IV, 201.04-V or 201.04-VI for cationic, anionic, latex or polymer modified emulsified asphalts or prime coat emulsified asphalt, respectively.

Emulsified Asphalts shall consist of a paving grade asphalt blended with water and a suitable emulsifying agent.

201.05 EMULSIFIED REJUVENATING AGENTS. This specification covers emulsified rejuvenating agents which shall conform to Table 201.05-I.

Emulsified Rejuvenating agents shall consist of a paving grade asphalt blended with water and suitable emulsifying and rejuvenating agents.

201.06 RECYCLING AGENTS. This specification covers recycling agents which shall conform to Table 201.06-I.

201.07 HOT APPLIED CRACK FILLER. This specification covers hot-applied crack filler which shall conform to ASTM D5078.

201.08 HYDRATED LIME FOR HMA. This specification covers hydrated lime which shall conform to ASTM C1097.

201.09 MINERAL FILLER FOR HMA. This specification covers mineral filler for bituminous paving mixtures which shall conform to ASTM D242.

BITUMINOUS MATERIALS

201.00-2

TABLE 201.02-I
Specifications for Asphalt Cement Graded by Viscosity at 140°F
Deleted 12/21/2016

TABLE 201.02-II

Specification for Polymerized Asphalt Cement Graded by Viscosity at 140 °F
Deleted 12/21/2016

TABLE 201.02-III
Specifications for Performance Graded Asphalt Cement

| Test | Test Method | Requirements | Limit with Tolerance | Rejection Limit |
|--|--------------|-----------------|----------------------|-----------------|
| | | PG 64-22 | | |
| Tests on Original Asphalt Cement | | | | |
| Rotational Viscosity @135° C (Pa.s) | AASHTO T 316 | 3.00 Maximum | 3.21 Maximum | 3.50 Maximum |
| Flash Point using Cleveland Open Cup (°C) | AASHTO T 48 | 230 Minimum | 222 Minimum | 163 Minimum |
| Dynamic Shear, $G^*/\sin\delta$ @64° C, 10 rads/sec (kPa) | AASHTO T 315 | 1.00 Minimum | 0.90 Minimum | 0.75 Minimum |
| Solubility (%) | AASHTO T 44 | 99.0 Minimum | 98.9 | 98.6 |
| Tests on Residue from Rolling Thin Film Oven (Nev. T728) | | | | |
| Dynamic Shear, $G^*/\sin\delta$ @64° C, 10 rads/sec (kPa) | AASHTO T 315 | 2.20 Minimum | 1.98 Minimum | 1.65 Minimum |
| Average Mass Change (%) | Nev. T728 | 1.00 Maximum | 1.00 Maximum | 1.01 Maximum |
| Tests on Residue from Pressure Aging Vessel @100° C(AASHTO R 28) | | | | |
| Dynamic Shear, $G^* \sin\delta$ @25° C, 10 rads/sec (kPa) | AASHTO T 315 | 5000 Maximum | 5500 Maximum | 6250 Maximum |
| Flexural Creep Stiffness | AASHTO T 313 | | | |
| Stiffness Modulus, S @ -12° C, 60 sec (MPa) | AASHTO T 313 | 300 Maximum | 330 Maximum | 375 Maximum |
| m-value @ -12° C, 60 sec | AASHTO T 313 | 0.300 Minimum | 0.290 Minimum | 0.245 Minimum |
| | | | | |

TABLE 201.02-IV
Specifications for Polymerized Performance Graded Asphalt Cement

| Test | Test Method | Requirements | Limit with Tolerance | Rejection Limit |
|---|--------------|-------------------|----------------------|-----------------|
| | | PG 64-28NV | | |
| Tests on Original Asphalt Cement | | | | |
| Rotational Viscosity @135° C (Pa.s) | AASHTO T 316 | 3.00 Maximum | 3.21 Maximum | 3.50 Maximum |
| Flash Point using Cleveland Open Cup (°C) | AASHTO T 48 | 230 Minimum | 222 Minimum | 163 Minimum |
| Ductility @4° C, 5 cm/min (cm) | Nev. T746 | 50 Minimum | 50 Minimum | 29 Minimum |
| Toughness @25° C (inch-lbs) | Nev. T745 | 110 Minimum | 110 Minimum | 57 Minimum |
| Tenacity @25° C (inch-lbs) | Nev. T745 | 75 Minimum | 75 Minimum | 22 Minimum |
| Sieve Test (Particulates Retained) | Nev. T730 | 0 | 1 | 10 |
| Dynamic Shear, G*/sinδ @64° C, 10 rads/sec (kPa) | AASHTO T 315 | 1.00 Minimum | 0.90 Minimum | 0.75 Minimum |
| Tests on Residue from Rolling Thin Film Oven (Nev. T728) | | | | |
| Ductility @4° C, 5 cm/min (cm) | Nev. T746 | 25 Minimum | 25 Minimum | 4 Minimum |
| Dynamic Shear, G*/sinδ @64° C, 10 rads/sec (kPa) | AASHTO T 315 | 2.20 Minimum | 1.98 Minimum | 1.65 Minimum |
| Average Mass Change (%) | Nev. T728 | 1.00 Maximum | 1.00 Maximum | 1.01 Maximum |
| Tests on Residue from Pressure Aging Vessel @100° C (AASHTO R 28) | | | | |
| Dynamic Shear, G* sinδ @22° C, 10 rads/sec (kPa) | AASHTO T 315 | 5000 Maximum | 5500 Maximum | 6250 Maximum |
| Flexural Creep Stiffness | AASHTO T 313 | | | |
| Stiffness Modulus, S @ -18° C, 60 sec (MPa) | AASHTO T 313 | 300 Maximum | 330 Maximum | 375 Maximum |
| m-value @ -18° C, 60 sec | AASHTO T 313 | 0.300 Minimum | 0.290 Minimum | 0.245 Minimum |

1. PG 64-28NV shall be blended at the source of supply and delivered as a completed mixture to the job site. PG 64-28NV shall not be transported by railroad car.

TABLE 201.02-V
Specifications for Polymerized Performance Graded Asphalt Cement

| Test | Test Method | Requirements | Limit with Tolerance | Rejection Limit |
|--|--------------|-------------------|----------------------|-----------------|
| | | PG 76-22NV | | |
| Tests on Original Asphalt Cement | | | | |
| Rotational Viscosity @135° C (Pa.s) | AASHTO T 316 | 3.00 Maximum | 3.21 Maximum | 3.50 Maximum |
| Flash Point using Cleveland Open Cup (°C) | AASHTO T 48 | 230 Minimum | 222 Minimum | 163 Minimum |
| Ductility @4° C, 5 cm/min (cm) | Nev. T 746 | 20 Minimum | 20 Minimum | 0 Minimum |
| Sieve Test (Particulates Retained) | Nev. T 730 | 0 | 1 | 10 |
| Dynamic Shear, $G^*/\sin\delta$ @76° C, 10 rads/sec (kPa) | AASHTO T 315 | 1.30 Minimum | 1.17 Minimum | 0.99 Minimum |
| Solubility (%), sample size 0.5 to 1.0 g | AASHTO T 44 | 99.0 Minimum | 98.9 Minimum | 98.6 Minimum |
| Tests on Residue from Rolling Thin Film Oven (Nev. T728) | | | | |
| Creep Recovery, R3.2, Test Temp 76° C @ 3.2 kPa, % | AASHTO T350 | 30.0 Minimum | 27.0 Minimum | 22.5 Minimum |
| Non-Recoverable Creep Compliance, J nr3.2, Test Temp 76°C @3.2kPa, kpa-1 | AASHTO T350 | 2.0 Maximum | 2.2 Maximum | 4.0 Maximum |
| Average Mass Change (%) | Nev. T728 | 1.00 Maximum | 1.00 Maximum | 1.01 Maximum |
| Tests on Residue from Pressure Aging Vessel @110° C (AASHTO R 28) | | | | |
| Dynamic Shear, $G^*/\sin\delta$ @31° C, 10 rads/sec (kPa) | AASHTO T 315 | 5000 Maximum | 5500 Maximum | 6250 Maximum |
| Flexural Creep Stiffness | AASHTO T 313 | | | |
| Stiffness Modulus, S @ -12° C, 60 sec (MPa) | AASHTO T 313 | 300 Maximum | 330 Maximum | 375 Maximum |
| m-value @ -12° C, 60 sec | AASHTO T 313 | 0.300 Minimum | 0.280 Minimum | 0.235 Minimum |

1. Certificates of compliance provided for the material shall document that the minimum rubber content is present.
2. PG 76-22NV shall be blended at the source of supply and delivered as a completed mixture to the job site. PG 76-22NV shall not be transported by railroad car.

TABLE 201.02-VI
Specifications for Polymerized Performance Graded Asphalt Cement with Tire Rubber

| Test | Test Method | Requirements | Limit with Tolerance | Rejection Limit |
|---|--------------|---------------------|----------------------|-----------------|
| | | PG 64-28NVTR | | |
| Tests on Original Asphalt Cement | | | | |
| Rotational Viscosity @135° C (Pa.s) | AASHTO T 316 | 3.00 Maximum | 3.21 Maximum | 3.50 Maximum |
| Flash Point using Cleveland Open Cup (°C) | AASHTO T 48 | 230 Minimum | 222 Minimum | 163 Minimum |
| Ductility @4° C, 5 cm/min (cm) | Nev. T 746 | 40 Minimum | 40 Minimum | 19 Minimum |
| Toughness @25° C (inch-lbs) | Nev. T 745 | 110 Minimum | 110 Minimum | 57 Minimum |
| Tenacity @25° C (inch-lbs) | Nev. T 745 | 75 Minimum | 75 Minimum | 22 Minimum |
| Sieve Test (Particulates Retained) | Nev. T 730 | 0 | 1 | 10 |
| Dynamic Shear, G*/sinδ @64° C, 10 rads/sec (kPa) | AASHTO T 315 | 1.00 Minimum | 0.90 Minimum | 0.75 Minimum |
| Solubility (%) | AASHTO T 44 | 96.0 Minimum | 95.9 Minimum | 95.0 Minimum |
| Rubber Content (% by Weight) | Note 1 | 10 Minimum | - | - |
| Tests on Residue from Rolling Thin Film Oven (Nev. T728) | | | | |
| Ductility @4° C, 5 cm/min (cm) | Nev. T746 | 20 Minimum | 20 Minimum | 0 Minimum |
| Dynamic Shear, G*/sinδ @64° C, 10 rads/sec (kPa) | AASHTO T 315 | 2.20 Minimum | 1.98 Minimum | 1.65 Minimum |
| Average Mass Change (%) | Nev. T728 | 1.00 Maximum | 1.00 Maximum | 1.01 Maximum |
| Tests on Residue from Pressure Aging Vessel @100° C (AASHTO R 28) | | | | |
| Dynamic Shear, G* sinδ @22° C, 10 rads/sec (kPa) | AASHTO T 315 | 5000 Maximum | 5500 Maximum | 6250 Maximum |
| Flexural Creep Stiffness | AASHTO T 313 | | | |
| Stiffness Modulus, S @ -18° C, 60 sec (MPa) | AASHTO T 313 | 300 Maximum | 330 Maximum | 375 Maximum |
| m-value @ -18° C, 60 sec | AASHTO T 313 | 0.300 Minimum | 0.290 Minimum | 0.245 Minimum |

1. Certificates of compliance provided for the material shall document that the minimum rubber content is present.
2. PG 64-28NVTR shall be blended at the source of supply and delivered as a completed mixture to the job site. PG 64-28NVTR shall not be transported by railroad car.

TABLE 201.02-VII
Specifications for Performance Graded Asphalt Cement with Tire Rubber

| Test | Test Method | Requirements | Limit with Tolerance | Rejection Limit |
|---|--------------|-------------------|----------------------|-----------------|
| | | PG 70-22TR | | |
| Tests on Original Asphalt Cement | | | | |
| Rotational Viscosity @135° C (Pa.s) | AASHTO T 316 | 3.00 Maximum | 3.21 Maximum | 3.50 Maximum |
| Flash Point using Cleveland Open Cup (°C) | AASHTO T 48 | 230 Minimum | 222 Minimum | 163 Minimum |
| Dynamic Shear, $G^*/\sin\delta$ @70° C, 10 rads/sec (kPa) | AASHTO T 315 | 1.00 Minimum | 0.90 Minimum | 0.75 Minimum |
| Solubility (%) | AASHTO T 44 | 96.0 Minimum | 95.9 Minimum | 95.0 Minimum |
| Rubber Content (% by Weight) | Note 1 | 10 Minimum | - | - |
| Elastic Recovery @ 25° C (%) | AASHTO T 301 | 70 Minimum | 70 Minimum | 49 Minimum |
| Tests on Residue from Rolling Thin Film Oven (Nev. T728) | | | | |
| Ductility @4° C, 5 cm/min (cm) | Nev. T746 | 20 Minimum | 20 Minimum | 0 Minimum |
| Dynamic Shear, $G^*/\sin\delta$ @70° C, 10 rads/sec (kPa) | AASHTO T 315 | 2.20 Minimum | 1.98 Minimum | 1.65 Minimum |
| Average Mass Change (%) | Nev. T728 | 1.00 Maximum | 1.00 Maximum | 1.01 Maximum |
| Tests on Residue from Pressure Aging Vessel @100° C (AASHTO R 28) | | | | |
| Dynamic Shear, $G^*\sin\delta$ @28° C, 10 rads/sec (kPa) | AASHTO T 315 | 5000 Maximum | 5500 Maximum | 6250 Maximum |
| Flexural Creep Stiffness | AASHTO T 313 | | | |
| Stiffness Modulus, S @ -12° C, 60 sec (MPa) | AASHTO T 313 | 300 Maximum | 330 Maximum | 375 Maximum |
| m-value @ -12° C, 60 sec | AASHTO T 313 | 0.300 Minimum | 0.290 Minimum | 0.245 Minimum |

1. Certificates of compliance provided for the material shall document that the minimum rubber content is present.
2. PG 70-22TR shall be blended at the source of supply and delivered as a completed mixture to the job site. PG 70-22TR shall not be transported by railroad car.

TABLE 201.02-VIII
Specifications for Polymerized Performance Graded Asphalt Cement with Tire Rubber

| Test | Test Method | Requirements | Limit with Tolerance | Rejection Limit |
|---|--------------|---------------------|----------------------|-----------------|
| | | PG 76-22NVTR | | |
| Tests on Original Asphalt Cement | | | | |
| Rotational Viscosity @135° C (Pa.s) | AASHTO T 316 | 3.00 Maximum | 3.21 Maximum | 3.50 Maximum |
| Flash Point using Cleveland Open Cup (°C) | AASHTO T 48 | 230 Minimum | 222 Minimum | 163 Minimum |
| Ductility @4° C, 5 cm/min (cm) | Nev. T 746 | 20 Minimum | 20 Minimum | 0 Minimum |
| Sieve Test (Particulates Retained) | Nev. T 730 | 0 | 1 | 10 |
| Dynamic Shear, $G^*/\sin\delta$ @76° C, 10 rads/sec (kPa) | AASHTO T 315 | 1.30 Minimum | 1.17 Minimum | 0.99 Minimum |
| Solubility (%), sample size 0.5 to 1.0 g | AASHTO T 44 | 96.0 Minimum | 95.9 Minimum | 95.0 Minimum |
| Rubber Content (% by Weight) | Note 1 | 10 Minimum | - | - |
| Tests on Residue from Rolling Thin Film Oven (Nev. T728) | | | | |
| Creep Recovery, R3.2, Test Temp 76° C @ 3.2 kPa, % | AASHTO T350 | 30.0 Minimum | 27.0 Minimum | 22.5 Minimum |
| Non-Recoverable Creep Compliance, J nr3.2, Test Temp 76° C @3.2kPa, kpa-1 | AASHTO T350 | 2.0 Maximum | 2.2 Maximum | 4.0 Maximum |
| Average Mass Change (%) | Nev. T728 | 1.00 Maximum | 1.00 Maximum | 1.01 Maximum |
| Tests on Residue from Pressure Aging Vessel @110° C (AASHTO R 28) | | | | |
| Dynamic Shear, $G^*/\sin\delta$ @31° C, 10 rads/sec (kPa) | AASHTO T 315 | 5000 Maximum | 5500 Maximum | 6250 Maximum |
| Flexural Creep Stiffness | AASHTO T 313 | | | |
| Stiffness Modulus, S @ -12° C, 60 sec (MPa) | AASHTO T 313 | 300 Maximum | 330 Maximum | 375 Maximum |
| m-value @ -12° C, 60 sec | AASHTO T 313 | 0.300 Minimum | 0.280 Minimum | 0.235 Minimum |

1. Certificates of compliance provided for the material shall document that the minimum rubber content is present.
2. PG 76-22NVTR shall be blended at the source of supply and delivered as a completed mixture to the job site. PG 76-22NVTR shall not be transported by railroad car.

TABLE 201.03-I
Specifications for Medium Curing Cutback Asphalt

| Test | Test Method | Requirements | | | | Allowable Tolerance ⁽¹⁾ |
|--|--------------|------------------------------|------------------------------|---------------------------|---------------------------|------------------------------------|
| | | MC-70 | MC-250 | MC-800 | MC-3000 | |
| Tests on Original Liquid Asphalt | | | | | | |
| Kinematic Viscosity @ 140° F (cSt) | AASHTO T 201 | 70-140 | 250-500 | 800-1600 | 3000-6000 | 1.5 to 8.9 % ⁽²⁾ |
| Flash Point using Tag Open Cup (°F) | AASHTO T 79 | 100 Minimum | | 150 Minimum | | 15° F |
| Water in Petroleum Products (%) | AASHTO T 55 | | | 0.2 Maximum | | 0.1 |
| Distillation of Cut-Back Asphalt to 680° F (AASHTO T 78) | | | | | | |
| Percent of total distillate to 437° F to 500° F to 600° F | AASHTO T 78 | 20 Maximum 20-60 65-90 | 10 Maximum 15-55 60-87 | -- 35 Maximum 45-80 | -- 15 Maximum 15-75 | 1.0 1.0 1.0 |
| Volume (percent by difference) | AASHTO T 78 | 55 Minimum | 67 Minimum | 75 Minimum | 80 Minimum | 1.0 |
| Tests on Residue from Distillation (AASHTO T 78) | | | | | | |
| Viscosity @ 140° F, 300±0.5mm Hg (P) | AASHTO T 202 | | | 300-1200 | | 7 % |
| Ductility @ 77° F, 5 cm/min (cm) | AASHTO T 51 | | | 100 Minimum | | 30 % |
| Solubility in Trichloroethylene (%) | AASHTO T 44 | | | 99.0 Minimum | | 0.1 |

1. When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.
2. Below 3000 = 1.5 %, 3000 to 6000 = 2.0 %, above 6000 = 8.9 %

TABLE 201.03-II
Specifications for Slow Curing Cutback Asphalt

| Test | Test Method | Requirements | | | | Allowable Tolerance ⁽¹⁾ |
|--|--------------|--------------|-------------|-------------|-------------|------------------------------------|
| | | SC-70 | SC-250 | SC-800 | SC-3000 | |
| Tests on Original Liquid Asphalt | | | | | | |
| Kinematic Viscosity @ 140°F (cSt) | AASHTO T 201 | 70-140 | 250-500 | 800-1600 | 3000-6000 | 1.5 to 8.9 % ⁽²⁾ |
| Flash Point using Cleveland Open Cup (°F) | AASHTO T 48 | 150 Minimum | 175 Minimum | 200 Minimum | 225 Minimum | 15° F |
| Water in Petroleum Products (%) | AASHTO T 55 | 0.5 Maximum | | | | 0.1 |
| Distillation of Cut-Back Asphalt to 680° F (AASHTO T 78) | | | | | | |
| Volume (%) | AASHTO T 78 | 10-30 | 4-20 | 2-12 | 5 Maximum | 1.0 |
| Tests on Residue from Distillation (AASHTO T 78) | | | | | | |
| Kinematic Viscosity @ 140°F (cSt) | AASHTO T 201 | 400-7000 | 800-10000 | 2000-16000 | 4000-35000 | 1.5 to 8.9 % ⁽²⁾ |
| Ductility @ 77°F, 5 cm/min (cm) | AASHTO T 51 | 100 Minimum | | | | 30 % |
| Solubility in Trichloroethylene (%) | AASHTO T 44 | 99.0 Minimum | | | | 0.1 |

1. When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.
2. Below 3000 = 1.5 %, 3000 to 6000 = 2.0 %, above 6000 = 8.9 %

TABLE 201.04-I
Specifications for Cationic Emulsified Asphalt

| Test | Test Method | Requirements | | | | | | | | | | Allowable Tolerance ⁽¹⁾ |
|---|--------------|---------------|------------------------|-------------------------|---------------|-------------|---------|----------------|------------|--------------|----------|------------------------------------|
| | | Quick Setting | | | Rapid Setting | | | Medium Setting | | Slow Setting | | |
| Test on Emulsion | | CQS | CQS-1NV | CQS-1hTR ⁽⁵⁾ | CRS-1 | CRS-2 | CRS-2h | CMS-2 | CMS-2h | CSS-1 | CSS-1h | |
| Residue (% by mass) | AASHTO T 59 | 60 Min. | 57 Min. | 57 min | 60 Min. | 65 Minimum. | | | 57 Minimum | | | 1 |
| Oil Distillate (% by volume of emulsion) | AASHTO T 59 | 3 Max. | | | 3 Maximum | | | 12 Maximum | | | | None |
| Particle Charge Test | AASHTO T 59 | | Positive | | | | | | | | | None |
| Saybolt Furol Viscosity @77° F(sec) | AASHTO T 59 | 16-90 | 20-100 | | | | | | | 20-100 | 20-100 | None |
| Saybolt Furol Viscosity @122°F(sec) | AASHTO T 59 | | | | 20-100 | 150-450 | 150-450 | 50-450 | 50-450 | | | None |
| Demulsibility (%) | AASHTO T 59 | | 40 Minimum | | | | | | | | | 5 |
| Settlement @ 5 days (% difference) ⁽²⁾ | AASHTO T 59 | | 5 Maximum | | | | | | | | | 5 |
| Cement Mixing Test (%) | AASHTO T 59 | | 25 Min. ⁽³⁾ | | | | | | | 2 Maximum | | 0.2 |
| Sieve Test, Retained on No. 20 (%) | AASHTO T 59 | | 0.1 Maximum | | | | | | | | | 0.03 |
| Storage Stability, 24hr (%) | AASHTO T 59 | 1 Max. | | | 1 Maximum | | | | | | | 0.5 |
| Dry Aggregate Coating @ Job (%) ⁽⁴⁾ | AASHTO T 59 | | | | | | | 80 Min. | 80 Min. | | | None |
| Wet Aggregate Coating @ Job (%) ⁽⁴⁾ | AASHTO T 59 | | | | | | | 60 Min. | 60 Min. | | | None |
| pH | AASHTO T 200 | | | | | | | | | 6.7 Max. | 6.7 Max. | None |
| Tests on Residue from Distillation (AASHTO T 59) | | | | | | | | | | | | |
| Penetration @77° F, 100g, 5 sec (dmm) | AASHTO T 49 | 40-90 | | | 100-250 | | 40-90 | 100-250 | 40-90 | 100-250 | 40-90 | 7 % |
| Ductility @77° F, 5 cm/min (cm) | AASHTO T 51 | 40 Minimum | | | | | | | | | | 10 % |
| Solubility in Trichloroethylene (%) | AASHTO T 44 | | 97.5 Minimum | | | | | | | | | 0.1 |

1. When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.
2. The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 Days; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 Days.
3. If the amount of breakage is significant enough to impede the flow of water through the testing screen, thus making it impossible to calculate a result, the test will be considered passing.
4. Calcium carbonate shall not be added to the job aggregate when making samples for the aggregate coating water resistance test.
5. Supplier will certify that the basestock contains a minimum of 5% crumb rubber.

TABLE 201.04-II
Specifications for Anionic Emulsified Asphalt

| Test | Test Method | Requirements | | | | Allowable Tolerance⁽¹⁾ | |
|---|--------------------|----------------------|-------------|-----------------------|---------------------|--|------|
| | | Rapid Setting | | Medium Setting | Slow Setting | | |
| Tests on Emulsion | | RS-1 | RS-2 | MS-2 | SS-1 | SS-1h | |
| Residue by Distillation (% by mass) | AASHTO T 59 | 55 Minimum | 63 Minimum | 65 Minimum | 57 Minimum | | 1 |
| Saybolt Furol Viscosity @77° F(sec) | AASHTO T 59 | 20-100 | | 100 Minimum | 20-100 | | None |
| Saybolt Furol Viscosity @122°F(sec) | AASHTO T 59 | | 150-450 | | | | None |
| Demulsibility (%) | AASHTO T 59 | 60 Minimum | | | | | 5 |
| Settlement @ 5 days (% difference) ⁽²⁾ | AASHTO T 59 | 3 Maximum | | | | | 5 |
| Cement Mixing Test (%) | AASHTO T 59 | | | | 2 Maximum | | 0.2 |
| Storage Stability, 24hr, (%) | AASHTO T 59 | 1 Maximum | | | | | 0.5 |
| Sieve Test (Retained on No. 20, %) | AASHTO T 59 | 0.1 Maximum | | | | | 0.03 |
| Tests on Residue from Distillation (AASHTO T 59) | | | | | | | |
| Penetration@77°F, 100g, 5 sec (dmm) | AASHTO T 49 | 100-200 | | | | 40-90 | 7 % |
| Ductility @77°F, 5 cm/min (cm) | AASHTO T 51 | 40 Minimum | | | | | 10 % |
| Solubility in Trichloroethylene (%) | AASHTO T 44 | 97.5 Minimum | | | | | 0.1 |

1. When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.
2. The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 Days; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 Days.

BITUMINOUS MATERIALS

201.00-14

TABLE 201.04-III
Specifications for Latex Modified Emulsion

| Test | Test Method | Requirements | | | | | | Allowable Tolerance ⁽¹⁾ | | |
|---|-------------|--------------|--------------|-----------------------------|------------|----------------|------------------|------------------------------------|--|--|
| | | LMCQS | LMCQS-1h | LMCQS-1h TR5 ⁽³⁾ | LMCRS-2h | RTS With LMCQS | MICRO With LMCQS | | | |
| Tests on Emulsion | | | | | | | | | | |
| Residue by Evaporation (% by mass) | NEV T756 | 62 Minimum | 60 Minimum | | 65 Minimum | 64 Minimum | | 1 | | |
| Oil Distillate (% by volume of emulsion) | AASHTO T59 | 3 Maximum | | | | 3 Maximum | 4 Maximum | | | |
| Particle Charge | AASHTO T59 | | Positive | | Positive | | | None | | |
| Saybolt Furrol Viscosity @77° F (sec) | AASHTO T59 | 16 – 90 | 15 – 90 | 15 - 100 | | 16 – 90 | | None | | |
| Saybolt Furrol Viscosity @122°F (sec) | AASHTO T59 | | | | 150-450 | | | None | | |
| Demulsibility (%) | AASHTO T59 | | | | 40 Minimum | | | 5 | | |
| Settlement @ 5 days (% difference) ⁽²⁾ | AASHTO T59 | 5 Maximum | | | | | | 5 | | |
| Storage Stability, 24hr (%) | AASHTO T59 | 1 Maximum | | | | | | 0.5 | | |
| Sieve Test, Retained on No. 20 (%) | AASHTO T59 | | | | 0.3 Max. | | | 0.03 | | |
| Tests on Residue by Evaporation | | | | | | | | | | |
| Penetration @ 77°F, 100g, 5 sec (dmm) | AASHTO T49 | 40 – 90 | | | | 35 - 70 | 7.0 % | | | |
| Ductility @77°F, 5 cm/min (cm) | AASHTO T51 | 50 Minimum | 60 Minimum | | 40 Minimum | 50 Minimum | 60 Minimum | 10 % | | |
| Solubility in Trichloroethylene (%) | AASHTO T44 | | 97.5 Minimum | | | | | 0.10 | | |
| Torsional Recovery (%) | NEV T757 | 18 Minimum | 20 Minimum | | 18 Minimum | 20 Minimum | 22 Minimum | None | | |
| Ring & Ball Softening Point, (° F) | AASHTO T53 | 135 Minimum | 130 Minimum | 135 Minimum | | 140 Minimum | 142 Minimum | None | | |

1. When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.
2. The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 Days; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 Days.
3. Supplier will certify that the basestock contains a minimum of 5% crumb rubber.

TABLE 201.04-IV-I
Specifications for Polymer Modified Pavement Sealants and Tack Coat

| Test | Test Method | Requirements | | | | Allowable Tolerance ⁽¹⁾ |
|--|---------------------|------------------------|---------------|----------------|----------------|------------------------------------|
| Test on Emulsion | | <i>PMPS</i> | <i>PMPS-h</i> | <i>PMPS-QB</i> | <i>PMPS-FS</i> | |
| Residue (% by mass) | <i>Nev. T759</i> | 65 Minimum | | 64 Min. | | 1.0 |
| Oil Distillate (% by volume of emulsion) | <i>Nev. T759</i> | 0.5 Maximum | | | | None |
| Particle Charge Test | <i>Nev. T759</i> | | | Pass | | None |
| Saybolt Furol Viscosity @77° F (sec) | <i>Nev. T759</i> | | | 20 - 100 | | None |
| Saybolt Furol Viscosity @122°F(sec) | <i>Nev. T759</i> | 50 -3 50 | 120 - 450 | | 20 - 100 | None |
| Sieve Test, Retained on No. 20 (%) | <i>Nev. T759</i> | 0.1 Maximum | | 0.30 Maximum | | 0.03 |
| PH | <i>AASHTO T 200</i> | 2.0 - 5.0 | | | | None |
| Tests on Residue from Evaporation | | | | | | |
| Viscosity @140° F, Poises | <i>AASHTO T 202</i> | 5000 Maximum | | | | 7.0% |
| Penetration @39.2° F, 200g, 60 sec (dmm) | <i>Nev. T759</i> | 40 Minimum | 10 - 70 | 35 Minimum | | 7.0% |
| Softening Point, °F | <i>AASHTO T 53</i> | | | | 130 Min. | 12° F |
| Elastic Recovery @ 77° F, % | <i>AASHTO T 301</i> | | 40 Minimum | | 45 Minimum | None |
| Elastic Recovery @ 39.2° F, % | <i>AASHTO T 301</i> | 45 Minimum | | 45 Minimum | | None |
| Ductility @77° F, 5 cm/min (cm) | <i>AASHTO T 51</i> | | | | 100 Minimum | 20 |
| Tests on Diluted Emulsions | | | | | | |
| Residue, %, 70% and 30% | <i>Nev. T759</i> | | | 46 Minimum | | 1.0 |
| Residue, %, 60% and 40% | <i>Nev. T759</i> | | | 39 Minimum | 38 Minimum | 1.0 |
| Residue, %, 50% and 50% | <i>Nev. T759</i> | | | 33 Minimum | 32 Minimum | 1.0 |
| Tests on Latex | | | | | | |
| Specific Gravity | <i>ASTM D1475</i> | 1.08 - 1.15 | | | --- | None |
| Tensile Strength, die C dumbbell, psi (b) | <i>ASTM D412</i> | 500 Minimum | | | --- | None |
| Swelling in rejuvenating agent, %, 48 hour exposure @ 104° F | <i>Nev. T747</i> | 40 Maximum Intact Film | | | --- | None |

TABLE 201.04-IV-I Continued
 Specifications for Polymer Modified Pavement Sealants and Tack Coat

| Test | Test Method | Requirements | | | | Allowable Tolerance ⁽¹⁾ |
|-----------------------------------|-------------|--------------|---------------|----------------|----------------|------------------------------------|
| Test on Rejuvenating Agent | | <i>PMPS</i> | <i>PMPS-h</i> | <i>PMPS-QB</i> | <i>PMPS-FS</i> | |
| Kinematic Viscosity @ 140° F, cSt | | AASHTO T 201 | | 50 - 175 | | 2% |
| Flash Point, ° F | | AASHTO T 48 | | 380 Minimum | | 15° F |
| Saturate, % | | ASTM D2007 | | 30 Maximum | | None |
| Asphaltenes, % | | ASTM D2007 | | 1.0 Maximum | | None |
| Weight Change, % | | AASHTO T 240 | | 6.5 Maximum | | None |
| Viscosity Ratio | | AASHTO T 240 | | 3.0 Maximum | | None |
| | | | | | | |

202.01 GENERAL.

202.01.01 DESCRIPTION. This section covers the quality of cementitious materials, admixtures, fibers, joint materials, bonding systems, curing materials, and other materials related to PCC and masonry construction.

202.01.02 SDS. A SDS shall be available for all cementitious and related materials.

202.02 CEMENTITIOUS MATERIALS.

202.02.01 PORTLAND CEMENTS. This specification covers Type II, Type III and Type V, low alkali Portland cements. Type II, Type III and Type V, low alkali Portland cements shall conform to ASTM C150, including a 0.60 percent limitation on total alkalis expressed as $(Na_2O + 0.658 K_2O)$ as determined in accordance with ASTM C114.

202.02.02 BLENDED HYDRAULIC CEMENT. This specification covers blended hydraulic cement, such as Type IL, Type IP, Type IS and Type IT, which shall conform to ASTM C595.

202.02.03 MASONRY CEMENTS. This specification covers Type I and Type II masonry cements which shall conform to ASTM C91.

202.02.04 PLASTIC (STUCCO) CEMENT. This specification covers plastic (stucco) cement which shall conform to ASTM C1328.

202.02.05 MORTAR CEMENT. This specification covers mortar cement which shall conform to ASTM C1329.

202.02.06 SCM.**202.02.06.01 Pozzolan.**

202.02.06.01.01 Raw or Calcined Natural Pozzolan for Use in Portland Cement Concrete. This specification covers raw or calcined natural pozzolan for use as a mineral admixture in concrete. Raw or calcined natural pozzolan shall conform to ASTM C618. The supplemental optional chemical and physical properties of Tables 1A and 2A contained in ASTM C618 shall apply.

202.02.06.01.02 Coal Fly Ash for Use in Portland Cement Concrete. This specification covers coal fly ash for use as a mineral admixture in concrete. Coal fly ash shall conform to ASTM C618, Class F. The supplemental optional chemical and physical properties of Tables 1A and 2A contained in ASTM C618 shall apply.

202.02.06.01.03 Silica Fume for Use in Cementitious Mixtures. This specification covers silica fume for use in cementitious mixtures which shall conform to ASTM C1240.

202.02.06.01.04 Slag Cement for Use in Portland Cement Concrete and Mortars. This specification covers slag cement for use in concrete and mortars which shall conform to ASTM C989, Grade 100 or 120.

202.02.06.02 Lime.

202.02.06.02.01 Hydrated Lime for Structural Purposes. This specification covers hydrated lime for structural purposes which shall conform to ASTM C41.

202.02.06.02.02 Quick Lime for Structural Purposes. This specification covers quick lime for structural purposes which shall conform to ASTM C5.

202.02.06.02.03 Hydrated Lime for Finishing Purposes. This specification covers Type N and Type S hydrated lime for finishing purposes which shall conform to ASTM C206.

202.02.06.02.04 Hydrated Lime for Masonry Purposes. This specification covers hydrated lime for masonry purposes which shall conform to ASTM C207.

202.02.06.02.05 Hydrated Lime for Soil Stabilization. This specification covers hydrated lime for soil stabilization which shall conform to ASTM C977.

203.01 GENERAL.

203.01.01 DESCRIPTION. This Section covers the quality, manufacture, and fabrication of materials for pressure and non-pressure pipes, appurtenances, fittings and couplings, including hardware for the fittings and couplings, and the related materials used in new construction and rehabilitation of pipe systems.

This Section is for material specifications only and is not intended to be a "qualified products list" and is not intended to encourage or discourage the use of any product. This Section does not address the structural design, installation, and construction requirements that must be taken into account by the *Engineer* in order to ensure proper application of the individual products and achieve the expected performance of the resulting conveyance system.

The conveyance materials used for each project shall be as determined by the *Engineer*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

203.01.01.01 Terms. Whenever the following terms are used in this Section, the intent and meaning shall be defined as follows:

Manufacture. Manufacture shall be defined as the mechanical production of the pipe length and/or fittings.

Fabrication. Fabrication shall be defined as plant alteration of the pipe length.

Joints, Leak Proof. Leak proof joint shall be defined as a joint that provides zero leakage of water infiltration and exfiltration for the head or pressure application as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Joints, Silt-Tight. Silt-tight joint shall be defined as a joint that is resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. Silt-tight joints provide protection against infiltration of backfill material containing a high percentage of fines.

Joints, Soil-Tight. Soil-tight joint shall be defined as a joint that is resistant to infiltration of particles larger than those retained on the No. 200 sieve. Soil-tight joints provide protection against infiltration of backfill material containing high percentage of coarse grain soils.

Joints, Special Design. Special Design joint shall be defined as a joint requiring special strength in bending or shear; special pull-apart capabilities; or unusual features, including, but not limited to, restrained joints placed on severe slopes, welded joints, or flanged and bolted joints for high pressures, high heads. Special design requirements shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Joints, Watertight. Watertight joint shall be defined as a joint which limits water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the head or pressure as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.01.02 IDENTIFICATION. Each section of pipe or plate, appurtenances and fittings shall, at a minimum, be clearly marked such that the manufacturer, plant location, material type, nominal diameter or dimensions and all applicable *ASTM* and *AASHTO* designations can be readily identified.

203.02 CM PIPE.

203.02.01 DESCRIPTION. This Subsection covers pipe, pipe-arches, slotted pipe, and spiral rib pipe constructed from corrugated metal; and the related appurtenances, coupling bands and hardware for coupling bands, rivets, bolts and gaskets. Pipe covered by this Subsection is intended for use in drainage applications and other conveyance systems. Pipe covered by this Subsection is not normally used in pressure applications or for the conveyance of sanitary or industrial wastes.

Pipe-Arches. Pipe-arches shall consist of metal pipe, with the exception of spiral rib pipe, which has been reformed to a multi-centered pipe, having an arch shaped top with a slightly curved integral bottom. The resulting rise and span dimensions shall conform to the applicable requirements of *ASTM*, *AASHTO* and/or *AISI* standards.

Slotted Pipe. Slotted pipe shall be concrete form-type with grate heights of 2-1/2 or 6 Inches, as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. Where specified, a heel guard shall be attached over the grate.

Spiral Rib Pipe. Spiral rib pipe shall consist of metal pipe with a box rib corrugation to provide for a "smooth" interior surface for improved hydraulics.

Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

Pipe-Arches. Nominal dimension (rise and span) for pipe arches shall be defined as the minimum inside dimensions at maximum span and maximum rise of the pipe arch.

203.02.02 IDENTIFICATION. Each section of pipe, appurtenances and fittings shall be marked in accordance with Subsection 203.01.02 – "Identification" and also be marked with the gage and /or thickness and the heat and/or lot number.

203.02.02.01 Corrugated Aluminum Pipe and Pipe-Arches. Corrugated aluminum pipe and pipe-arches shall be clearly marked in accordance with ASTM B745.

203.02.02.02 Corrugated Steel Pipe and Pipe-Arches. Corrugated steel pipe and pipe-arches shall be clearly marked in accordance with ASTM A760.

203.02.02.03 Corrugated Aluminized Steel Type 2 Pipe and Pipe-Arches. Corrugated aluminized steel Type 2 pipe and pipe-arches shall be clearly marked in accordance with ASTM A760.

203.02.03 MATERIALS.

203.02.03.01 Corrugated Aluminum Pipe and Pipe-Arches. Aluminum alloy sheets used in the fabrication of corrugated aluminum pipe and pipe-arches shall conform to ASTM B744, except as modified by Subsection 203.02.03.01.01.

203.02.03.01.01 Mechanical Properties. The aluminum alloy sheet shall conform to the applicable requirements of Table 203.02.03.01.01-I.

TABLE 203.02.03.01.01-I

| Test | Test Method | Requirements | |
|---|-------------|--------------------|----------------|
| | | Thickness (Inches) | |
| | | 0.051 to 0.113 | 0.114 to 0.249 |
| | | | |
| Tensile Strength (PSI) | ASTM B744 | 31,000 Minimum | |
| Yield Strength, at 2 % Elongation (PSI) | ASTM B744 | 4,000 Minimum | |
| Elongation, % | ASTM B744 | 4 Maximum | 5 Maximum |

203.02.03.02 Corrugated Steel Pipe and Pipe-Arches.

203.02.03.02.01 Metallic and Polymer Precoated Steel Sheet. Metallic coated and polymer precoated steel sheets used in the fabrication of corrugated steel pipe and pipe-arches shall conform to ASTM A742.

203.02.03.02.02 Steel. Steel sheets used in the fabrication of corrugated steel pipe and pipe-arches shall conform to ASTM A929.

203.02.03.02.03 Aluminized Steel Type 2. Aluminized steel sheets used in the fabrication of corrugated steel pipe and pipe-arches shall conform to ASTM A929.

203.02.04 FABRICATION.

203.02.04.01 Corrugated Aluminum Pipe and Pipe-Arches. Fabrication of corrugated aluminum pipe and pipe-arches for drainage applications and other conveyance systems shall conform to ASTM B745.

203.02.04.01.01 Corrugations. The corrugations for all corrugated aluminum pipe shall conform to the applicable requirements of Table 203.02.04.01.01-I. The corrugations shall be measured perpendicular to the direction of the corrugation.

TABLE 203.02.04.01.01-I

| | Pipe Shape | | | | | |
|-----------------------------|------------------------|------------------|------------------------|-------|------------------|--|
| | Annular | | Helical | | | |
| | Pipe Diameter (Inches) | | Pipe Diameter (Inches) | | | |
| Minimum | 15 | 30 | 6 | 12 | 30 | |
| Maximum | 27 | 120 | 10 | 72 | 120 | |
| Width (Inches) | 2-2/3 | 2-2/3, 3 or 5 | 1-1/4 | 2-2/3 | 2-2/3, 3 or 5 | |
| Depth (Inches) ¹ | 1/2 | 1/2 or 1 | 1/4 | 1/2 | 1/2 or 1 | |

1. Minimum

203.02.04.01.02 Hot-Applied Bituminous Coated. When corrugated aluminum pipes are to have a hot-applied bituminous coating, the fabrication requirements specified in ASTM B745 shall be altered so that the rivet heads inside will be in the valley of corrugations.

203.02.04.01.03 End Finish. When no headwalls or flared end sections are shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, the ends of 0.060 Inch and 0.075 Inch thick corrugated aluminum pipes shall be reinforced. The reinforcement shall consist of an aluminum band of at least 0.135 Inch thickness and at least 6 Inches wide, on at least the outer 1 Foot of the pipe.

203.02.04.02 Corrugated Steel Pipe and Pipe-Arches. Fabrication of corrugated steel pipe and pipe-arches for drainage applications and other conveyance systems shall conform to ASTM A760.

203.02.04.02.01 Corrugations. The corrugations for all corrugated steel pipe shall conform to the applicable requirements of Table 203.02.04.02.01-I. The corrugations shall be measured perpendicular to the direction of the corrugation.

TABLE 203.02.04.02.01-I

| | Pipe Shape | | | | | |
|-----------------------------|------------------------|--------|------------------------|-------|--------|--|
| | Annular | | Helical | | | |
| | Pipe Diameter (Inches) | | Pipe Diameter (Inches) | | | |
| Minimum | 12 | 48 | 6 | 12 | 48 | |
| Maximum | 84 | 144 | 10 | 84 | 144 | |
| Width (Inches) | 2-2/3 | 3 or 5 | 1-1/2 | 2-2/3 | 3 or 5 | |
| Depth (Inches) ¹ | 1/2 | 1 | 1/4 | 1/2 | 1 | |

1. Minimum

203.02.04.03 Aluminized Steel Type 2 Corrugated Steel Pipe and Pipe-Arches. Fabrication of aluminized steel Type 2 corrugated steel pipe and pipe-arches for drainage applications and other conveyance systems shall conform to ASTM A762.

203.02.04.03.01 Corrugations. The corrugations for all aluminized steel Type 2 corrugated steel pipe shall conform to the applicable requirements of Table 203.02.04.03.01-I. The corrugations shall be measured perpendicular to the direction of the corrugation.

TABLE 203.02.04.03.01-I

| | Pipe Shape | | | | | |
|-----------------------------|------------------------|--------|------------------------|-------|--------|--|
| | Annular | | Helical | | | |
| | Pipe Diameter (Inches) | | Pipe Diameter (Inches) | | | |
| Minimum | 12 | 48 | 6 | 12 | 48 | |
| Maximum | 84 | 144 | 10 | 84 | 144 | |
| Width (Inches) | 2-2/3 | 3 or 5 | 1-1/2 | 2-2/3 | 3 or 5 | |
| Depth (Inches) ¹ | 1/2 | 1 | 1/4 | 1/2 | 1 | |

1. Minimum

203.02.04.04 Underdrains. Corrugated aluminum, steel or aluminized steel Type 2 for underdrains, shall be of the full-circle type. Perforations in the pipe may be drilled or punched. The perforation may be either in the inside crests or in the flat, tangent portion of the corrugations, but not in both locations in the same length of pipe.

203.02.05 COUPLING BANDS, RIVETS, BOLTS, GASKETS AND NUTS.

203.02.05.01 Coupling Bands for Corrugated Aluminum Pipe and Pipe-Arches. Coupling bands for corrugated aluminum pipe and pipe-arches shall be connected with steel bolts of not less than 1/2 Inch diameter and shall conform to ASTM B745 and Tables 203.02.05.01-I and 203.02.05.01-II.

TABLE 203.02.05.01-I

| Corrugation Size (Inches) | Minimum Width of Coupling Band (Inches) |
|---------------------------|---|
| 12 and Greater | 12 Minimum |
| Less than 12 | 7 Minimum |

TABLE 203.02.05.01-II

| Corrugation Size (Inches) | Minimum Width of Coupling Band (Inches) |
|---------------------------|---|
| 2 2/3 x 1/2 | 12 Minimum |
| 3 x 1 | 12 Minimum |
| 5 x 1 | 12 Minimum |

The gage of the coupling bands for corrugated aluminum pipe and pipe-arches may be a maximum of two standard-use thicknesses lighter than that used for the pipe. Minimum thickness shall be 0.060 Inches. The coupling bands shall be fabricated from the same base metal as the base metal of the pipe.

203.02.05.02 Coupling Bands for Corrugated Steel Pipe and Pipe-Arches. Coupling bands for corrugated steel pipe and pipe-arches shall be connected with steel bolts of not less than 1/2 Inch diameter and shall conform to ASTM A760 and Tables 203.02.05.02-I and 203.02.05.02-II.

TABLE 203.02.05.02-I

| Corrugation Size (Inches) | Minimum Width of Coupling Band (Inches) |
|------------------------------|---|
| 12 and Greater | 12 Minimum |
| Less than 12 | 7 Minimum |

TABLE 203.02.05.02-II

| Corrugation Size (Inches) | Minimum Width of Coupling Band (Inches) |
|------------------------------|---|
| 2 2/3 x 1/2 | 7 Minimum |
| 3 x 1 | 12 Minimum |
| 5 x 1 | 12 Minimum |

The gage of the coupling bands for corrugated steel pipe and pipe-arches may be a maximum of two standard-use thicknesses lighter than that used for the pipe. Minimum thickness shall be 0.060 Inches. The coupling bands shall be fabricated from the same base metal as the base metal of the pipe.

203.02.05.03 Coupling Bands for Corrugated Aluminized Steel Type 2 Pipe and Pipe-Arches. Coupling bands for corrugated aluminized steel Type 2 pipe and pipe-arches shall be connected with steel bolts of not less than 1/2 Inch diameter and shall conform to ASTM A762 and Tables 203.02.05.03-I and 203.02.05.03-II.

TABLE 203.02.05.03-I

| Corrugation Size (Inches) | Minimum Width of Coupling Band (Inches) |
|------------------------------|---|
| 12 and Greater | 12 Minimum |
| Less than 12 | 7 Minimum |

TABLE 203.02.05.03-II

| Corrugation Size (Inches) | Minimum Width of Coupling Band (Inches) |
|------------------------------|---|
| 2 2/3 x 1/2 | 12 Minimum |
| 3 x 1 | 12 Minimum |
| 5 x 1 | 12 Minimum |

The gage of the coupling bands for aluminized steel Type 2 pipe and pipe-arches may be a maximum of two standard-use thicknesses lighter than that used for the pipe. Minimum thickness shall be 0.060 Inches. The coupling bands shall be fabricated from the same base metal as the base metal of the pipe.

203.02.05.04 Coupling Bands for Underdrains. Sleeve-type couplings may be substituted for the coupling bands for underdrains. The couplings shall not distort under normal conditions of use. Minimum thickness for underdrains shall be 0.060 Inches.

203.02.06 COATINGS, LININGS AND PAVINGS. When approved by the *Engineer*, shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, corrugated aluminum, steel, and aluminized steel Type 2 pipe, coupling bands and fittings shall be coated, lined, or paved.

203.02.06.01 Coatings. Coatings shall be applied to one or both pipe surfaces. Coupling bands need not be coated on the interior surface. Any appearances of pinholes, blisters, cracks, or lack of bond shall be cause for rejection.

203.02.06.01.01 Hot-Applied Bituminous Coating for CM Pipe and Pipe-Arches. Hot-applied bituminous coating for CM pipe and pipe-arches shall conform to AASHTO M 190, except that the bituminous material shall be at least 90 percent soluble in cold carbon disulfide.

203.02.06.01.01.01 Corrugated Aluminum Pipe and Pipe-Arches. Hot-applied bituminous coating paving for corrugated aluminum pipe and pipe-arches shall be applied to both surfaces. Minimum coating thickness shall be 0.050 Inches (50 Mil). The thickness shall be measured on the crest of the corrugations.

203.02.06.02 Linings.

203.02.06.02.01 Hot-Applied Bituminous Lining for CM Pipe and Pipe-Arches. Hot-applied bituminous lining for CM pipe and pipe-arches, shall conform to AASHTO M 190, except that the bituminous material shall be at least 90 percent soluble in cold carbon disulfide.

203.02.06.03 Pavings.

203.02.06.03.01 Hot-Applied Bituminous Paving for CM Pipe and Pipe-Arches. Hot-applied bituminous paving for CM pipe and pipe-arches shall conform to AASHTO M 190, except that the bituminous materials shall be at least 90 percent soluble in cold carbon disulfide.

203.02.07 JOINTS.

203.02.07.01 Watertight Joints.

203.02.07.01.01 Downdrains. Watertight joints for downdrains shall conform to the applicable requirements of Table 203.02.07.01.01-I.

Table 203.02.07.01.01-I

| Test | Test Method | Requirements | |
|---------------------------------------|-------------|------------------------|----------------|
| | | Pipe Diameter (Inches) | |
| | | 0 to 42 | 48 to 84 |
| Tensile Strength, Pull-Apart (Pounds) | ASTM D487 | 5,000 Minimum | 10,000 Minimum |
| | | | |

203.04 SP PIPE.

203.04.01 DESCRIPTION. This Subsection covers SP pipe, pipe-arches, and horizontal and vertical ellipses constructed from corrugated metal plates that are field assembled into their design shape; and the related appurtenances. Pipe covered by this Subsection is intended for use in drainage applications and other conveyance systems.

Round Pipe and Pipe-Arches. Pipe and pipe-arches shapes shall consist of metal plates that have been curved to a specific radius resulting with a rise and span dimension that meets the requirements of AASHTO and A/SI standards.

Horizontal and Vertical Ellipse. Horizontal and vertical ellipse shapes shall consist of metal plates that have been curved with multi-radii resulting with a rise and span dimension that meets the requirements of AASHTO and A/SI standards.

Underpass. Underpass shapes shall consist of metal plates that have been curved with multi-radii resulting with a rise and span dimension that meets the requirements of AASHTO and A/SI standards.

Nominal Dimensions. Nominal diameter for round pipe shall be defined as the minimum *ID* of the pipe. Nominal dimension (rise and span) for multi-radii shapes shall be defined as the minimum *ID* at maximum span and maximum rise of the structure.

203.04.02 IDENTIFICATION. Each individual plate shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the gage and /or thickness and the heat and/or lot number.

203.04.02.01 Corrugated Steel SP Pipe, Pipe-Arches, Horizontal and Vertical Ellipses, and Underpass Shapes. Each individual steel plate shall be clearly marked in accordance with AASHTO M 167.

203.04.02.02 Corrugated Aluminum SP Pipe, Pipe-Arches, Horizontal and Vertical Ellipses, and Underpass Shapes. Each individual aluminum plate shall be clearly marked in accordance with ASTM B746.

203.04.03 MATERIALS.

203.04.03.01 Corrugated Steel SP Pipe, Pipe-Arches, Horizontal and Vertical Ellipses, Field-Assembled. Corrugated steel structural plates used in the fabrication of corrugated steel structural shapes shall conform to the requirements of AASHTO M 167 and shall meet the minimum mechanical properties as shown in Table 203.04.03.01-I.

Table 203.04.03.01-I

| Test | Test Specification | Requirements |
|------------------------------|--------------------|------------------------------|
| Tensile Strength (PSI) | AASHTO M 167 | 45,000 Minimum |
| Yield Point (PSI) | AASHTO M 167 | 33,000 Minimum |
| Modulus Of Elasticity. (PSI) | AASHTO M 167 | 29 x 10 ⁶ Minimum |

203.04.03.02 Corrugated Aluminum SP Pipe, Pipe-Arches, Horizontal and Vertical Ellipses, and Underpass Shapes, Field-Assembled. corrugated aluminum structural plate used for the manufacture of corrugated aluminum structural shapes shall conform to ASTM B746 and shall meet the minimum mechanical properties as shown in Table 203.04.03.02-I.

Table 203.04.03.02-I

| Test | Test Specification | Requirements | |
|------------------------------|--------------------|------------------------------|------------------------------|
| | | Thickness (Inches) | |
| | | 0.100 to 0.175 | 0.176 to 0.250 |
| Tensile Strength (PSI) | AASHTO M 219 | 35,000 Minimum | 34,000 Minimum |
| Yield Point (PSI) | AASHTO M 219 | 24,000 Minimum | 24,000 Minimum |
| Modulus Of Elasticity. (PSI) | AASHTO M 219 | 10 x 10 ⁶ Minimum | 10 x 10 ⁶ Minimum |

203.04.04 FABRICATION. Fabrication of the plate shall conform to ASTM B746, ASTM A796 or AASHTO M 167 as applicable.

203.04.04.01 Corrugated Steel Plate Structures, Field-Assembled. Fabrication of corrugated steel plate structures which are field-assembled shall conform to ASTM A796.

203.04.04.01.01 Corrugations. The corrugations for all corrugated steel plate shall conform to the applicable requirements of Table 203.04.04.01-I. The corrugations shall be measured perpendicular to the direction of the corrugation.

Table 203.04.04.01-I

| 6 Inch x 2 Inch Corrugations | | | | |
|------------------------------|--------------------|-------------------------|-----------------------------|----------------------------|
| Gage | Thickness (Inches) | Area (Square Inch/Foot) | Radius of Gyration (Inches) | 1 x 1000 (Cubic Inch/Inch) |
| 12 | 0.111 | 1.556 | 0.682 | 60.411 |
| 10 | 0.138 | 2.003 | 0.684 | 78.175 |
| 8 | 0.168 | 2.449 | 0.686 | 96.163 |
| 7 | 0.188 | 2.739 | 0.688 | 108.000 |
| 5 | 0.218 | 3.199 | 0.690 | 126.922 |
| 3 | 0.249 | 3.650 | 0.692 | 146.172 |
| 1 | 0.280 | 4.119 | 0.695 | 165.836 |
| 3/16 | 0.318 | 4.671 | 0.698 | 190.000 |
| 3/8 | 0.375 | 5.613 | 0.704 | 232.000 |

203.04.04.02 Corrugated Aluminum Plate Structures, Field-Assembled. Fabrication of corrugated aluminum plate structures which are field-assembled shall conform to ASTM B746.

203.04.04.02.01 Corrugations. The corrugations for all corrugated aluminum plate shall conform to the applicable requirements of Table 204.04.04.02-I. The corrugations shall be measured perpendicular to the direction of the corrugation.

Table 204.04.04.02.01-I

| 9 Inch x 2-1/2 Inch | | | |
|---------------------|-------------------------|-----------------------------|----------------------------|
| Thickness (Inches) | Area (Square Inch/Foot) | Radius of Gyration (Inches) | 1 x 1000 (Cubic Inch/Inch) |
| 0.100 | 1.404 | 0.8438 | 83.065 |
| 0.125 | 1.750 | 0.8444 | 103.991 |
| 0.150 | 2.100 | 0.8449 | 124.883 |
| 0.175 | 2.449 | 0.8454 | 145.895 |
| 0.200 | 2.799 | 0.8460 | 166.959 |
| 0.225 | 3.149 | 0.8468 | 188.179 |
| 0.250 | 3.501 | 0.8473 | 209.434 |

203.04.04.03 High Strength Bolts and Nuts. Hot-dipped, specially heat-treated, 3/4 Inch diameter steel bolts conforming to ASTM A307 shall be used to assemble *SP* (steel and aluminum) plate sections. 3/4 Inch diameter bolt lengths shall conform to the applicable requirements of Table 203.04.04.03.-I.

Table 203.04.04.03-I

| Normal Bolt Usage | | | |
|-------------------|----------------------|-------------|--|
| Plate Gage | Bolt Length (Inches) | | |
| | 2 LAP SEAMS | 3 LAP SEAMS | |
| 12, 10, and 8 | 1-1/4 | 1-1/2 | |
| 7 and 5 | 1-1/2 | 1-3/4 | |
| 3 and 1 | 1-3/4 | 2 | |
| 5/16 and 3/8 | 2 | 2-1/2 | |

.203.04.05 FITTINGS.

203.04.05.01 Pre-Assembled Fittings. Pre-assembled fittings, including, but not limited to, elbows, skewers, and bevels shall be verified for manufacturing limits and shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.05 CI SOIL PIPE.

203.05.01 DESCRIPTION. This Subsection covers pipe constructed from gray cast iron. Pipe covered by this Subsection is intended for use in drain, waste, vent and drainage applications. This pipe should not be used for any pressure applications.

203.05.02 IDENTIFICATION. Each section of pipe, appurtenances and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, strength designation and nominal diameter.

203.05.03 MATERIALS. Materials used in the manufacture of *Ci* soil pipe shall conform to ASTM A74.

203.05.04 FABRICATION. Fabrication of the pipe shall conform to ASTM A74.

203.05.05 FITTINGS. Fittings shall include elbows, tees, wyes, plugs, caps, adapters, increasers and reducers.

203.05.01 Hub and Spigot. Hub and spigot fittings shall conform to ASTM A74.

203.05.02 Hubless. Hubless fittings shall conform to ASTM A888.

203.05.03 Rubber Gasket. Rubber gasket fittings shall conform to ASTM C564.

203.05.06 COATINGS, ENCASEMENTS, LININGS AND PAVINGS. All coatings shall be as specified by the applicable *Specifications* or as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. The coating shall be evenly and smoothly applied to all surfaces except threaded openings.

203.05.07 JOINTS. Joints shall be as required for the application as specified on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.06 DI PIPE.

203.06.01 DESCRIPTION. This Subsection covers pipe constructed from ductile iron. Pipe covered by this Subsection is intended for use in water distribution and transmission systems, force mains, sanitary sewers, drainage applications, and other conveyance systems.

203.06.02 IDENTIFICATION. Each section of pipe, appurtenances, and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, strength designation, weight without lining, nominal diameter, all applicable AWWA designations and the letters “DI” or “Ductile”.

203.06.03 MATERIALS. Materials used in the manufacture of *DI* pipe shall conform to AWWA C51, ASTM A716 or ASTM A746, as applicable.

203.06.04 FABRICATION. Fabrication of the pipe shall conform to AWWA C151, ASTM A716 or ASTM A746, as applicable.

203.06.05 FITTINGS. Fittings shall include elbows, tees, wyes, plugs, caps, adapters, increasers and reducers. Fittings shall comply with AWWA C110 or AWWA C153 as applicable.

203.06.06 COATINGS, ENCASEMENTS, LININGS, AND PAVINGS. All coatings, internal or external, shall be applied in accordance with the manufacturer’s recommendations.

203.06.06.01 Sanitary Sewer.

203.06.06.01.01 Linings. Unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, pipe with flexible lining used for sewer mains shall conform to ASTM A746. Unlined pipe and fittings shall not be used.

When shown the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* the internal surfaces of all *DI* pipe used for the conveyance of sewage shall be lined with a uniform thickness of an amine cured novolac epoxy conforming to the requirements of Table 203.06.06.01.01-I.

Table 203.06.06.01.01-I

| | Test Method | Requirement |
|--------------------------------------|-------------------------|-------------|
| Ceramic Quartz Pigment (% by Volume) | | 20 Minimum |
| Permeability Rating | ASTM E96 ⁽¹⁾ | 0.00 |

1. Use Method A, Procedure A for a 42 *Calendar Day* duration.

Unless waived by the *Engineer*, coupons obtained from the factory lined *DI* pipe shall conform to the requirements of Table 203.06.06.01.01-II.

Table 203.06.06.01.01-II

| | Test Method | Requirement |
|---|-----------------------------------|-------------|
| Salt Spray ⁽¹⁾ | ASTM B117 | (2) |
| Cathodic Disbondment (1.5 Volts at 77°F) | ASTM G95 | (3) |
| Immersion Test | ASTM D714 | |
| Using 20% Sulfuric Acid | | (4) |
| Using 25% Sodium Hydroxide at 140 °F | | (4) |
| Using Distilled Water at 160 °F | | (4) |
| Using Tap Water at 140 °F | | (5) |
| Acidithiobacillus Bateria (7 Days at 30°C) | ASTM G22 | Trace |
| Abrasion Resistance (mils) | EN 598 Section 7.8 ⁽⁶⁾ | 3 Maximum |

1. Use scribed panel.
2. Results equal to 0.0 undercutting after 730 *Calendar Days*.
3. Results equal to no more than 0.5 MM undercutting after 30 *Calendar Days*.
4. No effect after 730 *Calendar Days*.
5. 0.0 undercutting after 730 *Calendar Days* with no effect.
6. Loss after one million cycles.

203.06.06.02 Potable Water.

203.06.06.02.01 Encasements. Unless otherwise specified in the *Special Provisions* and/or *Special Technical Specifications*, *DI* pipe shall be encased in accordance with *ASTM A674*.

203.06.06.02.02 Linings. Unless otherwise specified in the *Special Provisions* and/or *Special Technical Specifications*, the internal surfaces of all *DI* pipe used for the conveyance of potable water shall be lined with a uniform thickness of cement mortar then sealed with a bituminous coating in accordance with *AWWA C104*.

203.06.07 JOINTS. *DI* Pipe joints shall conform to the applicable requirements of Table 203.06.07-I for the types shown on the *Plans* or in the *Special Provisions* and/or *Special Technical Specifications*.

Table 203.06.07-I

| Joint Type | Specification |
|-----------------------|---------------|
| Rubber Gasket Push-On | AWWA C111 |
| Mechanical | AWWA C111 |
| Flanged | AWWA C115 |

203.06.08 FLANGES. Flanges shall comply with AWWA C115.

203.06.09 BOLTS AND NUTS. Flanges shall comply with AWWA C111.

203.07 STEEL PIPE.

203.07.01 DESCRIPTION. This Subsection covers pipe constructed from steel plates or steel sheets. Pipe covered by this Subsection is intended for use in water distribution and transmission systems, drainage applications, and other conveyance systems.

203.07.02 IDENTIFICATION. Each section of pipe shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, nominal diameter and all applicable AWWA designations.

203.07.03 MATERIALS. Materials used in the manufacture of steel pipe shall conform to AWWA C200, ASTM A238, ASTM A570, or ASTM A36 as applicable.

203.07.03.01 Steel Sheets. Sheets used in the manufacture of steel pipe shall conform to ASTM A570, Grades 30 or 33.

203.07.03.02 Steel Plates. Plates used in the manufacture of steel pipe shall conform to ASTM A238, Grades C or D, or ASTM A36.

203.07.04 FABRICATION. Fabricated steel pipe shall conform to AWWA C200. Prior to fabrication, shop fabrication drawings for all pipe, fittings and joints shall be submitted to the Design Engineer for review and comment. Prior to any lining or coatings being applied, each size of pipe being fabricated shall be hydrostatically tested to 75 percent of the specified minimum yield strength of the steel sheets or plates used.

Mill-type steel water pipe shall conform to AWWA C200. Acceptable grades shall be ASTM A53 Grades A and B, ASTM A135, ASTM A139, and ASTM A134 (steel grade per AWWA C151 only).

203.07.05 FITTINGS. Fittings shall include elbows, returns, tees, reducers, increasers, and crosses. All fittings shall be manufactured from mill-type steel pipe in accordance with ANSI/B 16.9 and AWWA C208.

203.07.06 COATINGS, ENCASEMENTS, LININGS AND PAVINGS. The interior and exterior of all steel water pipe and fittings shall be coated by one of the following methods or as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.07.06.01 Cement-Mortar Lining and Coating. Cement-mortar linings and coatings shall conform to AWWA C05. If a curing compound is used, it shall conform to AWWA C205 and be left on the pipe for a minimum of 7 *Calendar Days*.

203.07.06.02 Asphaltic Mastic Coating. Asphaltic mastic coatings shall conform to “Asphaltic Protective Coating for Pipelines” of the Asphalt Institute, Construction series No. 96. Specifications M-2. A Grade 3 system shall be furnished.

203.07.06.03 Coal-Tar Enamel Lining and Coating. Coal-tar enamel linings and coatings shall conform to AWWA C203.

203.07.06.04 Cement-Mortar Lining. Cement-mortar linings shall conform to AWWA C305.

203.07.07 JOINTS. Joints for steel pipe shall be one of the types listed below. All rubber gaskets shall conform to AWWA C200.

203.07.07.01 General.

203.07.07.01.01 Bell and Spigot with Rubber Gaskets.

203.07.07.01.02 Lap Joints for Field Welding.

203.07.07.01.03 Plain Ends Fitted With Butt Straps for Field Welding. Pipe less than 27 Inches in diameter shall be furnished with a 4 Inch diameter hand hole with screw cap or plug for “pointing” the joint.

203.07.07.01.04 Mechanical Coupled Field Joints.**203.07.07.01.05 Plain End With Flanges.**

203.07.07.02 Mill-Type Steel Water Pipe. Joints for mill-type steel water pipe shall be one of the types listed below.

203.07.07.02.01 Mechanical Couplings.**203.07.07.02.02 Field Butt-Welded Joint.**

203.07.07.02.03 Flanged Joints. Flanges shall conform to *ASTM A181, ANSI B 16.5 and ANSI B 2.1*. Class 125 shall be the minimum class flange for water distribution lines.

203.08 VC PIPE.

203.08.01 DESCRIPTION. This Subsection covers pipe, and fittings from fire clay, shale, surface clay, or a combination of these materials that, when formed into a pipe and fired to suitable temperatures, yields a product that conforms to this specification. Pipe covered by this Subsection is intended for use in gravity sanitary sewer, drainage and industrial waste applications.

The material type, strength designation, thickness, nominal diameter and dimensions of the pipe, bends, bevels and fittings to be furnished shall conform to *ASTM C700* and the applicable requirements of Table 203.08.01-I, or as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

TABLE 203.08.01-I

| Nominal Size (Inches) | Minimum Test Loads (Pounds per Linear Foot) | |
|--------------------------|--|---------------|
| | Extra Strength | High Strength |
| 4 | 2000 | 2200 |
| 6 | 2000 | 2200 |
| 8 | 2200 | 2400 |
| 10 | 2400 | 2600 |
| 12 | 2600 | 2900 |
| 15 | 3100 | 3400 |
| 18 | 3600 | 4000 |
| 21 | 4200 | 4600 |
| 24 | 4800 | 5300 |
| 27 | 5200 | 5700 |
| 30 | 5500 | 6100 |
| 33 | 5800 | 6400 |
| 36 | 6300 | 6900 |
| 39 | 6600 | 7300 |
| 42 | 7000 | 7700 |

203.08.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.08.02 IDENTIFICATION. Each section of pipe shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the strength designation.

203.08.03 MATERIALS. VC pipe and fittings shall be manufactured from fire clay, shale, surface clay, or a combination of these materials that, when formed into a pipe and fired to suitable temperatures, yields a product that conforms to this specification.

203.08.03.01 Microtunneling, Sliplining, Pipe Bursting, and Tunnels. Pipe used for microtunneling, sliplining, pipe bursting, and tunnels shall conform to ASTM C1208. The pipe shall have a minimum compressive strength of 7000 PSI. The pipe joint collar shall be manufactured of Series 316 stainless steel. A factory supplied load distributing compression ring shall be placed at each joint of pipe.

203.08.04 FITTINGS. Fittings shall include elbows, tees, wyes, plugs, caps, adapters, increasers and reducers.

203.08.05 JOINTS. Joints for vitrified clay pipe and fittings shall be manufactured in accordance with ASTM C700 and C425.

203.09 NRC PIPE.

203.09.01 DESCRIPTION. This Subsection covers pipe constructed from non-reinforced concrete. Pipe covered by this Subsection is intended for use in sanitary sewers, drainage applications, and other conveyance systems.

Strength class of NRC pipe shall be as identified in ASTM C14, Class 1, Class 2, or Class 3 NRC pipe. Unless otherwise specified, Class 3 NRC pipe shall be used.

203.09.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.09.02 IDENTIFICATION. Each section of pipe shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, strength designation, and nominal diameter.

203.09.03 MATERIALS. Materials used in the manufacture of non-reinforced concrete pipe shall conform to ASTM C14.

203.09.03.01 Cementitious and Related Materials. Cement and related materials shall conform to Section 202 – “Cementitious and Related Materials”.

203.09.03.02 Aggregates. Aggregates shall conform to ASTM C33, except that the requirement for gradation shall not apply.

203.09.04 FABRICATION. Fabrication of the pipe shall conform to ASTM C14.

203.09.04.01 Calcium Chloride. The pipe manufacturer shall certify that no calcium chloride or admixtures containing chloride or calcium chloride has been used in the manufacture of the pipe.

203.09.05 FITTINGS. Fittings shall be fabricated of the same material as the pipe and shall include elbows, tees, wyes, plugs, caps, adapters, increasers, and reducers.

203.09.06 COATINGS, ENCASEMENTS, LININGS, AND PAVINGS. When approved by the *Engineer*, shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, NRC pipe shall be coated. All coatings, internal or external applications shall be applied in accordance with the manufacturer's recommendations.

203.09.07 JOINTS. The type of joint to be used shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. If no type is shown or specified, the joint may be any of the types listed below. Only one type of joint shall be used on any run of pipe.

203.09.07.01 T & G Mortar Joints. *T & G* mortar joints shall be sealed with mortar or grout consisting of one part cement and two parts sand, by volume. The quantity of water in the mixture shall produce a soft workable mortar, but shall not exceed a water-cement ratio of 0.53.

203.09.07.02 T & G Mastic Joints. *T & G* mastic joints shall be sealed with pre-formed flexible joint sealant conforming to ASTM C990. The material shall be applied in accordance with the manufacturer's recommendations. A single or double application of joint material may be used. If not specified by the *Engineer*, shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, a single application is acceptable.

203.09.07.03 Flexible Gasket Joints. Rubber gasket joints shall conform to ASTM C443 or ASTM C1619. The gasket may be either a circular or non-circular shape.

Unless the pipe will be installed by jacking or boring methods, in lieu of the gaskets conforming to ASTM C1619 or mastic material conforming to ASTM C990, the following extruded cellular rubber gaskets may be used for soil tight applications:

203.09.07.03.01 Extruded Cellular Rubber Gaskets. Gaskets shall be manufactured from extruded closed cellular rubber, and meeting the physical requirements of ASTM D1056, Class 2C1. Each gasket shall be a single continuous part, conforming to the joint size and shape. The outer surface shall be completely covered with a smooth, impermeable natural skin of the same material.

Gasket cross-sectional diameters and installation practices, to include maximum and minimum joint gaps, shall be in accordance with the manufacturer's recommendations. The *Contractor* shall submit a copy of the manufacturer's installation instructions.

203.09.07.04 Flexible Sealant. Flexible sealant material shall conform to ASTM C990.

203.10 RC PIPE.

203.10.01. DESCRIPTION. This Subsection covers pipe and elliptical pipe constructed from reinforced concrete. Pipe covered by this Subsection is intended for use in sanitary sewers, drainage applications, and other conveyance systems. Such pipe shall conform to ASTM C76, ASTM C506, ASTM C507 or ASTM C655, as applicable and except as modified herein.

Unless otherwise specified, pipe shall be cast, spun or machine-made.

203.10.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.10.02 IDENTIFICATION. Each section of pipe, appurtenances, and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, strength designation, and nominal diameter.

203.10.03 MATERIALS. Materials used in the manufacture of RC Pipe shall conform to ASTM C76, ASTM C506, ASTM C507 or ASTM C655, as applicable.

203.10.03.01 Cementitious and Related Materials. Cementitious and related materials shall conform to Section 202 – “Cement and Related Materials”.

203.10.03.02 Aggregates. Aggregates shall conform to ASTM C33, except that the requirement for gradation shall not apply.

203.10.04 FABRICATION. Fabrication of the pipe shall conform to ASTM C76 for round pipe, ASTM C506 for arch pipe and ASTM C507 for elliptical pipe.

203.10.04.01 Calcium Chloride. The pipe manufacturer shall certify that no calcium chloride or admixtures containing chloride or calcium chloride has been used in the manufacture of the pipe.

203.10.04.02 Lift Holes. Lift holes (located by the manufacturer) may be installed in each pipe. Lift holes shall be plugged prior to backfilling as shown on the *Plans* or in the *Special Provisions* and/or *Special Technical Specifications*. Optional methods of lifting may be used as approved by the *Engineer*.

203.10.05 FITTINGS. Fittings shall be fabricated of the same material as the pipe and shall include elbows, tees, wyes, plugs, caps, adapters, increasers and reducers.

203.10.06 COATINGS, ENCASEMENTS, LININGS, AND PAVINGS.

203.10.06.01 Coatings. When approved by the *Engineer*, shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, RC pipe shall be coated. All coatings, internal or external applications shall be applied in accordance with the manufacturer's recommendations.

203.10.06.02 Linings. When required by the *Engineer*, linings shall be either *HDPE* or *PVC*, as shown on the *Plans* or in the *Special Provisions* and/or *Special Technical Specifications*. Liner material properties shall be listed in the *Special Provisions* and/or *Special Technical Specifications*.

203.10.07 JOINTS. The type of joint to be used shall be shown on the *Plans* or in the *Special Provisions* and/or *Special Technical Specifications*. If no type is shown or specified, the joint may be any of the types listed below. Only one type of joint shall be used on any run of pipe.

203.10.07.01 T & G Mortar Joints. T & G mortar joints shall be sealed with mortar or grout consisting of one part cement and two parts sand, by volume. The quantity of water in the mixture shall produce a soft workable mortar, but shall not exceed a water-cement ratio of 0.53.

203.10.07.02 T & G Mastic Joints. T & G mastic joints shall be sealed with pre-formed flexible joint sealant conforming to ASTM C990. The material shall be applied in accordance with the manufacturer's recommendations. A single or double application of joint material may be used. If not specified by the Engineer, a single application is acceptable.

203.10.07.03 Gasket Joints. Gasket joints shall conform to ASTM C361 or ASTM C1619. The gasket may be either a circular or non-circular shape.

Unless the pipe will be installed by jacking or boring methods, in lieu of the flexible joints conforming to Subsections 203.10.07.02 or 203.10.07.03, the following extruded cellular rubber gaskets may be used for soil tight applications:

203.10.07.03.01 Extruded Cellular Rubber Gaskets. Gaskets shall be of tubular cross section, manufactured from extruded closed cellular rubber, and meeting the physical requirements of ASTM D1056, Class 2C1. Each gasket shall be a single continuous part, conforming to the joint size and shape. The outer surface shall be completely covered with a smooth, impermeable natural skin of the same material.

Gasket cross-sectional diameters and installation practices, to include maximum and minimum joint gaps, shall be in accordance with the manufacturer's recommendations. Submit a copy of the manufacturer's installation instructions.

This type of gasket shall not be used when the pipe is installed by jacking or boring methods.

203.11 THIS SUBSECTION INTENTIONALLY LEFT BLANK.

203.12 RC PRESSURE PIPE.

203.12.01 DESCRIPTION. This Subsection covers pressure pipe and pressure cylinder pipe constructed from reinforced concrete. Pipe covered by this Subsection is intended for use in supply pipelines, and distribution and transmission systems that carry water under pressure.

203.12.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.12.01.02 Pipe Type. This Subsection applies to four types of pipe.

203.12.01.02.01 RC Steel Cylinder Pipe. RC steel cylinder pipe shall conform to AWWA C300.

203.12.01.02.02 Prestressed Concrete Steel Cylinder Pipe. Prestressed concrete steel cylinder pipe shall conform to AWWA C301.

203.12.01.02.03 RC Non-Cylinder Pipe. RC non-cylinder pipe shall conform to AWWA C302.

203.12.01.02.04 RC Low-Head Pressure Pipe. RC low-head pressure pipe shall conform to ASTM C361.

203.12.02 IDENTIFICATION. Each section of pipe shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, strength designation and nominal diameter can be readily identified.

203.12.03 MATERIALS. Materials used in the manufacture of RC pressure pipe shall conform to AWWA C300, AWWA C301, AWWA C302, or ASTM C361 depending upon the pipe type designated on the *Plans* or in the *Special Provisions* and/or *Special Technical Specifications*.

203.12.03.01 Cementitious and Related Materials. Cementitious and related materials shall conform to Section 202 – “Cementitious and Related Materials”.

203.12.04 FABRICATION. Fabrication of the pipe shall be in accordance with AWWA C300 for *RC* steel cylinder pipe, AWWA C301 for prestressed concrete steel cylinder pipe, AWWA C302 for *RC* non-cylinder pipe and ASTM C361 for *RC* low-head pressure pipe.

203.12.04.01 Calcium Chloride. The pipe manufacturer shall certify that no calcium chloride or admixtures containing chloride or calcium chloride has been used in the manufacture of the pipe.

203.12.04.02 Lift Holes. Lift holes are not allowed in *RC* pressure pipe.

203.12.05 FITTINGS. Fittings shall be fabricated of the same material as the pipe and shall include elbows, tees, wyes, plugs, caps, adapters, increasers and reducers.

203.12.06 JOINTS. Joints and gaskets shall be as specified in the particular pipe standard that is specified in the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. Minimum bell reinforcement shall be as specified in Table 2 in the Appendix of the U.S. Bureau of Reclamation Standard Specifications for Reinforced Concrete Pressure Pipe.

203.13 THIS SUBSECTION INTENTIONALLY LEFT BLANK.

203.14 ABS PIPE.

203.14.01 DESCRIPTION. This Subsection covers pipe constructed from *ABS* composite compounds. Pipe covered by this Subsection is intended for use in sanitary sewers and drainage applications and other conveyance systems. The pipe shall conform to *ASTM D2680* (composite pipe) or *ASTM D2751* (solid wall pipe) and as specified on the *Plans* or in the *Special Provisions* and/or *Special Technical Specifications*.

The material type, strength designation, nominal diameter and dimensions of the pipe to be furnished shall be shown on the *Plans* or in the *Special Provisions* and/or *Special Technical Specifications*.

203.14.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.14.02 IDENTIFICATION. Each section of pipe and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, strength designation, and nominal diameter.

203.14.03 MATERIALS. Materials used in the manufacture of the pipe shall conform to *ASTM D2680* or *ASTM D2235* as applicable. Plastic shall contain polymers or blends of polymers meeting the following requirements listed below. The polymer fraction by weight shall add up to 100 in any specific compound. Additives such as stabilizers, anti-oxidants, lubricants, and colorants, shall not exceed 10 parts by weight per 100 parts of polymer.

203.14.03.01 Acrylonitrile. Pipe shall contain 13 to 35 minimum parts acrylonitrile content by weight.

203.14.03.02 Butadiene. Pipe shall contain 8 to 16 minimum parts butadiene content by weight.

203.14.03.03 Styrene. Pipe shall contain 40 to 70 minimum parts styrene content by weight.

203.14.04 FABRICATION. Fabrication of the pipe shall conform to *ASTM D2680* or *ASTM D2751* as applicable. Minimum wall thickness of solid wall *ABS* pipe shall correspond with *SDR 35* requirements.

203.14.04.01 Test Specimens. Unless waived by the *Engineer* the manufacturer shall prepare test specimens in accordance with *ASTM D3641*, and test for impact in accordance with *ASTM D256*, Method A, tensile strength in accordance with *ASTM D 628* and weight changes in accordance with *ASTM D543*. Unless waived by the *Engineer*, testing for elongation at break, *ASTM D412*, compression set, *ASTM D395*, Method B, and physical requirements after exposure to ozone, *ASTM D1149*, will also be required.

203.14.05 FITTINGS. Fittings shall include elbows, tees, wyes, plugs, caps, adapters, increasers and reducers.

203.14.06 JOINTS. Joints shall be sealed with *ABS* joint solvent cement supplied by the pipe manufacturer and conforming to *ASTM D2235*.

203.15 PVC PRESSURE PIPE.

203.15.01 DESCRIPTION. This Subsection covers pressure pipe constructed from *PVC* compounds. Pipe covered by this Subsection is intended for use in water transmission and distribution systems, force mains, sanitary sewers, and other conveyance systems.

The material type and nominal diameter of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.15.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.15.02 IDENTIFICATION. Each section of pipe and fittings shall, at a minimum, be clearly marked in accordance with AWWA C900 and AWWA C905, as applicable.

203.15.03 MATERIALS. Materials used in the manufacture of *PVC* pressure pipe and fittings shall consist of *PVC* compounds which conform to ASTM D1784. The pipe and materials shall be manufactured of *PVC* compounds having a minimum cell classification of 12454 as defined in ASTM D1784. Compounds that have different cell classifications than required by ASTM D1784 which are equal to or exceed this standard are also acceptable as approved by the *Engineer*.

Pipe and fittings shall meet the requirements of AWWA C900 for *CIOD*'s of 4 Inch through 12 Inch or AWWA C905 for *CIOD*'s 14 Inch through 48 Inch.

203.15.03.01 Water Transmission and Distribution. Unless otherwise specified for a higher pressure class designation, *PVC* pressure pipe shall be a minimum Pressure Class 235 DR 18 meeting the requirements of AWWA C900 for nominal diameters of 4 Inch through 12 Inch and a minimum Pressure Class 235 DR 18 conforming to AWWA C905 for nominal diameters of 14 Inch through 48 Inch.

203.15.03.02 Reclaimed Water. *PVC* pressure pipe used for reclaimed water shall be colored purple.

PVC pressure pipe shall have been manufactured within the 730 *Calendar Day* period prior to installation.

203.15.04 FABRICATION. Fabrication of the pipe shall conform to AWWA C900 or AWWA C905, as applicable.

203.15.05 FITTINGS. Unless otherwise specified or shown on the drawings, all fittings to be used with *PVC* pressure pipe shall conform to either AWWA C110 or AWWA C153.

203.15.06 JOINTS. Joints shall be watertight in accordance with ASTM D3139 and joined with a gasketed integral bell and spigot joint. Gaskets shall conform to ASTM F477.

203.16 SOLID WALL HDPE PIPE.

203.16.01 DESCRIPTION. This Subsection covers solid wall pipe and fittings constructed from *HDPE*. Pipe covered by this Subsection is intended for use water transmission and distribution systems, force mains, sanitary sewers, drainage applications, and other conveyance systems.

The material type, strength designation, thickness, nominal diameter and dimensions of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.16.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.16.02 IDENTIFICATION. Each section of pipe and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the strength designation, thickness, nominal diameter and weight.

203.16.03 MATERIALS. Materials used in the manufacture of high density polyethylene pipe shall conform to ASTM F714 and the following requirements:

203.16.03.01 Gravity Pipe. Pipe and fitting material shall conform to ASTM D3350 with a cell classification of 345464C or 345464E.

203.16.03.02 Pressure Pipe. Pipe and fitting material shall conform to ASTM D3350 with a cell classification of 445474C or 445574C.

203.16.03.02.01 Potable Water. Pipe and fitting material shall conform to ASTM D3350, *NSF* 61-Drinking Water Systems and AWWA C901 and AWWA C906 as applicable.

203.16.04 FABRICATION. Fabrication of pipe shall conform to ASTM D3261, ASTM F1055, and ASTM F2206 as applicable.

203.16.05 FITTINGS. Fittings shall be injection molded, molded butt fusion, electrofusion, fabricated or welded and shall include elbows, tees, manhole adapter rings, plugs, caps, adapters and reducers.

203.16.06 REPAIR. Pipe that does not conform to the referenced standards shall not be used.

203.17 CORRUGATED HDPE PIPE.

203.17.01 DESCRIPTION. This Subsection covers corrugated pipe and fittings constructed from *HDPE* material. Pipe covered by this Subsection is intended for use in sanitary sewers, drainage applications, and other conveyance systems.

The material type, strength designations, thickness, nominal diameter and dimensions of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.17.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.17.02 IDENTIFICATION. Each section of pipe and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the strength designation, thickness, nominal diameter and weight.

203.17.03 MATERIALS. Materials used in the production of *HDPE* pipe and fittings shall be virgin *HDPE* conforming to the minimum requirements of cell classification 424420C for 4-through 10 inch diameters, or 435400C for 12- through 60-inch diameters conforming to *ASTM D3350*, except that carbon black content should not exceed 4 percent. The 12- through 60-inch virgin pipe material shall comply with the *NCLS* test as specified in Section 5.1 of *ASTM F2306*.

203.17.03.01 Single Wall Pipe. 4-10" shall conform to *AASHTO M252*, Type C. 12-24" shall conform to *AASHTO M 294*, Type C.

203.17.03.02 Dual Wall Pipe. 4-10" shall conform to *AASHTO M 252*, Type S, 12-60" shall conform to *AASHTO M294*, Type S or *ASTM F2306*.

203.17.04 FABRICATION. Fabrication of pipe shall conform to *ASTM F2306*, *AASHTO M 252*, or *AASHTO M 294* as applicable. Fabrication of pipe fittings shall conform to *ASTM F2306*, *AASHTO M 252*, or *AASHTO M 294* and shall be performed by the pipe manufacturer. As directed by the *Engineer* or as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* pipe may be perforated.

203.17.05 FITTINGS. Fittings shall be injection molded or welded and shall include elbows, tees, manhole adapter rings, plugs, caps, adapters and reducers. Bell and spigot joints shall use a spun-on or welded bell with valley or saddle gasket meeting the joint requirements in this Subsection.

203.17.06 JOINTS. Joints shall be watertight in accordance with *ASTM D3212* and joined with a gasketed integral bell and spigot joint. Gaskets shall conform to *ASTM F477*. Perforated pipe joints shall be soil tight.

203.17.07 REPAIR. Pipe shall be repaired in accordance with the manufacturer's recommendations.

203.18 GEOCOMPOSITE DRAINAGE PIPE.

203.18.01 DESCRIPTION. This Subsection covers geocomposite drainage pipe and fittings manufactured from corrugated *HDPE*. Pipe covered by this Subsection is intended for use in subsurface drainage applications.

The material type and nominal diameter of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.18.01.01 Nominal Dimensions. Geocomposite drainage pipe shall be 12 Inch and 18 Inch wide or tall and have a thickness of 1.5 Inches. Slot length shall be 1.125 Inches long and 0.125 Inches wide for 12 Inch geocomposite drainage pipe. Slot length shall be 1.125 Inches long and 0.15 Inches wide for 18 Inch geocomposite drainage pipe.

203.18.02 IDENTIFICATION. Each section of pipe and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the strength designation, thickness, nominal dimensions and weight.

203.18.03 MATERIALS. All pipe and fittings shall be manufactured of corrugated high density polyethylene with a minimum cell classification of 424420C as defined in *ASTM D3350*. The material shall be made available in long rolls to minimize the use of fittings and joints.

203.18.03.01 Filter Fabric. Geocomposite drainage pipe shall be made available with and without an external geotextile fabric. The use of geotextile fabric shall be as specified by the *Engineer*. When required, geotextile fabrics shall conform to the applicable requirements of Table 203.18.03.01-I.

TABLE 203.18.03.01-I

| Fabric Properties | Test Method | Requirements |
|--|-------------|--------------|
| Grab Tensile Strength (lbs), Weakest principle direction | ASTM D4632 | 120 |
| Grab Elongation (%), Weakest principle direction | ASTM D4633 | 60 |
| Trapezoidal Tear (lbs), Weakest principle direction | ASTM D4533 | 40 |
| Puncture (lbs) | ASTM D3786 | 30 |
| Permittivity | ASTM D4491 | 0.7 |
| Apparent Opening Size (US Sieve Size) | ASTM D4751 | 60 |
| U.V. Resistance (% Retained) | ASTM D4355 | 70 |

203.18.04 FABRICATION. Fabrication of pipe and fittings shall conform to ASTM D7001.

203.18.05 FITTINGS. Fittings shall be injection molded or welded and shall include elbows, tees, manhole adapter rings, plugs, adapters and reducers. Other fittings shall be made available including end caps, wyes, end outlets, flat outlets, and side outlets.

203.18.06 JOINTS. Connection between rolls shall be made with fittings and/or couplings.

203.18.07 REPAIR. Pipe that does not conform to the referenced standards shall not be used.

203.19 PP PIPE.

203.19.01 DESCRIPTION. This Subsection covers profile wall pipe and fittings constructed from *PP*. Pipe covered by this Subsection is intended for use in sanitary sewer and drainage applications.

The material type, strength designation, thickness, nominal diameter and dimensions of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.19.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe.

203.19.02 IDENTIFICATION. Each section of pipe and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the strength designation, thickness, nominal diameter and weight.

203.19.03 MATERIALS. Materials used in the manufacture of *PP* and fittings shall be manufactured from virgin material conforming to ASTM D4101, except as modified herein.

203.19.03.01 Dual Wall Pipe. Dual wall pipe and fittings in diameters 6 Inch through 60 Inch shall have a corrugated exterior and have a smooth interior liner and conform to ASTM F2736 and AASHTO M 330.

203.19.03.02 Triple Wall Pipe. Triple wall pipe and fittings in diameters 30 Inch through 60 Inch shall have a smooth exterior liner, corrugated interior wall and smooth interior liner and conform to ASTM F2764.

203.19.03.03 Flexible Elastomeric Gaskets. Gaskets shall be manufactured in accordance with ASTM F477.

203.19.04 FABRICATION. Fabrication of *PP* pipe and fittings shall conform to ASTM F2736 and F2764 and shall be performed by the pipe manufacturer.

203.19.05 FITTINGS. Fittings shall be injection molded or welded *PP* and shall include elbows, tees, manhole adapter rings, plugs, caps, adapters and reducers. Bell and spigot joints shall use a spun-on or welded bell with valley or saddle gasket meeting the joint requirements in this section. Fittings may also be *SDR 35 PVC* upon request for diameters up to 30 Inch. Gaskets shall conform to ASTM F477. As directed by the *Engineer* or as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* pipe may be perforated.

203.19.06 JOINTS. Joints shall be watertight in accordance with ASTM D3212 and joined with a dual gasketed integral bell and spigot joint. Gaskets shall conform to ASTM F477.

203.19.06.01 Gravity Storm Sewer. Gravity storm sewer applications shall use either a dual gasket.

203.19.06.02 Gravity Sanitary Sewer. Gravity sanitary sewer applications shall use a double gasketed joint and have a minimum strength of 46 pounds per inch diameter.

203.19.07 REPAIR. Pipe that does not conform to the referenced standards shall not be used.

203.20 PVC GRAVITY PIPE.

203.20.01 DESCRIPTION. This Subsection covers gravity pipe constructed from *PVC* compounds. Pipe covered by this Subsection is intended for use in sanitary sewers, drainage applications and other conveyance systems.

The material type, nominal diameter and wall thickness of the pipe, appurtenances and fittings to be furnished shall be in accordance with the applicable *ASTM* designation and as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.20.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe, including allowable manufacturing tolerances.

203.20.02 IDENTIFICATION. Each section of pipe shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the manufacturer’s production code, production date, nominal pipe size, pipe stiffness, and resin cell classification.

203.20.03 MATERIALS. Materials used to manufacture profile wall *PVC* pipe and related fittings and appurtenances shall be *PVC* compounds having a minimum cell classification as listed below based on pipe type as defined and described in *ASTM D1784*. Pipe and fittings shall conform to *ASTM D3034 SDR 35* or greater for nominal diameters of 4 Inches through 15 Inches. Pipe and fittings shall conform to *ASTM F679* for nominal diameters of 18 Inches through 36 Inches.

The pipe and materials shall be manufactured of *PVC* compounds having a minimum cell classification of 12454 as defined in *ASTM D1784*. Compounds that have different cell classifications because one or more properties are superior to those of the specified compounds are also acceptable as approved by the Engineer.

203.20.03.01 PVC Solid Wall Gravity Pipe. Pipe and fittings shall conform to *ASTM D3034 SDR 35* or greater for nominal diameters 4 Inch through 15 Inch. Pipe and fittings shall conform to *ASTM F679* for nominal diameters 18 Inch through 48 Inch.

Minimum “pipe stiffness” ($F/\Delta y$) at 5 percent deflection shall be 46 *PSI* for *SDR 35* and 115 *PSI* for *SDR 26* for all sizes when tested in accordance with *ASTM D2412*.

203.20.03.02 Profile Wall PVC Pipe shall conform to *ASTM F949*. Profile Wall *PVC* Pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects.

203.20.03.03 Type 46 Pipe. Pipe shall be manufactured to a stiffness of 46 *PSI* when tested in accordance with *ASTM D2412*. There shall be no evidence of splitting, cracking or breaking when the pipe is tested. Pipe shall have a minimum cell classification of 12454 as defined in *ASTM D1784*.

203.20.03.04 Type 115 Pipe. Pipe shall be manufactured to a stiffness of 115 *PSI* when tested in accordance with *ASTM D2412*. Pipe shall have a minimum cell classification of 12454 as defined in *ASTM D1784*.

203.20.03.05 PVC Ribbed or High Profile Gravity Pipe. Pipe and fittings shall be manufactured from *PVC* compounds as defined and described in *ASTM D1784*. Pipe and fittings shall conform to *ASTM F949/ASTM F794* or *AASHTO M 304*.

The pipe and materials shall be manufactured of *PVC* compounds having a minimum cell classification of 12454 or 12364 as defined in *ASTM D1784*. Compounds that have different cell classifications because one or more properties are superior to those of the specified compounds are also acceptable as approved by the Engineer.

Minimum pipe stiffness ($F/\Delta y$) at 5 percent deflection shall be 46 psi when tested in accordance with *ASTM D2412*.

203.20.04 FABRICATION. Perforated pipe shall be as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. For slotted and standard perforated pipe, the perforation dimensions shall conform to *ASTM F949*. Instead of slots, round holes 1/4 Inch in diameter may be used for 15 Inch and 18 Inch diameter pipe and 3/8 Inch diameter for 21 Inch through 48 Inch diameter pipe.

203.20.05 FITTINGS. All fittings for profile wall *PVC* pipe shall conform to *ASTM F949*. To insure compatibility, the pipe manufacturer shall provide all fittings. Fittings for Type 46D pipe shall conform to *ASTM F949*.

203.20.06 JOINTS. Pipe shall be configured such that it can be joined on the project site with integrally-formed bell and spigot gasketed connections. The manufacturer shall provide documentation showing no leakage when gasketed pipe joints are tested in accordance with *ASTM D3212*. Elastomeric seals (gaskets) shall conform to *ASTM F477*. Gaskets shall have a double fluted cross section. Gaskets shall be protected from damage during shipping, handling and storage. Appropriate lubricant shall be supplied by the manufacturer.

203.20.07 REPAIR. Pipe that does not conform to the referenced standards shall not be used.

203.21 CENTRIFUGALLY CAST *FRPM* PIPE.

203.21.01 DESCRIPTION. This Subsection covers centrifugally cast pipe constructed from *FRPM*. Pipe covered by this Subsection is intended for use in sanitary sewers, drainage applications, and other conveyance systems. Centrifugally cast *FRPM* pipe conforming to *ASTM D3262*, or as modified herein, may be used for direct bury installation, jacking installation, and sliplining installation in gravity service applications. Centrifugally cast *FRPM* pipe conforming to *ASTM D3754*, or as modified herein, may be used in pressure applications.

The material type, strength designation, nominal diameter and dimensions of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. Unless otherwise specified, pipe shall be manufactured by the centrifugal casting process.

203.21.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe which shall be within plus or minus 5 percent of the specified diameter.

203.21.02 IDENTIFICATION. Each section of pipe and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the production date, strength designation and nominal diameter.

203.21.03 MATERIALS. Materials used in the manufacture of *FRPM* shall conform to *ASTM D3262*, and *ASTM D3754* and shall have a minimum cell class 123 (Type 1, Liner 2 and Grade 3).

203.21.03.01 Resin Systems: Only isophthalic polyester resin systems with a proven history of performance in this particular application shall be used. A reference list of projects constructed in the United States with a combined minimum total footage total of 3,500,000 lineal foot of pipe with a diameter of 36 Inches or greater installed in the US and Canada conveying gravity sanitary and/or storm flow shall be provided as part of the submittals.

203.21.03.02 Glass Reinforcement: The reinforcing glass fibers used shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

203.21.03.03 Silica Sand: Sand shall be minimum 98 percent silica with a maximum moisture content of 0.2 percent.

203.21.03.04 Additives: Resin additives, such as curing agents, pigments, dyes, fillers, and thixotropic agents, when used, shall not detrimentally affect the performance of the product. No dyes and or fillers are allowed in the liner resin. Liner should be free of colorants to allow for field inspection by the owner representative.

203.21.04 FABRICATION. Fabrication of the pipe shall conform to *ASTM D3262* with Cell Limits Type 1, liner 2, Grade 3 and Pipe Stiffness Class C or higher. Centrifugally cast *FRPM* pipe shall have been fabricated within the 180 *Calendar Day* period prior to installation.

203.21.05 FITTINGS. Fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy coated steel and stainless steel fittings may also be used.

203.21.06 COATINGS, ENCASEMENTS, LININGS AND PAVINGS. When approved by the *Engineer*, coatings may be used on centrifugally cast *FRPM* pipe. All coatings, internal or external applications shall be applied in accordance with the manufacturer's recommendations.

203.21.06.01 Exterior UV Protection Layer. The layer shall be comprised of a 90 percent sand and 10 percent resin by volume without any fiberglass surface tapes placed over or within the *UV* layer. No glassfibers or resin coated exterior is allowed. Jacking pipe shall have a 20 mil compressed smooth silica sand exterior for impact and abrasion resistance during jacking and microtunneling in accordance with *ASTM D3262* Grade 3 only.

203.21.07 JOINTS. The type of joint to be used shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.21.07.01 Direct Bury – Gravity Service. The joint shall be field connected with fiberglass Filament Wound Couplings which use a mechanically built-in double-fin elastomeric sealing gaskets made of *EPDM* rubber compound. The joints shall conform to *ASTM D4161*. The joint shall withstand 200 feet of external head pressure.

203.21.07.02 Jacking – Gravity Service. The joint shall be field connected with fiberglass sleeve couplings or bell-spigot joints which use elastomeric sealing gaskets made of *EPDM*. The joints shall conform to *ASTM D4161*.

203.21.07.03 Sliplining – Gravity Service. The joint shall be field connected with low-profile, fiberglass bell-spigot joints or flush fiberglass bell-spigot joints which use elastomeric sealing gaskets made of *EPDM*. The joints shall conform to *ASTM D4161*.

203.21.07.04 Pressure Service. The joints shall be field connected with fiberglass sleeve couplings which use elastomeric sealing gaskets made of *EPDM*. All gaskets shall act as the sole means to maintain joint watertightness. The joints shall conform to *ASTM D4161*.

203.22 STEEL REINFORCED HDPE PIPE.

203.22.01 DESCRIPTION. This Subsection covers pipe, fittings, gaskets and related appurtenances manufactured from galvanized steel reinforced *HDPE*. Steel reinforced *HDPE* pipe is intended for sanitary sewer, drainage applications, and other conveyance systems.

The material type, joint designation, nominal diameter, and dimensions of the pipe, appurtenances and fittings to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.22.01.01 Nominal Diameter. Nominal diameter is defined as the minimum inside diameter of the pipe with allowance for manufacturing tolerance in accordance with *ASTM F2562*.

203.22.02 IDENTIFICATION. Each section of pipe shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the trade name or trademark; manufacturer's code, identifying the plant location and machine; production date; nominal pipe size in inches, and pipe stiffness class.

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.

203.22.03 MATERIALS. Materials used in the manufacture of steel reinforced *HDPE* pipe and fittings shall conform to the following requirements:

203.22.03.01 ASTM D3350. Steel reinforced *HDPE* pipe and fittings shall be manufactured from virgin, *HDPE*, stress-rated resins conforming to the minimum requirements of cell classification 345464 C as defined in *ASTM D3350*.

203.22.03.02 ASTM F2562. Steel reinforced *HDPE* pipe and fittings shall be manufactured and/or fabricated in accordance with *ASTM F2562*. Steel reinforced *HDPE* pipe shall have a smooth waterway wall and ribbed exterior profile.

203.22.03.03 Base Steel Materials. Continuous high strength galvanized ribs shall be cold rolled steel conforming to either *ASTM A1008* or *ASTM A1011* with minimum yield strength of 80,000 *PSI*. The steel shall have a galvanized coating conforming to *ASTM A653* with a G60 minimum coating weight. Steel ribs shall be completely encased within the *HDPE* profile.

203.22.03.04 HDPE Material Composition. Steel reinforced *HDPE* pipe material and fittings shall, in accordance with *ASTM F2562*, be made from *HDPE* plastic compound conforming to the minimum requirements of cell classification 335464C or higher cell classification, in accordance with *ASTM D3350* and *AASHTO MP-20*.

203.22.03.05 Gaskets. Elastomeric gaskets shall comply with the requirements in *ASTM F477* and be as recommended by the pipe manufacturer.

203.22.03.06 Water Stops. Elastomeric Water stop gaskets shall conform to the requirements of *ASTM C923*.

203.22.03.07 Thermal Welding Material. The material used for thermal welding of the pipe shall be compatible with the pipe's base material.

203.22.03.08 Lubricant. The lubricant used for assembly shall comply with the manufacturer's recommendations and have no detrimental effect on the gasket or pipe.

203.22.03.09 Joining Systems.

203.22.03.09.01 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 water tight 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 conform to *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.

203.22.03.09.02 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*.

203.22.03.09.03 Pipe to PCC Structure Connections. An approved flexible connector, mechanical seal or water stop shall be provided at manhole entry or *PCC* structure connection to reduce infiltration and exfiltration. When grouting is necessary at a water stop connection, non-shrink grout shall be used.

203.22.03.10 Fittings. Fittings for steel reinforced *HDPE* 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 *ASTM F2532*.

203.22.04 FABRICATION. Pipe fittings shall be welded from steel reinforced *HDPE* pipe components or solid wall *HDPE* components. Pipe fittings shall conform to *ASTM F2562*. Perforated pipe shall be as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.22.05 FITTINGS. All fabricated fittings and couplings shall be fabricated to ensure no loss of structural integrity or watertightness at welded seams and joints for watertight applications. Only those fittings supplied by or recommended by the manufacturer shall be used. Pipe fittings shall conform to *ASTM F2562*.

203.22.06 JOINTS. Pipe shall be configured such that it can be joined on the project site using bells and spigots especially designed for steel reinforced *HDPE* pipe. Both the bell and the spigot shall conform to *ASTM D3212* and shall be watertight. Steel reinforcement within the bell and spigot shall be an integral part of the manufacturing process.

203.22.06.01 Gaskets. Gaskets shall be those designed for steel reinforced *HDPE* pipe and shall conform to *ASTM F477*.

203.22.07 REPAIR. Pipe that does not conform to the referenced standards shall not be used.

203.23 CURED-IN-PLACE PIPE.

203.23.01 DESCRIPTION. This Subsection covers sewer pipe rehabilitation using cured-in-place pipe.

The material type, *ASTM* designation, wall thickness, nominal diameter and dimensions of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.23.02 IDENTIFICATION. Each section of fabric tubing shall, at a minimum, be clearly marked such that the internal circumference, length, and all applicable *ASTM* numbers can be readily identified.

203.23.03 MATERIALS. Materials used in the manufacture of cured-in-place pipe shall conform to *ASTM F1216* and/or *ASTM F1743*, as applicable.

203.23.03.01 Resin. Resin shall be compatible with the cured-in-place pipe system used and resistant to high hydrogen sulfide environment. Resin shall be an unsaturated polyester and tinted for adequate visibility suitable for internal inspection and provide positive indication of adequate liner wet-out.

203.23.04 FABRICATION. Fabrication of the pipe shall be in accordance with *ASTM F1216* and/or *ASTM F1743* as applicable.

203.23.05 JOINTS. Joints at pipe ends (end seal) and connections shall use epoxy sealing or connection liner material compatible with the liner.

203.23.06 REPAIR. Pipe that does not conform to the referenced standards shall not be used.

203.24 STEEL RIBBED PE PIPE.

203.24.01 DESCRIPTION. This Subsection covers pipe, fittings, gaskets and related appurtenances manufactured from zinc coated galvanized steel sheets with an exterior polymer film *PE* liner. Pipe covered by this Subsection is intended for use in sanitary sewer, drainage applications, and other conveyance systems.

The material type, joint designation, nominal diameter, and dimension of the pipe, appurtenances and fittings to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

203.24.01.01 Nominal Diameter. Nominal diameter is defined as the minimum *ID* of the pipe with allowance for manufacturing tolerance in accordance with *ASTM A978*.

203.24.02 IDENTIFICATION. Each section of pipe, appurtenances and fittings shall be marked in accordance with Subsection 203.01.02 – “Identification” and also be marked with the manufacturer’s code, production date, nominal pipe size, and pipe stiffness class.

203.24.03 MATERIALS. Materials used in the manufacture of steel ribbed *PE* pipe and fittings shall conform to *ASTM A978*.

203.24.04 FABRICATION. Fabrication of the pipe shall conform to *ASTM A978* and as required by the *Special Provisions* and/or *Special Technical Specifications*.

203.24.05 FITTINGS. All fabricated fittings and couplings supplied by the manufacturer shall be fabricated to ensure no loss of structural integrity or watertightness at welded seams and joints for watertight applications. Only those fittings supplied by or recommended by the manufacturer shall be used. Pipe fittings shall conform to *ASTM A978*.

203.24.06 JOINTS. Joints shall be watertight in accordance with *ASTM D3212*.

204.01 GENERAL.

204.01.01 DESCRIPTION. This section covers the quality of materials used in the construction of manholes and catch basins, both precast and cast-in-place.

204.02 MATERIALS.**204.02.01 CAST-IN-PLACE MANHOLE COMPONENTS AND CATCH BASINS.****204.02.01.01 PCC.**

204.02.01.01.01 Composition of Mixtures. The compressive strength at 28 Days, slump, target air content, aggregate gradation and type of cementitious material shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. A mix design shall be submitted to the *Engineer* in accordance with Subsection 337.01 - "Mix Design".

204.02.01.01.02 Aggregates. Aggregates shall conform to Section 200 – "Aggregates".

204.02.01.01.03 Cementitious Materials. Cementitious materials shall conform to Subsection 202.02 – "Cementitious Materials".

204.02.01.01.04 Admixtures. Admixtures shall conform to Subsection 202.03.01 – "Admixtures".

204.02.01.01.05 Fibers. Fibers shall conform to Subsection 202.03.02 – "Fibers".

204.02.01.01.06 Curing Materials. Curing materials shall conform to Subsection 202.03.05 – "Curing Materials".

204.02.01.01.07 Water. Water shall conform to Section 205 – "Water".

204.02.01.01.08 Reinforcing Steel. Reinforcing steel shall conform to Section 206 – "Reinforcing Steel".

204.02.02 PRECAST PCC MANHOLE COMPONENTS AND CATCH BASINS. All precast PCC manhole components and catch basin shall conform to *ASTM C478*.

204.02.02.01 Precast Pcc Riser Sections. Precast riser section joints shall be sealed with preformed mastic joint sealants.

204.02.03 CAST IRON FRAME AND COVER. Gray iron frame and cover castings shall conform to *ASTM A48*, Class 35B. The cover and frame shall be machined so that the cover may be rotated to any position in the frame and maintain a satisfactory seat. Manhole frames and covers shall be traffic rated 24 inch cast iron frame and cover No. A-1032 for vented application or No. A-1024 for non-vented application, both as provided by D&L Foundry and Supply, Utah, or approved equal.

204.02.04 Catch Basin Castings. Gray iron catch basin castings shall conform to Subsection 204.03.03 – "Cast Iron Frame and Cover", except as modified herein.

A. Frames and grates shall be constructed in a manner provided the interchanging of frame and grate castings without having to perform any grinding or other work to prevent working of the grate as it rests in the frame.

204.03.05 Steps. Unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, steps shall be obtained from M.A. Industries, Peachtree, Georgia, polyethylene coated and steel reinforced, or approved equal, or as indicated in the project documents. Steps shall conform to *ASTM C 478*.

205.01 GENERAL.

205.01.01 DESCRIPTION. This section covers the quality of water necessary for the construction of earth embankments, preparation of cement concrete or soil-cement mixtures, and for wetting backfill, subgrade, and gravel base and surfacing courses.

205.02 MATERIALS. All water for embankments, backfill, subgrade, landscaping, gravel base and surface courses, cement concrete curing, and concrete shall be clean and free from excessive amounts of acids, alkalai, oil, vegetable matter, and other deleterious substances and shall be subject to the approval of the *Engineer*.

Additionally, all water for use in *PCC* shall conform to *Nev. T506*. Water which is suitable for drinking or ordinary household use may be accepted for use without being tested.

206.01 DESCRIPTION. This section covers the quality of bar steel, fabricated reinforcement, and welded steel wire used in the reinforcement of concrete for street and highway structures.

206.02 REQUIREMENTS

206.02.01 Defects. Metal reinforcement, except prestressing steel, with rust, mill scale, or a combination of both shall be considered as satisfactory, provided the minimum dimensions, including height of deformations and weight of a hand wire brushed test specimen, are not less than the applicable ASTM specification requirements.

206.03 MATERIALS, PHYSICAL PROPERTIES AND TESTS

206.03.01 Bar Steel Reinforcement. This steel shall conform to the applicable following requirements:

| Test | Test Method | Requirements |
|---|-------------|--------------|
| Deformed Billet-Steel Bars for Concrete Reinforcement | ASTM A 615 | Grade 40, 60 |
| Axle-Steel Deformed Bars for Concrete Reinforcement | ASTM A 617 | Grade 40, 60 |
| Spiral Reinforcement | ASTM A 615 | Grade 60 |

206.03.02 Fabricated Steel Bar or Rod Mats Reinforcement. This steel shall conform to the requirements of ASTM A 184.

206.03.03 Welded Steel Wire Fabric Reinforcement. This steel shall conform to the requirements of ASTM A 185.

206.03.04 Prestressing Steel. Prestressing steel shall be high-tensile wire conforming to ASTM Designation A421, high-tensile wire strand conforming to ASTM Designation A416 or uncoated high-strength steel bars conforming to the following requirements:

| | Plain Bars | | Deformed Bars |
|--|----------------------|----------------------|------------------------|
| | Grade 145 | Grade 160 | Grade 150 |
| Ultimate tensile strength, p.s.i. | 145,000 | 160,000 | 150,000 ⁶ |
| Yield Strength, p.s.i. | 130,000 ² | 140,000 ² | 120,000 ^{1,6} |
| Elongation, min. percent | 4 ³ | 4 ³ | 7 ⁴ |
| Reduction in area, min. percent | 20 ⁵ | 20 ⁵ | 20 ^{6,7} |
| Modulus of Elasticity at 70 percent of guaranteed ultimate strength, min. p.s.i. | 25x10 ⁶ | 25x10 ⁶ | 25x10 ⁶ |

1. Measured at 0.2 percent offset.
2. Measured at 0.7 percent extension under load method.
3. Measured at 20 bar diameters.
4. Measured in 10 bar diameters or 8 inch minimum.
5. Based on nominal area.
6. Based on effective area which is determined from the bar weight less 31/2 percent for the ineffective weight of the deformations.
7. For deformed bars, the reduction of area shall be determined from a bar from which the deformations have been removed. Such a bar shall be machined no more than necessary to remove the deformations over a length of 12 inches, and reduction will be based on the area of the machined portion.

Dimensions and Weights of High Strength Bars

| Nominal Diameter Inch ¹ | Nom. Wt. Lb./ft. | Nom. Area In. ² | Nom. Wt. Lb./ft. | Eff. Area In. ² |
|------------------------------------|------------------|----------------------------|------------------|----------------------------|
| 5/8 | | | 0.98 | 0.28 |
| 3/4 | 1.50 | 0.44 | 1.49 | 0.42 |
| 7/8 | 2.04 | 0.60 | | |
| 1 | 2.67 | 0.78 | 3.01 | 0.85 |
| 1 1/8 | 3.38 | 0.99 | | |
| 1 1/4 | 4.17 | 1.23 | 4.49 | 1.25 |
| 1 3/8 | 5.05 | 1.48 | 5.56 | 1.58 |

1. The maximum variation in diameter of a plain bar shall not exceed +0.030, -0.010 inch from the nominal diameter.
2. The maximum variation in weight for deformed bars shall not exceed +3.0 percent or -2.0 percent of the nominal weight for the respective bar size.

Both plain and deformed bars shall show no evidence of cracking after being bent 90 degrees around a pin. For bars 5/8 inch diameter through 1 1/8 inch diameter, the pin diameter shall be six times the bar diameter. For 1 1/4 inch and 1 3/8 inch diameter bars the pin diameter shall be eight times the bar diameter.

The bend test shall be made when the steel is between 60 degrees and 80 degrees F. The bending apparatus shall provide a continuous and uniform application of force throughout the duration of the bending operation, unrestricted movement of the specimen at the points of contact, and close wrapping of the specimen around the pin or mandrel during the bending operation.

All bars in any individual member shall be of the same grade, unless otherwise permitted by the Engineer.

When bars are to be extended by the use of couplers, the assembled units shall have a tensile strength of not less than the manufacturer's minimum guaranteed ultimate tensile strength of the bars. Failure of any one sample to meet this requirement will be cause for rejection of the heat of bars and lot of couplers. The location of couplers in the member shall be subject to approval by the Engineer.

Wires shall be straightened, if necessary, to produce equal stress in all wires or wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the ducts.

Where wires are to be button-headed, the buttons shall be cold formed symmetrically about the axis of the wires. The buttons shall develop the minimum guaranteed ultimate tensile strength of the wire. No cold forming process shall be used that causes indentations in the wire. Button-heads shall not contain wide open splits, more than two splits per head, or splits not parallel with the axis of the wire.

Sampling and testing shall conform to the specifications of ASTM Designation A 416 and ASTM Designation A 421 and as specified below.

Samples from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire, and from each lot of anchorage assemblies and bar couplers to be used shall be furnished for testing if required by the Engineer or Contract Documents. With each sample of prestressing steel wires, bars, or strands furnished for testing, there shall be submitted a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

All materials for testing shall be furnished by the Contractor at his expense. The Contractor shall have no claim for additional compensation in the event his work is delayed awaiting approval of the materials furnished for testing.

All bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

The following samples of materials 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, strand, or bars, one 5 foot long sample of each size shall be furnished for each heat and pack or reel.
- 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 5-foot length complete with one end anchorage shall be furnished and in addition, if couplers are to be used with the bar, two 4-foot lengths of bar equipped with one coupler and fabricated-to-fit coupler shall be furnished.

Before being allowed to use, the proposed prestressing system must have prior approval by the Engineer. Approval of new prestressing systems will be contingent on prequalification testing by the Contractor, at his expense, of complete tendon assemblies as proposed for the use and the submittal of written information as may be requested by the Engineer.

For prefabricated tendons, the Contractor shall give the Engineer at least 10 days notice before commencing the installation of end fittings installations and wire headings while such fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.

No prefabricated 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 members are to be manufactured whether at the bridge 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.

206.03.05 Cold Drawn Steel Wire for Spiral Reinforcement. This steel shall conform to the requirements of ASTM A 82.

207.01 DESCRIPTION. This specification covers the quality of structural steel used in highway structures.

207.02 REQUIREMENTS.

207.02.01 DEFECTS. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength or durability.

The *Engineer* reserves the right to reject material which he deems unsuitable for the purpose intended even though the material meets the requirements of mill tolerances.

207.02.02 CHARPY V-NOTCH TEST. All steels used in and designated as main load carrying members subject to tensile stress, shall comply with all the requirements specified for charpy v-notch test in the various *AASHTO* designations for the steels involved. Sampling and testing procedures shall be in accordance with the requirements of the applicable *AASHTO* Temperature Zone Designation as shown on the Contract Documents, but not less than the requirements of Zone 2.

207.03 MATERIALS, PHYSICAL PROPERTIES AND TESTS.

207.03.01 Structural Steel.

207.03.01.01 Standard Steel. Unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* all standard steel for use in miscellaneous structures shall conform to *ASTM A36*.

207.03.01.02 High Strength Low Alloy Columbium-Vanadium Steel. High strength low alloy Columbium-Vanadium steel shall conform to *ASTM A572*, Grade 50, and shall be other than rimmed or capped steel.

207.03.01.03 Bolts, Nuts and Washers.

207.03.01.03.01 Standard. All bolts, nuts, and washers not intended for high-strength connections shall conform to *ASTM A307*.

207.03.01.03.02 High-Strength Connections. All bolts, nuts, and washers to be used in high-strength connections shall conform to *ASTM A325*.

207.03.01.04 Stainless Steel Bolts. Steel for stainless steel bolts shall conform to the requirements of *ASTM A276*.

207.03.01.05 Welded Seamless Steel Pipe. Welded seamless steel pipe shall conform to *ASTM A53*, Grade B.

207.03.01.06 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes. Cold-formed welded and seamless carbon steel structural tubing in round, square and rectangular shapes shall conform to *ASTM A500*, Grade B.

207.03.01.07 Shear Stud Connectors. Steel for shear stud connectors shall conform to *ASTM A8*, Grade 1015 or 1020. Flux retaining caps shall be low carbon grade suitable for welding and shall conform to the requirements of *ASTM A109*.

207.03.01.08 Pins and Rollers. Pins and rollers 9 inches or less in diameter shall be formed and heat treated or cold finished carbon-steel shafting. Pins or rollers more than 9 inches in diameter shall be forged and heat treated in accordance with the requirements of *ASTM A668*.

207.03.01.09 Structural Steel. Unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, all structural steel for use in main load carrying members of bridge structures shall conform to the requirements of *ASTM A36*.

207.03.01.10 High Strength Low Alloy Steel. High strength low alloy steel shall conform to *ASTM A588*.

207.03.01.11 High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding. High-yield-strength, quenched and tempered alloy steel plate suitable for welding shall conform to *ASTM A514*.

207.03.01.12 High-Yield-Strength, Alloy Steel Plates, Quenched and Tempered for Pressure Vessels. High-yield-strength, alloy steel plates, quenched and tempered for pressure vessels shall conform to *ASTM A517*.

208.01 TIMBER

208.01.01 Description. This section covers the quality requirements for structural timber, lumber, guardrail posts, markers, and miscellaneous items.

208.01.02 Grades. Grades furnished shall be as noted on the Plans or in the Special Provisions.

208.01.03 Certificates of Inspection. Inspection certificates shall be furnished without extra charge with each shipment of timber. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

208.01.04 Species. The standard commercial and botanical names recognized by these Specifications are described as follows:

| Standard Commercial Name | Botanical Name |
|--------------------------|---|
| Cedar, Port Orford | Chamaecyparis lawsoniana |
| Fir, Douglas (coast) | Pseudotsuga taxifolia (coast type) |
| Fir, Douglas (inland) | Pseudotsuga taxifolia (inter-mountain type) |
| Hemlock, West Coast | Tsuga Heterophylla |
| Larch | Larix Occidentalis |
| Redwood, California | Sequoia sempervirens |

208.01.05 Grades. Structural timber and lumber shall meet the requirements for the numerical stress shown on the Plans, or as may be otherwise specified, when graded by rules developed in accordance with AASHTO M168, or the grading rules of any other lumber grading agency approved by the Engineer. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

The West Coast Lumber Inspection Bureau and the Western Wood Products Association grading rules shall be included as grading rules which may be used. Grading rules in effect of the date of advertisement of bids shall govern.

Guardrail posts and blocks shall meet the following requirements:

Douglas fir or Western Larch shall conform to the requirements for "No. 1 Structural" grade as set forth in paragraph 131(b) of the grading rules of the West Coast Lumber Inspection Bureau of paragraph 80.11 of the grading rules of the Western Wood Products Association.

208.02 PRESERVATIVE TREATMENTS FOR TIMBER

208.02.01 General. This work shall consist of preservative treatment for lumber, timber, and piles as herein specified.

208.02.02 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set forth in these Specifications.

208.02.03 Treatment. All structural timber, piling, and other lumber shall be thoroughly seasoned or conditioned before treatment by air seasoning, kiln drying, steaming, or heating in the preservative, either at atmospheric pressure or under a vacuum, or by a combination thereof that will not cause damage. The moisture remaining in the wood prior to treatment shall be reduced so that the injection and proper distribution of the required amount of preservative will be obtained. The method of seasoning, conditioning and treating used shall conform to the requirements of the American Wood Preservers Association or ASTM D1760.

208.02.04 Amount of Preservative. The minimum amount of preservative retained per cubic foot of timber, lumber, or piling shall conform to the minimum specification requirements of the American Wood Preservers Association or ASTM D 1760.

Unless otherwise specified, material treated with pentachlorophenol shall have a minimum retention of 8 pounds unless it is to be painted, then 6 pounds will be the minimum retention.

Material to be treated with Ammoniacal Copper Arsenite shall have a net retention of dry salts of not less than 0.3 pound.

209.01 DESCRIPTION. This section covers the quality and types of materials used in the construction of fencing. All fencing materials shall be new and undamaged. All fencing materials shall comply with the current applicable standards, types, classes, sizes, and other related citations and supplemental requirements of this section and the corresponding drawings unless specifically otherwise required in the Bid Documents. All ferrous fencing materials shall be galvanized or have other coatings specified herein.

209.02 WIRE FENCING. This portion describes the requirements for materials necessary for wire fencing, including barbed wire (Type BW) and wire mesh (Type WM) fencing. These fence types are similar, with the exception of the fence fabric.

209.02.01 Metal Posts. Metal line posts for Type BW and Type WM fencing shall be "T" type posts with anchor plate and clip type wire fasteners, conforming with either ASTM Designation A 702, Class B steel, or with Federal Specification RR-F-221/3. T-posts shall weigh not less than 1.3 pounds per lineal foot plus 0.67 pound for the anchor plate. Metal brace panel, end corner, and gate posts, when specified, shall be tubular steel posts conforming with Federal Specification RR-F-191/3 Class 1 Steel Pipe, Grade A or B. In addition, Class 1 Steel pipe Grade B shall be manufacturer certified to meet the following minimum performance criteria when subjected to salt spray testing in accordance with ASTM B 117:

- A. Exterior – 1,000 hours exposure with maximum 5 percent red rust
- B. Interior – 600 hours exposure with maximum of 5 percent red rust.

See Section 207.03.01 for additional requirements. Unless specified in the Plans, metal fence post colors are optional except that all posts on a project must be the same color.

209.02.02 Wood Posts and Braces. Round posts and braces shall be peeled to remove all outer bark and all inner cambium bark, except that occasional strips of inner bark may remain if not over 1/2 inch wide or 3 inches long. All knots shall be trimmed flush with the sides, spurs and splinters removed, and ends cut square. All dimension requirements shall exclude bark.

Line and brace posts shall have small end diameters between 3 1/2 and 6 inches, a maximum taper of 2 1/2 inches, and a minimum mid-length diameter of 4 inches. The maximum deflection in any plane on the long axis of a post shall be 2 inches. Sawed square posts shall have a minimum dimension of 3.5 inches and a maximum of 6 inches. Sawed posts shall be Grade No. 2 or better.

WOOD POST LENGTHS

| Nominal Height Top Wire Aboveground | Nominal Post* and Brace Length |
|-------------------------------------|--------------------------------|
| 42 inches | 78 inches |
| 50 inches | 84 inches |

* Post lengths shall be not more than 1 inch less nor 2 inches more than nominal. The average length shall not be less than nominal.

209.02.03.01 Untreated Wood Posts. Untreated wood posts and braces shall be Juniper, Redwood, or Western Red Cedar.

209.02.03.02 Treated Wood Posts. Treated wood posts and braces shall be Douglas Fir, Hem-Fir, Yellow Pine, Lodge Pole Pine, or Larch, except that Lodge Pole is acceptable for line posts only.

Warning: Designers and Contractors are cautioned that all of the following specified alternate treatment materials are currently classified as either possible carcinogens or carcinogens. All are classified as "Restricted Use Pesticides." Certain health risks exist for handlers and installers, other persons, and birds and animals, dependent on levels of exposure. EPA Report PD-4 elaborates. Product-specific consumer information sheets summarize site use and handling precautions. Designers and Contractors are directed to familiarize themselves and comply with current regulations and bulletins prior to specifying use and/or handling of these products.

All treatment shall conform with Federal Specification FS-TT-W-00571 in addition to specific citations. All treated posts shall either have a treatment plant stamp identifying the species, grade, and treatment, or load specific AWPA approved treatment plant certification of compliance with applicable standards herein.

A. **Creosote.** The creosote method is acceptable only for butt-end treatment of split Western Red Cedar, unless otherwise stated on the drawings. Grade 1 coat tar creosote (conforming to AWPA P2) shall be applied in accordance with Federal Specification No. YY-W-00571, Table I and Parts 3 and 4, and AWPA C5 minimum net retention of preservative shall be 6 pounds per cubic foot, using the empty-cell pressure treating process.

- B. Pentachlorophenol. Five percent pentachlorophenol solution (conforming to AWPA P8) in petroleum (conforming to AWPA P9 Type A) shall be applied as prescribed in Federal Specification No. TT-W-00571, Table II and Parts 3 and 4, and AWPA C5. Minimum net retention of preservative shall be 0.3 pound per cubic foot by assay using the empty-cell pressure treating process.
- C. Ammoniacal Copper Arsenate. Ammoniacal Copper Arsenate (conforming to AWPA P5) shall be applied as prescribed in Federal Specification No. TT-W-00571. Minimum net retention of dry salts shall be 0.3 pound per cubic foot or wood.
- D. Chromated Copper Arsenate. Chromated Copper Arsenate waterborne preservative (conforming to Types A, B, and C in AWPA P5) shall be applied as prescribed in Federal Specification No. TT-W-00571, Table I and Parts 3 and 4. Minimum net retention of solid preservative shall be 0.4 pound per cubic foot (gauge only) using the full-cell pressure treating process.

209.02.04 Wire and Miscellaneous Fasteners.

209.02.04.01 Fence Wire.

- A. Barbed Wire. Barbed wire shall conform to ASTM Designation A 121, Class 1 coating. It shall consist of two strands of 12 1/2 gauge (0.010 inch) wire, twisted with 2-point, 14 gauge barbs at not more than 4 inch intervals.
- B. Barbless Wire. Barbless wire for wildlife accommodation (normally top and/or bottom stands are to be used only when and where specifically required on the Plans. Used for Type BW and Type WM fences, this wire consists of 2-strand twisted, 12 1/2 gauge (0.010 inch) galvanized wire. Wire shall be zinc coated with not less than 0.3 ounces of zinc per square foot or coated surface area (Class 1 coating) and have a minimum tensile breaking strength of 950 pounds force. Wire shall conform with Federal Specification RR-F-221/1.

209.02.04.02 Woven Wire Mesh. Galvanized woven wire shall conform to the requirements of ASTM A116, Class 1 or better coating, No. 12 1/2 farm. Heights shall be specified, except that where unspecified, it shall be designation 832-06 12 1/2 (32 inch height, 6 inch wide mesh.)

209.02.04.03 Miscellaneous Fasteners. Miscellaneous accessories including spikes, nails, and staples shall be galvanized.

- A. Staples shall be made from No. 9 gauge (0.148 inch) galvanized wire, U-shaped (stronghold) type, and length shall be not less than 1 3/4 inches.
- B. Nails shall be galvanized 40 d to 60 d, dependent on installation application.
- C. Steel dowels, 3/8 inch x 4 inch length, may be fabricated from steel rebar or rod stock and need not be galvanized.
- D. Miscellaneous wire applications including optional (nonbarbed) diagonal brace wire, deadman anchors, and other related uses shall be smooth galvanized 9 gauge steel wire meeting Federal Specification RR-F-221/1, Type I, Class I, with not less than 0.4 ounce zinc per square foot of coated surface.
- E. Fence wire stays shall be single member twisted smooth 9 gauge galvanized steel wire manufactured specifically for this application.
- F. Wire fasteners shall be galvanized steel wire clip style as normally furnished with T-Type steel fence posts (see Section 207.02.02) and manufactured for the specific purpose. The nominal gauge is 11 (0.120 inch).
- G. All metal gate hinges, latches, and related accessories, shall be galvanized at not less than 1.2 ounces zinc per square foot coated surface. All gate latches shall be outfitted to permit padlocking with common commercial grade padlocks. Swing driveway gates shall have semi-automatic outer latches to secure the gate in an open position. All wire gates (Missouri type unframed) shall be fitted with galvanized or rust inhibiting painted mechanical lever/latch style closures with high leverage and low release impact potential. Submittals are required.
- H. Gate reflectors shall be circular and a minimum of 4 inches in diameter. The reflective surface shall be red glass or plastic. The reflectors shall be designed for exterior use and rated for extended sunlight (UV) exposure and SAE approved. The reflectors shall have holes or other attachment configurations permitting secure attachment to barbed and barbless fence wire, wire mesh and chain link fence fabric. Fasteners shall be not less than two hog rings, 11 gauge galvanized tie wire, or equivalent. Submittals are required.

209.02.04.04 Electrical Grounding

209.02.03.04.01 Ground Rods. Grounding rods shall be copper coated rods, 8 feet in length, and a minimum of 1/2 inch in diameter, manufactured for this purpose. Ground wire shall be Number 6 solid copper wire or 5 gauge steel wire.

209.03 CHAIN LINK FENCING. This portion describes the requirements for chain link fencing materials.

209.03.01 Metal Posts, Rails, and Braces. All metal posts, rails, and braces shall meet the following requirements. Federal Specification RR-F-191/3 Class 1, Steel Pipe, Grade A or B; Class 3 Formed Steel Sections; or Class 4, Steel H-sections. In addition, Class 1, Steel Pipe, Grade B, shall be manufacturer certified to meet the following minimum performance criteria when subjected to salt spray testing in accordance with ASTM B 117:

- A. Exterior – 1,000 hours exposure with maximum 5 percent red rust;
- B. Interior – 600 hours exposure with a maximum 5 percent red rust.

For slatted chain link fence 72 inches and less in height use 2.38 inch O.D. x 3.65 pounds for line posts and 2.88 inch O.D. x 5.79 pounds for end, corner, slope and gate posts (6 foot or shorter gate leaves) and 1.62 inch O.D. x 2.27 pound top rail and braces.

STEEL POSTS, RAIL AND BRACES

| Use | Nominal Type & Size (inches) | Actual O.D. (inches) | Grade A | | Grade B | |
|---|--|----------------------|----------------------|--------------------|----------------|--------------------|
| | | | Weight (lb/LF) | Wall Tnks (inches) | Weight (lb/LF) | Wall Tnks (inches) |
| Fences 72 inches or less in height; line posts for fences 72 inches or less in height | 1 1/2 inch Pipe 1.88 inch x 1.62 inch H 1.88 inch x 1.62 inch FS | 1.90 | 2.72 2.80 2.40 | 0.148 | 2.28 | 0.120 |
| End, corner, slope and gate posts for single gates 6 feet or less in width and double gates 12 feet or less in width for fences 72 inches or less in height | 2 inch Pipe 3.5 inch x 3.5 inch FS | 2.375 5.10 | 3.65 | 0.157 | 3.12 | 0.130 |
| Fences higher than 72 inches; line posts for fences higher than 72 inches | 2 inch Pipe 2.25 inch x 1.88 inch H 2.25 inch x 1/70 inch FS | 2.375 | 3.65 3.43 2.78 | 0.157 | 3.12 | 0.130 |
| End, corner, slope and gate posts for single gates 6 feet or less in width and double gates 12 feet or less in width for fences higher than 72 inches | 2 1/4 inch Pipe 3.5 inch x 3.5 inch FS | 2.875 5.10 | 5.79 | 0.207 | 4.64 | 0.160 |
| All fence heights top rails and braces | 1 1/4 inch Pipe 1.52 inch x 1.25 inch H | 1.660 - | 2.27 2.20 | 0.143 - | 1.83 - | 0.11 |
| Gate posts for single swing gates over 6 feet but not over 13 feet in width and double swing gates over 12 feet but not over 26 feet in width or for all slide gates with leaves larger than 6 feet | 3 1/2 inch Pipe 3 inch Pipe | 4.0 3.5 | 9.11 - | 0.231 - | - 5.71 | - |
| Gate posts for singleswing gates over 13 feet but not over 18 feet in width and double swing gates over 26 feet but not over 36 feet in width | 6 inch Pipe | 6.625 | 18.97 | 0.286 | - | - |
| Frames for gates and stiffeners for gates | 1 1/2 inch Pipe | 1.900 | 2.72 | 0.148 | 2.28 | 0.120 |

Note: "H" identifies steel H-section; "FS" identifies formed steel section.

209.03.02 Chain Link Fencing Fabric. All chain link fencing fabric shall meet the following requirements: Federal Specification RR-F-191/1 Type I, zinc coated, or ASSHTO Designation M 181, Type I with Class A coating. Fence with fabric height of 72 inches or less shall be 11 gage. Fabric heights over 72 inches shall be 9 gage. The fabric edges shall be knuckled on top and barbed on bottom edges, unless otherwise specified, except that fencing for schools and playgrounds shall be knuckled on both selvages.

PVC coated steel chain link fence fabric shall meet or exceed ASTM F 668, Class 2. The color shall be medium green unless otherwise specified. The core wire shall be the same as required for normal galvanized wire for the height required.

Slatted chain link fence fabric shall have either plastic or wood slats, depending on the Plans requirements. Plastic slats shall be virgin high density polyethylene with UV inhibitors, adequate color base for opacity, and tensile strength of 3500 p.s.i. or more in accordance with ASTM D 638. Slats shall fit the fabric adequately to firmly retain their position with an effective locking system. Installed slats shall not generate noise when

exposed to wind. Slats shall be single members and lengths shall be slightly shorter than the fabric to preclude interference with top rails and fasteners. Slats shall be guaranteed/warranted for 20 years or more against color fade and brittle fracture. Wood slats shall be sound single members meeting the same fit criteria. Wood slats shall be stapled securely to fabric. Slat colors shall be forest green for plastic and rustic Redwood stain for wood slats unless otherwise specified. For plastic slats, wire gauge and mesh shall be the same as otherwise required for the application. Wood slats shall be provided only in 9 gauge chain link fabric with a mesh size of approximately 3 x 5 inches. When slats are required, all posts and braces shall be upgraded to the next larger equal quantity pipe size.

209.03.03 Miscellaneous Fittings and Appurtenances

Note: Some entries are identified as alternatives or options. Refer to the project Plans.

209.03.03.01 Fittings. All fittings shall be pressed steel or malleable or cast steel conforming with ASTM F 626 and Federal Specification RR-F-191/4 including galvanizing. Vinyl coating is required only when specified in the Plans. When required, vinyl coated quality and color shall match that specified for fence fabric.

- A. **Post Caps.** Galvanized pressed steel, malleable or cast steel and designed to fit snugly over posts to exclude moisture. Supply cone-type caps for terminal posts and loop-type for line posts.
- B. **Rail and Brace Ends.** Galvanized pressed steel or malleable or cast steel and cup-shaped to receive rail and brace ends.
- C. **Top Rail Sleeves.** Galvanized steel sleeves, equal in thickness to the top rail, not less than 6 inches to 7 inches long, expansion type. Swedged ends are acceptable also.
- D. **Brace Brands.** Galvanized pressed steel, 12 gauge (0.105 inch) thickness x 3/4 inch wide.

209.03.03.02 Truss Rods. Truss rods shall be galvanized steel 3/8 inch diameter rods, fitted with an equivalent strength turn buckle designed and manufactured for this application.

209.03.03.03 Tension Bars. Galvanized steel strip, not less than 5/8 inch wide x 3/16 inch thick.

209.03.03.04 Tension Bands. Galvanized pressed steel, not less than 14 gauge (0.080 inch) thickness x 3/4 inch wide.

209.03.03.05 Tension Wire. The bottom tension wire shall be at least 7 gauge (0.177 inch) coil spring steel of good commercial quality and shall be galvanized in accordance with the provisions of ASTM Designation A 116, Coating Class 3.

209.03.03.06 Tension Cable. Top tension cable shall be 3/8 inch diameter galvanized seven strand cable, conforming to the requirements of ASTM Designation A 475, common grade. Tension cable is required only when top rail is not utilized.

209.03.03.07 Hog Rings and Tie Wire. Hog rings and tie wire shall be not less than 11 gauge (0.120 inch) steel wire galvanized in conformance with ASTM Designation A 116, Class 3 coating or 9 gauge 1100 H4 aluminum alloy or better.

209.03.03.08 Security Fence

- A. **Security Top Arms.** Galvanized arms shall securely fasten to post tops and angle at 45 degrees from vertical, in the direction directed by the Engineer. Each arm shall be fabricated from pressed steel or malleable or cast steel, and include clips/slots necessary to rigidly attach three equally spaced double strand barbed wires. Each arm shall be capable of supporting a vertical load of 250 pounds at the outer barb attachment point without permanent deflection. All gates and posts shall be extended in height to permit equal level barbed wire attachment.
- B. **Barbed Wire.** Barbed wire shall conform to ASTM Designation A 121, Class 1 coating. It shall consist of two strands of 12 1/2 gauge wire, twisted with 4-point 14 gauge barbs at not more than 5 inch intervals.

209.03.04 Gates. Chain link gates shall conform with the requirements shown in the Standard Details and the project plans.

209.03.05 Portland Cement Concrete Post Anchorage. Portland Cement Concrete for post footings and anchorage shall conform with Section 202.12 – “Freeze-Thaw Environments” – with 3/4 inch maximum size aggregate and a compressive 28 day strength of not less than 4000 p.s.i. Commercial premixed rapid setting non-shrink post grouts are permitted for post anchorage and required for posts placed in drilled holes in rock or concrete.

210.01 GENERAL.

210.01.01 DESCRIPTION. This section describes the quality of materials used for timber piles, precast or cast-in-place PCC piles, sheet piling and steel piles.

210.02 TIMBER. Timber piles shall conform to ASTM D25 for Class B piles.

210.03 STEEL.

210.03.01 STEEL PIPE AND STEEL SHELL PILES. Steel for steel pipe and steel shell piles shall conform to ASTM A252, Grade 2. Seamless cylindrical tubes or cylindrical tubes with a straight or spiral weld seam shall be used. The *CE* shall not exceed 0.5 percent when calculated as follows:

$$CE = C + (Mn + Si)/6 + (Cr + Mo = V)/5 + (Ni + Cu)/15$$

210.03.02 STEEL "H" PILES AND SHEET PILING. Steel "H" piles and sheet piling shall conform to of ASTM A36.

210.03.03 STEEL "HP" PILES. Steel "HP" piles shall conform to ASTM A572, Grade 50.

210.03.04 PILE TIPS. Steel for pile tips shall conform to ASTM A148 (90/60) with a minimum yield point of 60 KSI.

210.04 PRECAST OR CAST-IN-PLACE PCC. PCC for precast or cast-in-place piles shall conform to *NDOT* Class A or AA PCC.

210.04.01 AGGREGATES. Aggregates shall conform to Section 200 – "Aggregates".

210.04.02 CEMENTITIOUS MATERIALS. Cementitious materials shall conform to Subsection 202.02 – "Cementitious Materials".

210.04.03 ADMIXTURES. Admixtures shall conform to Subsection 202.03.01 – "Admixtures".

210.04.04 WATER. Water shall conform to Section 205 – "Water".

210.04.05 REINFORCING STEEL. Reinforcing steel shall conform to Section 206 – "Reinforcing Steel".

210.04.06 STRUCTURAL STEEL. Structural steel shall conform to Section 207 – "Structural Steel".

211.01 DESCRIPTION. This section covers the quality and kind of materials used in the construction of culvert markers and guide posts.

211.02 CERTIFICATES. Without expense to the Agency, two certificates covering each order of material (plates, reflectors, and posts) shall be furnished by the manufacturer, certifying that the product complies with the Specifications. Certificates shall be delivered to the Engineer in charge at the job site at the time of, or prior to, delivery of the order.

For steel used in posts, the Contractor shall furnish two certified copies of mill test reports showing the chemical and physical characteristics from each heat.

211.03 PHYSICAL PROPERTIES AND TESTS

211.03.01 Metal Posts. Posts shall be steel conforming to ASTM Designation A 570, Grade C or ASTM Designation A 526, 12 or 13 gage.

Metal posts shall be galvanized in accordance with Section 213, – “Galvanizing,” – or in accordance with the requirements of ASTM Designation A 525, coating Designation G 210.

211.03.02 Target Plates

a) Base Metal. Base metal for the target plates shall be zinc coated steel sheet or aluminum sheet.

The zinc coated steel shall comply with Federal Specification QQ-S-775 Steel Sheet, carbon, zinc coated Type 1, Classes D and E, except that the zinc coated surface shall withstand a 180 degree bend on itself at room temperature without flaking the coating. The zinc coated surface shall be prepared for painting by the application of phosphate coating. Surface preparation shall conform to the following requirements:

The phosphatizing process shall be accomplished without damaging or removing the galvanized coating from the steel base metal;

Any evidence of damage or removal of the zinc coating shall be cause for rejection of the entire lot.

The aluminum sheet shall be prepared for painting with chemical conversion coating conforming to the requirements of Federal Specification MIL-C-5541. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operation. Two copies of certified mill tests of the aluminum sheets shall be furnished to the Engineer.

Target plates shall be fabricated from 20 gauge steel sheet of 0.050 inch thick aluminum sheet, alloy 3005-H14.

Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. Plates shall be cut to size and shape and the holes punched for mounting bolts and reflectors in accordance with the details shown on the Plans or as specified in the Special Provisions. Surfaces and edges of the plates shall be free from defects resulting from fabrication.

b) Paint. Target plates shall have satisfactory paint adherence. Paint properties and application shall be in accordance with Section 214 – “Paint,” – and Section 324 – “Painting, Pavement Striping and Marking.”

At the Contractor's option, metal reflector plates for metal guide posts may be furnished with one or both sides coated with a black, baked enamel finish. If only one side is coated, the coated side shall face oncoming traffic.

The plates shall be coated with baked enamel conforming to the following provisions:

The enamel finish coat for plates shall comply in all respects with the requirements of Federal Specification TT-E-489, Class B baking type enamel, with the added requirement that the yellowness index of the white enamel shall not exceed 0.08 when tested in accordance with Federal Test Method Standard No. 141, Method 6131.

Application of the baking enamel may be by spray, roller, or dip at the option of the manufacturer. Other methods may be used provided they are approved prior to use. The dry film thickness of the baked enamel coating on the galvanized steel plates shall be not less than 2 mils on both front and back surfaces. The dry film thickness on both front and back surfaces of the aluminum plates shall be not less than 1.5 mils on each side if enamel is applied by spray or dip method and not less than 1 mil if enamel is applied by continuous roller coat method.

The coating shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, or other surface imperfections.

The finished plates shall be free from dents and defects. The maximum surface deviation from a horizontal plane on which the finished plate lies shall not exceed 0.25 inch.

211.03.03 Reflectors. Metal guide posts shall be equipped with reflective sheeting conforming to the requirements of Subsection 215.03.01 – “Reflective Sheeting” – of these Specifications for Type I.

The size of the sheeting shall be as indicated on the Plans. The color of the sheeting shall be as indicated in the MUTCD Manual.

212.01 GENERAL.

212.01.01 DESCRIPTION. This Section covers the quality of materials used in guardrail construction.

212.02 MATERIALS. Materials shall conform to Section 720 – “Guardrail Materials” of the *Silver Book*.

213.01 DESCRIPTION. This section covers the quality and thickness of galvanize used on various material when called for on the Plans or designated in the Specifications.

213.02 REQUIREMENTS

213.02.01 Products One-Eighth (1/8) Inch Thick and Thicker. Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to the requirements of ASTM Designation A 123.

213.02.02 Rail Elements. All rail elements shall be galvanized in accordance with AASHTO Designation M 180, Type 1.

213.02.03 Hardware. Bolts, nuts, washers, and fastenings shall be galvanized in accordance with the requirements of ASTM Designation A 153.

213.02.04 Mechanical Galvanizing. In lieu of hot-dipped galvanizing as specified in these Specifications, ferrous metals may be mechanically galvanized in accordance with ASTM Designation B 695. Regardless of the method chosen, the coated product shall conform to the coating thickness, adherence, and quality requirements of ASSHTO Designation M 232.

214.01 DESCRIPTION. This section covers the following items:

214.01.01 Paint (Other than Traffic Paint). The quality, color, and number of applications of paint (other than Traffic Paint) used in painting various materials.

214.01.02 Traffic Paint. The quality requirements of ready mixed traffic line paint to be applied to either asphaltic or Portland Cement Concrete pavements.

214.01.03 Traffic Beads. The quality requirements of glass spheres to be embedded into traffic paint.

214.01.04 Pavement Marking Film. The quality requirements for permanent pavement marking film and thermoplastic paint.

214.01.05 Thermoplastic Paint. The quality requirements for thermoplastic paint to be applied to either asphaltic or Portland Cement Concrete pavements.

Attention is directed to Section 213 – “Galvanizing” – for galvanizing coating.

214.02 REQUIREMENTS.**214.02.01 PAINT (OTHER THAN TRAFFIC PAINT)**

214.02.01.01 Certificates. The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials thereof comply with all the requirements. Samples will be taken when required by the Engineer.

214.02.02 TRAFFIC PAINT

214.02.02.01 General. Paint shall be free from foreign materials such as dirt, sand, fibers from bags, or other material capable of clogging screens, valves, pumps, or other equipment used in a paint striping apparatus. The paint pigment shall be well ground and shall be properly dispersed in the vehicle. The dispersions shall be of such nature that the pigment does not cake or thicken in the container, and does not become granular or curdled. Any settlement of pigment in the paint shall be a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sidewise manual motion of the paddle across the bottom of the container to form a smooth uniform product of the proper consistency.

The specified amounts and materials used in each formula for achieving satisfactory pigment wetting and suspension may be varied or changed to suit the vendor's method of manufacture. Paint made with any deviations in anti-settling, wetting agents, or stabilizers shall still be required to conform to the characteristics of the finished paint and all other requirements of these Specifications.

214.02.02.02 Packaging. All manufactured paint shall be prepared at the factory ready for application. The addition of thinner or other material to the paint after the paint has been shipped will not be permitted unless otherwise specified in the Contract Special Provisions.

All shipping containers must comply with Department of Transportation Code of Federal Regulations, Hazardous Materials Regulations Board, Reference 49CFR. The containers must be lined, if necessary, so as to prevent attack by the paint or agents in the air space above the paint. The lining must not come off the container or lid as skins.

All containers shall be properly sealed with suitable gaskets and shall show no evidence of leakage.

All containers of paint shall be labeled showing the exact title of the Specification, manufacturer's name, date of manufacture, and manufacturer's batch number.

Precautions concerning the handling and application of paint shall be shown on the label of the paint container.

The lining of the containers shall be of such character as to resist the solvent of this paint and to permit no skins being loosened into the body of the paint.

214.02.03 TRAFFIC BEADS

214.02.03.01 General. The glass spheres shall lend themselves readily to firm embedment in the traffic paint when dropped on a freshly placed paint line. The embedment shall be of such character as to provide a highly reflectorized surface on the paint film with reserve reflectorizing capacity in the lower sections of the paint film. The reflection shall be effectively manifest to the operator of a motor vehicle when the headlights of the vehicle are played on the markings.

All glass beads shall have a moisture proof overlay consisting of water repellent material applied during the process of bead manufacture. The beads so treated shall not absorb moisture in storage, shall remain free of clusters and lumps, and shall flow freely from dispensing and testing equipment.

214.02.04 PAVEMENT MARKING FILM

214.02.04.01 Certificates. A Certificate of Compliance for the pavement marking film shall be furnished to the Engineer. The certificates shall be signed by the manufacturer of the material. A Certificate of Compliance must be furnished with each lot of material delivered to the work and the lot so certified be clearly identified in the certificate.

All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the work which conforms to the requirements of the Plans and Specifications and any such material not conforming to such requirements will be subject to rejection whether in place or not.

214.02.05 THERMOPLASTIC PAINT

214.02.05.01 Certificates. Certificates shall conform to Subsection 214.02.01.01 – “Certificates.”

214.03 PHYSICAL PROPERTIES AND TESTS.

214.03.01 PAINT (OTHER THAN TRAFFIC PAINT)

214.03.01.01 Iron and Steel Use Items. The Contractor may choose from SSPC (Steel Structures Painting Council) Alkyd Paint Systems 2.00 or Phenolic Paint System 3.00 when metal rail, bridge, or pedestrian rail and guardrail are specified to receive paint or when painting structural steel, miscellaneous iron and steel standards. The color of paint shall be as shown on the Plans or specified in the Special Provisions. The use of lead base paint will not be allowed.

The Contractor shall submit to the Engineer for approval a letter indicating his choice of system, accompanied by certificates attesting that the ingredients chosen meet the applicable specifications and requirements prior to application of any paint.

214.03.01.02 Aluminum Use Items. Aluminum bridge railing and posts specified to receive paint shall be prepared for painting with a chemical conversion coating conforming to the requirements of Federal Specification MIL-C-5541. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operations.

The Contractor may use any of the paint systems specified for use on iron or steel in Subsection 214.03.01.01 – “Iron and Steel Use Items” – for painting aluminum, and shall submit to the Engineer for approval a letter indicating his choice of system as required for iron or steel.

214.03.01.03 Timber Items. Paint for cattle guard wings, bridge railings, right-of-way markers, sign posts, and miscellaneous timber structures shall conform to the following:

| Purpose | Number of Coats | Color | General Type | Formula or Specification |
|---|-----------------|-------|------------------------------------|--------------------------|
| Prime | 1 | White | Mixed Pigment exterior Wood Primer | *TT-P-25 *TT-P-25 |
| Intermediate (first coat after primer) | 1 | Cream | Titanium Zinc Oxide | *TT-P-102 Class B |
| Finish (second coat after primer) | 1 | White | Titanium Zinc Oxide | *TT-P-102 Class B |
| Trim Lettering and Indications (used when indicated on plans) | 1 | Black | Titanium Zinc Oxide | *TT-P-61 |

* Federal Specifications

214.03.01.04 Concrete Items. Paint for concrete end posts (bridges), raised traffic bars, and miscellaneous concrete shall conform to the following:

| Purpose | Number of Coats | Color | General Type | Formula or Specification |
|---------|-----------------|-------|---------------|---|
| Finish | 1 | White | Water Thinned | Acrylic Resin or Synthetic Latex Alkyd Emulsion |

214.03.02 TRAFFIC PAINT

214.03.02.01 Sampling and Testing. Samples will be taken after delivery. The Agency reserves the right to have an inspector present to observe the manufacturing process. The vendor shall furnish a complete formulation record of his manufacturing process to the Engineer.

All tests shall be performed according to ASTM, Federal Test Method Standards No. 141a and methods designated by the Agency.

214.03.02.02 Fast Dry Traffic Paint Materials. The raw materials for use in the paint formula shall conform to the Specifications designated by federal serial number or paint material code number hereinafter specified. Subsequent amendments to the Specifications quoted shall apply to all raw materials and finished products.

Paint shall also comply with the following requirements:

214.03.02.02 (a) Composition Requirements. All percentages specified are by weight.

214.03.02.02 (b) Pigment Composition. Percent by weight of total pigment:

| | White | Yellow |
|--|-----------|-----------|
| Titanium Dioxide, Anatase (ASTM D 476, Type I 94 percent min. TiO ₂) | 24.0-26.0 | 7.0-9.0 |
| Medium Chrome Yellow (ASTM D 211, Type III, 87 percent min. PbCrO ₄) | | 15.0-17.0 |
| Zinc Oxide (ASTM D 79, American Process-Type) | 7.5-9.5 | 7.0-9.0 |
| Magnesium Silicate (ASTM D 605) | 26.0-38.0 | 35.0-37.0 |
| Calcium Carbonate (ASTM D 1199, Type GC, Grade I or II) | 28.0-30.0 | 31.0-33.0 |
| Antisettling Agent (Bentone 34 or Clayton 40) | Note 1 | Note 1 |

Note 1. Sufficient dispersing and suspending agent shall be added to prevent excessive settling as required in 2.2 and 2.4.

214.03.02.02 (c) Vehicle Composition. Percent by weight of vehicle:

| | White and Yellow |
|---|-----------------------------------|
| Alkyd Resin Solution (See Note 2) | 21.3 min. |
| Chlorinated Rubber (Parlon S20 or Allopren X20) | 16.4 min. |
| Chlorinated Paraffin (Federal Specification MIL-C 429C, Type I) | 11.3-13.3 |
| Lead Drier 24 percent (ASTM D 600, Class B) | 0.2-0.4 |
| Cobalt Drier 6 percent (ASTM D 600, Class B) | 0.05-0.25 |
| Antiskinning Agent (Exkin or Equivalent) | Note 3 White and Yellow (cont) |
| Stabilizer (Propylene Oxide) (See Note 4) | 0.45-0.55 |
| Toluene (ASTM D 62) | 26.1 Max. |
| Heptane (Technical Grade) | 6.5-8.5 |
| Methyl Ethyl Ketone (ASTM D 740) | 14.7 min. |
| Methanol (ASTM D 152) | 0.2-0.4 |

Note 2. Alkyd Resin Solution: The medium oil soya-modified alkyd resin shall be supplied as 59 to 61 percent nonvolatile solids in VM & P Naphtha (TT-N95b, Type I). The resin solids shall contain an oil acid content of 48 to 55 percent, a phthalic anhydride content of 33 to 37 percent and an acid number of 8 maximum. The alkyd resin solution shall have a maximum color of 9 (Gardner). The alkyd resin solution, reduced to 45 percent solids with VM & P Naphtha, shall have a viscosity of D to G (Gardner-Holdt). No rosin will be permitted. The oil fatty acids shall be of vegetable origin, either alkali refined soya bean oil or the fatty acids of soya bean oil having a minimum iodine number of 115. No recovered oil marine or soya food fatty acid derivatives shall be used. The alkyd resin solution must tolerate a 500 percent by weight dilution with VM & P Naphtha. A solution containing alkyd resin solution, chlorinated rubber, methyl ethyl ketone, toluene, and heptane in the proportions given in the vehicle composition shall be clear, transparent, and show no separating after storage of 24 hours in a 3/4 full test tube at 26.7 degrees plus or minus 2.8 degrees Centigrade (80 degrees plus or minus 5 degrees Fahrenheit).

Note 3. Sufficient antiskinning agent shall be used to prevent skinning as required in **3.3. Material** shall be added at the proper time during the manufacturing of the paint so as to minimize losses due to volatilization and maximum retention in the package.

Note 4. Other approved stabilizers: Styrene Oxide – 3 pounds per 100 gallons of paint; Thermolite 813 – 0.5 pounds per 100 gallons of paint.

214.03.02.02 (d) Manufacturing Formulations. Typical formulas which may serve as a guide for the paint manufacturer are as follows (yields are approximately 100 gallons.):

| | Pounds | |
|---|--------|--------|
| | White | Yellow |
| Titanium Dioxide | 150 | 50 |
| Medium Chrome Yellow | — | 100 |
| Zinc Oxide | 50 | 50 |
| Magnesium Silicate | 225 | 225 |
| Calcium Carbonate | 175 | 200 |
| Antisettling Agent (Claytone) | 4 | 4 |
| Methanol | 2 | 2 |
| Alkyd Resin Solution (60 percent nonvolatile) | 130 | 130 |
| Chlorinated Rubber (Parlon S-20) | 100 | 100 |
| Chlorinated Paraffin | 75 | 75 |
| 24 percent Lead Drier | 2 | 2 |
| 6 percent Cobalt Drier | 1 | 1 |
| Antiskinning Agent (Exkin) | 3 | 3 |
| Stabilizer (Propylene Oxide) | 3 | 3 |
| Toluene | 160 | 160 |
| Heptane | 45 | 45 |
| Methyl Ethyl Ketone | 90 | 90 |
| | 1215 | 1240 |

214.03.02.03 Quantitative Requirements of Mixed Paint

| | White | Yellow |
|--|------------|------------|
| 1. Pigment. Percent by weight | 49.0-51.0 | 50.0-52.0 |
| 2. Total Solids. Percent by weight, min. | 68.87 | 69.48 |
| 3. Nonvolatile Vehicle. Percent by weight vehicle, min. | 38.96 | 38.96 |
| 4. Consistency. Krebs-Stormer Shearing rate 200 r.p.m., Grams | 140 to 190 | 140 to 190 |
| 5. Weight per Gallon. Pounds, min. | 12.05 | 12.25 |
| 6. Fineness of Grind. Hegman gage, North Standard Scale, min. | 2 | 2 |
| 7. Drying Time. Minutes, max. | 10 | 10 |
| 8. Directional Reflectance, min. | 80 | 50 |
| 9. Uncombined Water. Percent by weight of paint, max. | 1.0 | 1.0 |
| 10. Coarse Particles and Skins. Retained on a No. 325 mesh sieve, percent by weight or pigment, max. | 1.0 | 1.0 |

214.03.02.04 Qualitative Requirements of Fast Dry Traffic Paint

214.03.02.04 (a) Color of Yellow Paint. The color of the yellow paint shall visually match color chip No. 33538 of Federal Standard 595a when tested as **specified in 4.1.5**. In case of dispute, the color shall be within the green and red tolerance limits when compared with the standard colorships of "Highway Yellow Color Tolerance Chart," U.S. Department of Commerce, Bureau of Public Roads PR Color No. 1, June 1965.

214.03.02.04 (b) Condition in Container. The paint shall not show excessive settling in a freshly-opened full can and shall be easily redispersed with a paddle to a smooth homogeneous state. The

paint shall show no curdling, livering, caking, gelling, or thixotropic properties, lumps, skins, or color separation. [see 214.03.02.04 (c) and 214.03.02.04.(d)].

214.03.02.04 (c) Skinning. The paint shall not skin within 48 hours in a 3/4 filled, tightly closed container.

214.03.02.04 (d) 3.4 Storage Stability. When stored for 12 months the paint must be usable; the drying time shall be as specified and the consistency range shall be 70 to 85 Krebs units.

214.03.02.04 (e) Flexibility and Adhesion. The paint shall show no cracking, flaking or loss of adhesion when tested as specified in 4.1.2.

214.03.02.04 (f) Water Resistance. The paint shall show no softening, blistering, loss of adhesion, or other evidence of deterioration other than a slight loss in gloss when tested as specified in 214.03.02.04 (b).

214.03.02.04 (g) Dilution Stability. The thinned paint shall be uniform and show no separation, curdling, or precipitation after reduction in the proportions of eight parts by volume of the packaged material with not more than one part by volume of the appropriate thinner for each type of paint.

214.03.02.04 (h) Spraying Properties. The paint as received or diluted no more than as specified herein shall have satisfactory spraying properties when applied (and held in a horizontal position) to tinplate or aluminum surfaces at a wet film thickness of approximately 0.015 inch.

214.03.02.04 (i) Appearance. The sprayed film [see 214.03.02.04 (h)] shall dry to a smooth uniform finish free from roughness, grit, unevenness, and other surface imperfections. The paint shall show no streaking or separation when placed on clean glass.

214.03.02.04 (j) Bleeding. The paint shall show a minimum rating of six when tested as specified in 4.1.4.

214.04 TEST PROCEDURES.

214.04.01 Test Procedures. The tests indicated in Table I shall be conducted in accordance with Federal Test Method Standard No. 141a or ASTM method as indicated.

TABLE I
TEST METHODS

| Test | Section of Federal Test Method Standard No. 141a or ASTM Method | Section of this Specification Giving Requirements | Section of this Specification with Further Reference |
|---------------------------------------|---|---|--|
| Percentage of Pigment | 4021 | 2.1 | ... |
| Nonvolatile in Vehicle | 4051 | 1.2 | 214.03.02.03 #3 |
| Consistency, Krebs-Stormer | 4281 | 214.03.02.03 #4 | ... |
| Weight per Gallon | 4184 | 214.03.02.03 #5 | ... |
| Water Resistance | 6011 | | 4.1.3 |
| Condition in Container | 3011.1 | 3.2 | ... |
| Dilution Stability | 4203 | 3.7 | ... |
| Skinning | 3021 | 3.3 | ... |
| Fineness of Grind, Hegman | 4411 | 2.2.6 | ... |
| Directional Reflectance | 6121 | 2.2.8 | ... |
| Uncombined Water | 4081 | 2.2.9 | ... |
| Coarse Particles and Skins | 4091 | 2.2.10 | ... |
| Phthalic Anhydride | 7021 | 2.1.2 | ... |
| Oil Acids | 7031 | 2.1.2 | ... |
| Rubber Base Precipitate | 5211.1 | 2.1.2 | ... |
| Iodine Number of Oils and Fatty Acids | 5061 | 2.1.2 | ... |
| Flexibility and Adhesion | 6221 | 3.5 | 4.1.2 |

| Test | Section of Federal Test Method Standard No. 141a or ASTM Method | Section of this Specification Giving Requirements | Section of this Specification with Further Reference |
|-----------------------------|---|---|--|
| Appearance of paint | 3011.1 | 3.9 | ... |
| Color of Pigmented Coatings | 4250 | 3.1 | 4.1.5 |
| Drying Time | ASTM D 711 | 2.2.7 | ... |
| Bleeding | ASTM D 969 | 3.10 | 4.1.4 |

4.2 Flexibility and Adhesion. Apply a wet film thickness of 0.005 inches with a film applicator to a 3 by 5 inch panel weighing 0.39 to 0.51 lbs./sq. ft., previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at 70 degrees to 80 degrees Fahrenheit in a horizontal position for 18 hours, then bake in an oven at 122 degrees plus 4 degrees Fahrenheit 47.8 degrees Centigrade to 52.2 degrees Centigrade for two hours, cool to room temperature for at least 1/2 hour and bend over 1/2 inch diameter rod and examine, without magnification, as specified in 3.5.

4.3 Water Resistance of Paint. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Let dry in a horizontal position at room temperature (70 to 80 degrees Fahrenheit) for 72 hours. Immerse one-half the painted plate in distilled water at room temperature for 18 hours as specified in Method 6011 of Federal Test Method Standard No. 141, allow to air dry for two hours and examine as specified in 3.6.

4.4 Bleeding. The bleeding characteristics shall be determined in accordance with ASTM D 969. The test panels shall be evaluated according to ASTM D 868, and the degree of resistance to bleeding shall have a numerical rating as specified in 3.10.

4.5 Color of Yellow Paint. Apply a wet film of 0.015 inch to a tin panel; let dry for 24 hours and compare color as required in 3.1.

214.05.01 TRAFFIC BEADS

1.0 Requirements. A minimum of 85 percent of all the beads by count shall be colorless, true spheres, free of dark spots, milkiness, air inclusions, and surface scratches which involve a substantial part of any individual sphere.

When tested according to ASTM D 1214 the beads delivered shall conform to the following gradation requirements:

| Sieve No. | Percent Passing |
|-----------|-----------------|
| 30 | 100 |
| 50 | 20-60 |
| 70 | 5-20 |
| 100 | 0-7 |

The Index of Refraction shall be a minimum of 1.5 by the oil immersion method utilizing tungsten light at 25 degrees Centigrade.

After refluxing a 50 gm. sample of beads in a Soxhlet Extractor for 8 hours with distilled water there shall be no more than a very slight reduction in luster or reflecting power of the beads.

The beads shall have a specific gravity of 2.44 to two and 2.56 at 25 degrees Centigrade.

The moisture content shall not exceed 0.01 percent when tested at 105 degrees Centigrade for three hours.

Two pounds of beads are added to a reserved unbleached cotton bag approximately 10 1/2 inches by 17 1/2 inches thread count 48 by 48. The sample is then immersed in distilled water at room temperature for 30 seconds or until the spheres are completely covered. The sample is then removed and excess water removed by twisting the neck of the bag. After two hours with the bag suspended at room temperature the sample is thoroughly mixed and transferred to a clean dry funnel 150 mm. top diameter, 120 mm. depth and 9 to 10 mm. stem i.d. The entire sample shall flow through the funnel with light tapping of the stem permissible only at the start of the test to initiate flow.

214.05.02 PAVEMENT MARKING FILM

1.0 Permanent Pavement Markings Film. The film shall conform to the following requirements:

a) **Composition.** The permanent pavement marking film shall be pliant polymer and shall consist of a mixture of polymeric materials, pigments and glass beads uniformly distributed throughout its cross-sectional areas and with a reflective layer of beads bonded to the top surface. These materials shall be composed as follows:

| | Minimum by Weight |
|-------------------------|--------------------------|
| Resins and Plasticizers | 20% |
| Pigments | 30% |
| Graded Class Beads | 30% |

b) **Glass Beads.** The glass beads shall be colorless and have a minimum index of refraction of 1.5 when tested using the liquid oil immersion method.

c) **Reflectance.** These markings shall have the following initial average reflectance value at 0.2 degrees and 0.5 degree observation angles and 86 degrees entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard No. 370.

| | White | Yellow |
|--------------------|--------------|---------------|
| Observation Angle | 0.2 | 0.2 |
| Specific Luminance | 550 380 | 410 250 |

d) **Thickness.** The nominal thickness, excluding adhesive, shall be 0.06 inch.

e) **Tensile Strength.** The film shall have a minimum tensile strength of 40 pounds per square inch of cross section when tested according to ASTM D 638-76. A sample 6 inches by 1 inch by 0.06 inch shall be tested at a temperature between 70 degrees Fahrenheit and 80 degrees Fahrenheit, using a jaw speed of 12 inches per minute.

f) **Elongation.** The film shall have a minimum elongation of 75 percent when tested according to ASTMD638-76, using a jaw speed of 12 inches per minute.

g) **Plastic Pull Test.** A test specimen made the same size as in paragraph (b) shall support a dead weight of 4 pounds for not less than 5 minutes at a temperature between 70 degrees Fahrenheit and 80 degrees Fahrenheit.

h) **Pigmentation.** The pigments shall be selected and blended to provide a marking film which is white or yellow conforming to standard highway colors through the expected life of the film.

i) **Effective Performance Life.** The Permanent Pavement Marking Film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature, if the pavement surface remains stable. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned resilient substrate that reduces bead crushing and loss. The film shall be weather resistant, and, through normal traffic wear, shall show no appreciable fading, lifting, or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back, or other signs of poor adhesion.

These materials shall be capable of being adhered to asphaltic and/or Portland cement concrete by means of a pressure sensitive precoated adhesive or a liquid contact cement which is applied at the time of installation. Application shall be made according to the manufacturer's recommendation.

214.05.03 Thermoplastic Paint. Thermoplastic traffic line paint shall be a reflectorized thermoplastic permanent striping material applied to the road surface in a molten state by mechanical means. It shall have a surface application of glass spheres which, upon cooling to normal pavement temperatures, will produce an adherent reflectorized stripe of the specific thickness and width, and will be resistant to deformation by traffic. The material shall contain at least 20 percent by weight of glass spheres in the white and yellow paints and at least 12 percent by weight titanium dioxide in the white paint. The material, when applied at a temperature of 400 to 425 degrees Fahrenheit and a thickness of 125 mils (1/8 inch) to 188 mils (3/16 inch) shall set to bear traffic in not more than two minutes when the air temperature is 50 degrees Fahrenheit and not more than 10 minutes when the air temperature is 90 degrees Fahrenheit.

215.01 MATERIALS COVERED. This Specification covers the kind and quality of materials used in the construction and fabrication of "Construction Signs," "Temporary Signs," and "Permanent Signs."

215.02 REQUIREMENTS.

215.02.01 General. The following materials shall conform to the requirements as noted:

| | |
|--------------------------|-------------|
| Portland Cement Concrete | Section 202 |
| Reinforced Steel | Section 206 |

215.02.02 Certificates. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

All materials shall be approved prior to use.

215.03 PHYSICAL PROPERTIES AND TESTS.

215.03.01 Reflective Sheeting. The reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface (Type I), or spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface (Type III). All sheeting shall be weather resistant and shall have a protected, precoated adhesive backing.

Color tolerance shall be within the limits of the FHWA Color Tolerance Charts. The instrumental testing restrictions noted on the FHWA Color Tolerance Charts relative to retroreflective materials may be disregarded to the following extent:

As an alternative to visual testing, instruments providing a system of diffuse illumination and unidirectional viewing may be used as a preliminary means of establishing that the colors meet the required CIE limits. In the event of any dispute concerning the results of instrumental testing, the visual test shall prevail.

The diffuse day color of the reflective sheeting shall conform to the requirements of the CIE Chromaticity Coordinate Limits hereinafter specified and shall be determined in accordance with ASTM Designation E97 "Standard Method of Test for 45 Deg. Directional Reflectance of Opaque Specimens by Filter Photometry." (Geometric characteristics must be confined to illumination incident within 10 degrees of and centered about a direction 45 degrees from the perpendicular to the test surface; viewing is within 15 degrees of and centered about the perpendicular to the test surface. Conditions of illumination and observation must not be interchanged.) The standards to be used for reference shall be the Munsell Papers. Papers must be recently calibrated on a spectrophotometer.

The test instrument shall be one of the following:

- a) Gardner Multipurpose Reflectometer,
- b) Gardner Model AC-2a Color Difference Meter,
- c) Meeco Model V Colormaster,
- d) Hunterlab D25 Color Difference Meter.

The reflective sheeting shall include a precoated pressure sensitive adhesive or a tack free, heat activated adhesive, either of which shall be applied exactly as specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without necessity of additional coats on the reflective sheeting or application surface.

Type I Reflective Sheeting

- a. **Photometric Requirements.** The reflective sheeting shall have the following minimum brightness values at 0.2 degrees and 0.5 degrees and 1.5 degrees divergence expressed as average candlepower per foot - candle per square foot (candelas per lux per square meter) of material. Measurements shall be conducted in accordance with standard testing procedures for reflex-reflectors of Federal Specification L-S-300A, "Sheeting and Tape, Reflective, Nonexposed Lens Adhesive Backing," paragraph 4.47, or as amended.
- b. **Wet Performance.** Wet performance measurement shall be conducted in accordance with standard rainfall test specified in Federal Specification L-S-300A and the brightness of the reflective sheeting, totally wet by rain, shall not be less than 90 percent of the above values.
- c. **Color.** The diffuse day color of Type III reflective sheeting shall conform to the following:

| Div. Ang. Inc. Ang. | Silver-White #1 | | | Silver-White #2 | | | Yellow | | |
|------------------------|-----------------|-----|------|-----------------|-----|------|--------|-----|------|
| | .2° | .5° | 1.5° | .2° | .5° | 1.5° | .2° | .5° | 1.5° |
| -4° | 70 | 30 | 4 | 80 | 41 | 4 | 50 | 25 | 5 |
| 40° | 14.5 | 8.5 | 1.5 | 16.5 | 9.5 | 2 | 11.5 | 7 | 1.5 |

| Div. Ang. Inc. Ang. | Red | | | Blue | | | Green | | | Orange | | |
|------------------------|------|-----|------|------|-----|------|-------|-----|------|--------|------|------|
| | .2° | .5° | 1.5° | .2° | .5° | 1.5° | .2° | .5° | 1.5° | .2° | .5° | 1.5° |
| -4° | 14.5 | 7.5 | 1 | 4 | 2 | 0.6 | 9 | 4.5 | 1 | 25 | 13.5 | 1.5 |
| 40° | 3 | 1.5 | 0.3 | 0.9 | 0.4 | 0.08 | 1.8 | 1.5 | 0.2 | 1 | 0.8 | .1 |

Type III - CIE Chromaticity Coordinate Limits

| Color | x | y | x | y | x | y | x | y | (Y) Reflectance Limit | | Ref. Std. Munsell Papers |
|--------------|------|------|------|------|------|------|------|------|-----------------------|------|--------------------------------|
| | | | | | | | | | Min. | Max. | |
| Silver-White | .302 | .289 | .286 | .306 | .324 | .344 | .342 | .327 | 30.0 | | 5PB7/0.7 |
| Green | .152 | .523 | .211 | .395 | .172 | .372 | .105 | .503 | 3.0 | 8.0 | 9.0G3.3/9.5 |
| Yellow | .483 | .352 | .510 | .490 | .560 | .440 | .534 | .414 | 16.0 | 32.0 | 1.25Y6/12 |
| Red | .608 | .288 | .700 | .298 | .644 | .352 | .608 | .352 | 4.0 | 8.0 | 8R3.2/13 |
| Orange | .535 | .375 | .535 | .399 | .582 | .417 | .607 | .393 | 19.8 | 30.0 | 2.5Y5.5/14.0 |

- d. Lens Elements. The reflective sheeting shall possess stable and durable spherical lens elements which, following extraction, shall show no deterioration following submersion in a 5N solution of sulfuric acid (H₂S0₄) for 30 minutes at 72 degrees Fahrenheit (23 degrees Centigrade).
- e. Adhesive. The reflective sheeting shall include a precoated pressure sensitive adhesive or a tack free, heat activated adhesive, either of which shall be applied exactly as specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without necessity of additional adhesive coats on the reflective or application surface.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for 4 hours at 150 degrees Fahrenheit (65 degrees Centigrade) under weight of 0.25 pounds per square inch (0.18 kg. per square cm.).

The adhesive shall form a durable bond to smooth, corrosion and weather resistant surfaces. The reflective sheeting, applied to cleaned and etched aluminum test panels shall adhere securely, 48 hours after application, at all normal application temperatures up to 150 degrees Fahrenheit (93 degrees Centigrade) after the panels are conditioned for 24 hours at minus 10 degrees Fahrenheit (minus 35 degrees Centigrade). The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and show no cracking when the surface of the reflective sheeting is exposed to the impact of a 2 pound (0.9 kg.) weight with a 5/8 inch (15.9 mm.) rounded tip dropped from a 10 inch pound (11.4 cm. kg.) setting on a Gardner Variable Impact Tester, IG-1120M. The sheeting shall resist peeling from the application surface when a 5 lb./in. width (2.27 kg. per 2.54 cm. width) force is applied as outlined in ASTM Designation D 903.

- f. Film. The reflective sheeting shall have sufficient strength and flexibility so that it can be handled, processed, and applied according to the recommendations of the sheeting manufacturer without appreciable damage. Following liner removal, the reflective sheeting shall not shrink more than 1/64 inch (0.4 mm.) in 24 hours in any dimension per 9 inch (22.9 cm.) square at 72 degrees Fahrenheit (23 degrees Centigrade) and 50 percent RH.

The sheeting with liner removed, conditioned for 24 hours at 72 degrees Fahrenheit and 50 percent RH, shall be sufficiently flexible to show no cracking when bent around a 1/8 inch (3.18 mm.) mandrel with adhesive side contacting mandrel. Note: For ease of testing, spread talcum powder on adhesive to prevent sticking to mandrel.

g. Surface. The sheeting surface shall be smooth and facilitate cleaning and wet performance, and exhibit 85 degrees gloss meter rating of not less than 50 (ASTM Designation D 523). The surface of the sheeting with the heat activated adhesive shall be readily processed in accordance with recommendations of the sheeting manufacturer, compatible with recommended transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application.

The sheeting shall permit cutting and color processing at temperatures of 60 degrees, minus 100 degrees, Fahrenheit (15 degrees, minus 39 degrees, Centigrade) and relative humidities of 20 to 80 percent. The sheeting surface shall permit cleaning by wiping with a clean soft rag damped in V.M. & P. Naptha or mineral spirits.

h. Impact Resistance. The sheeting, applied according to manufacturer's recommendations to cleaned, etched, 0.4 inch by 3 inch by 5 inches (1 mm. by 7.6 cm. by 12.7 cm.) aluminum (6061-T6) and conditioned for 24 hours at 72 degrees Fahrenheit (23 degrees Centigrade) and 50 percent humidity, shall show no cracking when face of panel is subjected to impact of a 2 pound (0.9 kg.) weight with 5/8 inch (15.9 mm.) rounded tip at 10 inch pound (11.4 cm. kg.) setting on a Gardner Variable Impact Tester (IG-1120).

i. Durability. Reflective sheetings, processed, applied to approved sign base materials, and cleaned, in accordance with manufacturer's recommendations for their use on traffic control signs, shall be capable of performing satisfactorily for the number of years stated in Table II if the sheetings have not deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a vehicle, or (2) the average nighttime reflective brightness is less than that specified in Table II.

TABLE II (Type III)

| Sheeting | Average Min. Candlepower per Foot Candle per Sq. Ft. at 0.2 Incidence | Satisfactory Life |
|--------------|---|-------------------|
| Silver-White | 200 | 10 |
| Green | 24 | 10 |
| Yellow | 120 | 10 |
| Red | 28 | 5 |
| Orange | 48 | 3 |

215.03.02 Aluminum Sign Panels. Sheet aluminum for sign panels shall be of 0.125 inch aluminum alloy alclad 5052-H38 or 6061-T6 and shall conform to specifications for ASTM Designation B 209.

Sign panel sections shall be fabricated of standard width aluminum sheets not less than 4 feet wide, except that not more than two sheets for any one sign may be cut not less than 18 inches in width, so as to provide sign widths to nearest 6 inch increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

The aluminum shall be free of all corrosion, white rust, and dirt. All sign dimensions, metal gage, and bolt holes shall conform to the requirements set forth on the Plans and in these Specifications. Metal degreasing will be required on all sheet aluminum and shall be performed by one of the following methods:

- Vapor degreasing. Signs shall be completely immersed in a saturated vapor of trichlorethylene or perchlorethylene. Trademark printing shall be removed with lacquer thinner or a controlled alkaline cleaning system, and rinsed thoroughly with running water.
- Alkaline degreasing. Signs shall be completely immersed in a tank containing alkaline solutions controlled and titrated to the solution manufacturer's specification. Immersion time shall depend upon the amount of soil to be removed. Signs shall then be thoroughly rinsed with running water.

Whenever reflective sheeting is required on the sign, the aluminum shall be etched by one of the following methods:

1. Acid etch. The aluminum shall be well-etched in a 6 to 8 percent phosphoric acid solution at 100 degrees Fahrenheit and rinsed thoroughly with running cold water, followed with a hot water tank rinse.
2. Alkaline etch. Etch well the precleaned aluminum in all alkaline etching material that is controlled by titration. Time, temperature, and concentration shall be as specified by the solution manufacturer. Smut shall be removed with an acidic, chromium compound-type solution as specified by the solution manufacturer and the sign then rinsed thoroughly.
3. The surface etch shall provide a clean, mat, nonshine or nonglare finish suitable for the application of paint or sheeting and for the unpainted back or reverse side of highway signs. After the degreasing and etching process, the aluminum shall be dried by use of a forced air drier.

Metal shall not be handled, except by device or clean canvas gloves between all cleaning operations and the application of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to the application of the background material.

Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. All fabrication, including cutting, shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs, and other defects resulting from fabrication. The surface of all sign panels shall be a plane surface.

215.03.03 Overhead Sign Structures and Sign Frames. The materials used in the fabrication of overhead sign structures and footings shall conform to the following requirements:

- a. Sign names. Bars, plates, and shapes shall be structural steel conforming to the specifications of ASTM Designation A 36.
- b. Sign pipe posts. Pipe posts shall be welded or seamless steel pipe conforming to the specifications of ASTM Designation A 53, Grade B. At the option of the Contractor, posts may be fabricated from structural steel conforming to the specifications of ASTM Designation A 36 or of ASTM Designation A 283, Grade D, except that plates more than 1 inch in thickness shall be structural steel conforming to the specifications of ASTM Designation A 373.
- c. Sign steel walkway gratings. Steel walkway gratings shall be furnished and installed in accordance with details shown on the Plans and the following provisions:
 1. Gratings shall be the standard product of an established grating manufacturer.
 2. Material for gratings shall be structural steel conforming to the specifications of ASTM Designation A 36.
 3. For welded type gratings, each joint shall be full resistance welded under pressure to provide a sound, completely beaded joint.
 4. For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved by the Engineer, and the fabricated grating shall be equal in strength to the welded type.
 5. After fabrication, gratings shall be hot-dip galvanized.
 6. Gratings shall be accurately fabricated and free from warps, twists, or other defects affecting their appearance or serviceability. Ends of all rectangular panels shall be square. The tops of the bearing bars and cross members shall be in the same plane. Gratings distorted by the galvanizing process shall be straightened.
- d. Bolts, Nuts, and Washers. High-strength steel bolts, nuts and washers shall conform to the specifications of ASTM Designation A 325. All other bolts and nuts, including anchor bolts and nuts for sign foundations, shall conform to the specifications of ASTM Designation A 307, and shall be furnished with commercial quality washers. Bolted connections shall conform to the provisions in Subsection 326.03.08 – “Bolts and Bolted Connections.”
- e. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the Plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A 36. Galvanizing shall conform to ASTM Designation A 123. All welding shall conform to the requirements set forth in Subsection 326.03.18 – “Welding.”
- f. Anchor bolts, nuts and washers shall be of structural carbon steel conforming to Section 207 – “Structural Steel,” and shall be galvanized in accordance with ASTM Designation A 165 Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plate portion will extend at least 2 inches into concrete. Anchor bolts shall be of the size, shape, and length as shown on the Plans.

- g. All bolts, nuts, clamps, and metal washers not otherwise noted shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation A 165, minimum thickness as prescribed for grade Type TS, and galvanizing shall conform to the requirements of ASTM Designation A 153.
- h. Steel sign panels shall be mounted using 1/4 inch by 20 inch flat head, brass, machine screws with a No. 14 brass, nickel plates, asbestos backed, finishing washer and one brass nut with a flat brass washer and lock washer for each machine screw. Lock washers shall be plain phosphor bronze or beryllium copper, shake-proof and externally toothed. Where obstructions prevent the normal installation of nuts, the frame shall be drilled and tapped to accept the screw. The exposed portion of fastening hardware on the face of the sign panels shall be painted out using commercial quality touch-up enamel that matches the background.

The following type fasteners may be used in lieu of those specified above:

Either a silicone bronze or an aluminum alloy 5052 or 5056, self-plugging blind rivet with a nominal diameter of 9/32 inch. The rivet head shall be not less than 0.7 inch nor more than 0.8 inch in diameter and shall be undercut to make deburring of the mounting hole unnecessary. The rivet shall develop a clamping force of not less than 350 pounds.

- i. Supporting frame shall be manufactured in accordance with the Plans and in accordance with the requirements herein specified. All metal parts shall be galvanized after fabrication, in accordance with the provisions of Section 213. When permission is granted by the Engineer to zinc coat a surface by means other than hot-dip galvanizing, the metalizing process shall be used to place the zinc. Metalizing shall be performed in accordance with the AWS Specifications and the thickness of the sprayed zinc coat shall be at least 5 mils.
- j. Truss frames shall be fabricated to the largest practical sections prior to galvanizing. Splice locations shall be submitted to the Engineer for approval and the Contractor shall not commence fabrication until such splice locations are approved.
- k. All welding in the fabrication of the structure shall be done in accordance with the requirements of Section 326. No field welding on any part of the structural assembly will be permitted.

Note: Before fabrication is started, five sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

215.03.04 Sign Hardware and Related Materials. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the Plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A 36. Galvanizing shall conform to ASTM Designation A 123. All welding shall conform to the requirements set forth in Section 326.

All bolts, nuts, clamps, and metal washers shall be of structural, carbon steel conforming to Section 207 and may be galvanized or cadmium plated as hereinafter stated.

Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section 207, and shall be galvanized in accordance with ASTM Designation A 153, or cadmium plated in accordance with ASTM Designation A 165, Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least 2 inches into concrete. Anchor bolts shall be of the size, shape, and length as shown on the Plans.

Aluminum alloy tubular stiffeners shall be schedule 40 pipe fabricated of 6061-T6 aluminum alloy and shall conform to the specifications of ASTM Designation B 241.

Steel pipe for posts shall conform to the specifications of ASTM Designation A 120 and shall be galvanized.

Galvanized steel pipe posts shall be of the diameter and length shown on the Plans. The top of the posts shall be fitted with a cover. Posts showing damage shall be repaired or rejected.

The straps, bars, and braces used on single support signs shall be of aluminum alloy 6061-T6 and shall conform to ASTM Designation B 209.

Stringers for horizontal supporting structural members shall be of 6061-T6 or 6062-T6 aluminum alloy and shall conform to ASTM Designation B 308, Alloy GS11A.

All bolts, nuts, clamps, and metal washers in contact with aluminum shall be cadmium plated. All other bolts, nuts, clamps and metal washers shall be galvanized or cadmium plated. Cadmium plating shall conform to the

specifications of ASTM Designation A 165, minimum thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation A 153.

Wood posts and braces for sign supports shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress rated wood material, at the option of the Contractor. Said wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and shall be graded in accordance with the provisions contained in Section 208. Sweep shall not exceed 0.08 feet in 10 feet.

The expansion assembly for fastening the aluminum tubing to the aluminum Z-bars shall be manufactured of a zinc die casting alloy which contains copper, aluminum, and magnesium. The anchor bolt for the expansion assembly shall be cadmium plated and shall conform to the specifications of ASTM Designation A 165, minimum thickness as prescribed for grade Type TS.

Square sign posts and anchors shall conform to the following requirements:

Material. Steel posts shall conform to ASTM Designation A 446 or A569. Steel posts shall have a minimum yield of 40,000 p.s.i. after fabrication with certification being required.

Shape. The cross section of post shall be a square tube formed of ten 0.135 inch (U.S.S. gauge) or twelve 0.105 inch (U.S.S. gauge) steel carefully rolled to size and welded. The cross section of the sign post anchor and sleeve used with the 2 inch post will be same as for the sign posts. The cross section of the sign post anchor used with the 2 1/2 inch post shall be a square tube formed of 3/16 inch steel carefully rolled to size and welded.

Fabrication. The furnished members shall be straight and shall have a smooth uniform finish. All holes and cut off ends shall be free from burrs.

Finish. All posts shall be weather protected. Posts made from material conforming to ASTM A446 shall be formed from steel which has been zinc coated in accordance with ASTM A525, Designation G-90.

Posts made from material conforming to ASTM A569 shall be coated in accordance with the applicable provisions of AASHTO M181 for Class 2 posts, except as hereinafter modified.

AASHTO M181 is hereby modified as follows:

- a) Article 8.2.2.2. The weight of zinc coating on the exterior surface of posts shall be a minimum of 0.45 ounce per square foot as determined from the average results of two or more specimens and not less than 0.40 ounce per square foot on an individual sample.
- b) Article 8.2.2.4. The weight of chromate conversion coating on posts shall be a minimum of 5 micrograms per square inch.

Size. Sizes shall conform to those shown on the Plans or as approved when used as an alternate. Channel sign posts and base posts shall conform to the following requirements:

Material. Posts shall be rolled form high strength hot rolled steel conforming to ASTM Designation A 499 modified to 60,000 p.s.i. minimum yield and 90,000 p.s.i. minimum tensile or equal.

Shape. Posts shall be of a uniform channel shape. The dimensions of these posts shall be as noted on special detail sheets in the Contract Plans.

Weight. The weight of each base post and each sign post before holes are punched shall be 2.75 and 4 pounds per foot for base posts and 2.5 and 4 pounds per foot for sign posts. The 2.75 pound base post shall be used with 2.5 pound sign post and the 4 pound base post with the 4 pound sign post.

Fabrication. The furnished members shall be straight and have a smooth uniform finish. All holes and cut off ends shall be free of burrs.

Finish. All posts shall be weather protected by galvanizing. This galvanizing shall conform to ASTM Designation A 123.

Size. Sizes shall conform to those shown on Plans or as approved when used as an alternate.

The pipe, wyes, tees and elbows used to construct Rent Construction Barricades (Type III B) shall be made of polyvinyl chloride (PVC) plastic pipe. The PVC pipe shall conform to the requirements of ASTM Designation D 2241 for PVC 1120 or 1220, SDR 21, pressure rating 200 p.s.i. The PVC wyes, tees, and elbows shall conform to the requirements of ASTM Designation D 2466, Type II, Grade 1. At the Contractor's option, pipe, wyes, tees and elbows may be acrylonitrile-butadiene-styrene (ABS) conforming to the requirements of ASTM Designation D 2751. Combinations of PVC and ABS pipe and fittings will be permitted. All joints shall be slip-fit and shall not be threaded or cemented.

216.01 GENERAL.

212.01.01 DESCRIPTION. This Section covers the quality of materials used in monument restoration.

216.02 MATERIALS.

216.02.01 Survey Markers. Survey markers shall be bronze as manufactured by Servco (No. 286), or approved equal. The top surface shall be flat and machined, and the shank shall be corrugated and flattened to prevent removal or turning once the marker has been set. The marker shall be cast of virgin metal, in one piece, free from casting imperfections. Marker size shall be 2 inch diameter top, 3/4 inch by 2-1/2 inch corrugated and flattened shank.

In the event that the Contractor desires to use a survey marker without a corrugated and flattened shank, the shank shall be either 6 inches in length (minimum) and bent to insure non-removal once set, or manufactured with a split shank, each side of which shall be bent, or flared, so that the marker cannot be removed after it is set.

216.02.02 Street Wells. Street wells, or "pots" used in the construction of survey monuments shall be Pinkerton Foundry assembly A 257 or approved equal. The "pot" shall be cast iron, and the cover shall have the word "Survey" in raised letters indicated on its top surface.

217.01 GENERAL.

217.01.01 DESCRIPTION. This Section covers the quality of materials for fire hydrant installation.

217.01.01.01 Type of Hydrant and Character of Service. All hydrants shall conform to the AWWA C-502-54 –“Standard for Fire Hydrants for Ordinary Water Works Service”, and the requirements of the governing Agency.

217.01.01.01.01 Pressure. All hydrants shall be designed for a working pressure of 150 *PSI* and a hydrostatic test pressure of 300 *PSI*.

217.01.01.01.02 Valve Opening. All hydrants shall be of the compression type with the main valve opening against the pressure and closing with the pressure.

217.01.01.01.03 Dry Top Design. Hydrants shall be of the dry top design; the operating threads shall be completely sealed away from the water at all times, whether or not the valve is open or closed. Hydrants having operating threads located in the waterway are not acceptable.

217.01.01.01.04 Operating Nut. Hydrants shall be opened by turning to the left (counter clockwise) and shall have a 1 3/16 inch pentagonal bronze operating nut. On high profile model fire hydrants (such as the Mueller 107), a corrosion-resistant stainless steel screw pin shall secure the combined cap and nut to the operating screw.

217.01.01.01.05 Packing Gland. The packing gland located in the bonnet shall be solid bronze with double “O” ring seals in lieu of a conventional stuffing box.

217.01.01.01.06 Nozzles. Hydrants shall have at least two, 2 1/2 inch nozzles with threads conforming to the National Standard Dimensions (7 1/2 threads per inch), and one, 4 1/2 inch pumper connection with an outside diameter of 5 7/16 inches and four threads per inch.

An exception to the above specification is in the Incline Village area, where a 4 1/2 inch pumper connection with a National Standard Thread will be acceptable.

217.01.01.01.07 Traffic Models. All hydrants shall be of the traffic model type so that the main valve will remain closed in the event the hydrant is broken off or destroyed. The barrel section and operating mechanism shall be designed with a breakable safety flange.

217.01.01.01.08 Bottom Flange Location. The bottom flange on the hydrant barrel must be between 4 and 12 inches above finished grade elevations at the hydrant location.

217.01.01.01.09 Main Valve Facing. The main valve facing shall be made of rubber with the main valve opening 5 1/4 inches in diameter.

217.01.01.01.10 Drain Valves. Hydrants shall be of the dry barrel type and shall have a minimum of two positive acting, non-corrosive drain valves that shall drain the hydrant completely by opening as soon as the main valve is closed, and by closing when the main valve is opened. Drain valves operated by springs or gravity flow will not be acceptable.

217.01.01.01.11 Main Valve Seat. The main valve seat shall be bronze with a bronze cap nut on bottom stem threads to prevent corrosion.

217.01.01.01.12 Inlet Connection. Hydrants shall have a 6 inch inlet and be connected to the main by means of a flanged, asbestos cement, or mechanical joint shoe, depending on the type of pipe specified.

217.01.01.01.13 Interchangeable Parts. All like parts of hydrants of the same size and model produced by the same manufacturer shall be interchangeable.

217.01.01.01.14 Features. All hydrants must be non-freezing and self-draining, and must have an independent shutoff valve.

217.01.01.01.15 Hydrant Capacity. Hydrants must have sufficient capacity to deliver 600 gallons per minute with a friction loss not exceeding 2-1/2 *PSI* in the hydrant, and a total friction loss not exceeding 5 *PSI* between the street main and outlet.

217.01.01.01.16 Flush Hydrants. Flush hydrants will not be acceptable.

217.01.01.01.17 Hydrant Color. Hydrant color shall be determined the Agency.

217.01.01.01.18 Hydrant Types. Unless otherwise directed or approved by the Agency, high profile hydrants (such as the Mueller 107) shall be installed in industrial and mercantile areas. Unless otherwise directed or approved by the Agency, low profile hydrants shall be installed in all residential areas and areas other than industrial and mercantile areas.

217.01.01.01.19 Hydrant Footpiece. The hydrant footpiece, after installation, shall bear on concrete. The minimum bearing area shall be 4 square feet.

217.01.01.01.20 Drain Valve Openings. Hydrant drain valve opening shall, after installation, be surrounded by a gravel sufficiently coarse so that no foreign substance may enter the drain valve and impair its operation.

217.01.02 IDENTIFICATION. All hydrants shall have permanent markings identifying the manufacturer by name, initials, or abbreviations in common usage, and designating the size of the main valve opening and the year of manufacture. An arrow and the word "OPEN" shall be cast in relief, so as to be clearly visible, on the top of the hydrant to designate the direction of opening. Markings shall be so placed as to be readily discernible and legible after hydrants have been installed.

217.02 MATERIALS.

217.02.01 Cast Iron. All cast iron shall conform to ASTM A126 Class B.

217.02.02 Steel. Steel shall conform to ASTM A575. Stainless steel shall conform to ASTM A276.

217.02.03 Brass or Bronze. Brass or bronze shall conform to ASTM B62, Grade 1.

Bronze may be used for drain valve parts, glands, bolts, bolt nuts, bushings, nozzles, stems or threaded portions of stems, and valve seats or valve seat rings.

217.02.04 Body Bolts and Nuts. Body bolts and nuts shall conform to ASTM A307, Grade B. Bolts and nuts shall be either cadmium plated or zinc coated in accordance with ASTM A123, or rust-proofed by some other process acceptable to the governing Agency. Body bolt studs shall conform to ASTM A307, Grade B.

Safety flange coupling bolts shall intentionally have a lower breaking point than the rest of the unit. The stainless steel coupling pins shall conform to Section 216.03.02 – "Steel".

217.02.05 Gasket Material. Gasket material shall be sheet asbestos, rubber composition, or paper free from corrosive ingredients, either alkaline or acid.

217.02.06 Main Valve Facing. The main valve facing of the hydrant shall be faced with a suitable yielding material, such as rubber, leather, balata, or composition, where it bears on metal seats. The material shall be clamped so that the valve will not leak at the stem. The bottom stem threads may be protected by a suitable cap nut.

217.02.07 Nozzles. Hose nozzles shall be bronze.

217.02.07.01 Nozzle Caps. Nozzle caps shall be cast iron.

217.02.08 Valve Seats or Seat Rings. Valve seats or seat rings shall be made of Grade 1 bronze.

300.01 GENERAL.

300.01.01 DESCRIPTION. This Section covers preparation including, but not limited to, the implementation of the requirements for erosion control due to storm water, construction related runoff and *Construction Activities*, both interior and exterior to the *Work Zone*; the removal and disposal of vegetation and natural or man-made objects not designated to remain; and the provision and maintenance of temporary systems needed during construction, of the *Work Zone* for *Construction Activities*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

300.01.03 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”, except as modified herein.

300.01.03.01 Roadway Removal.

300.01.02.01.01 Longitudinal Drop-Offs. After roadway removal, the *Contractor* shall safety slope all longitudinal drop-offs. Safety slopes shall be placed flush with the existing pavement, tapered and compacted prior to beginning of the non-working hours. The *Contractor* shall submit details for the proposed safety slope construction to the *Engineer* at least five *Working Days* prior to implementation. Unless otherwise directed or approved by the *Engineer*, all driveways shall be opened and accessible at the end of shift.

All longitudinal drop-offs must be acceptably delineated and signed. Unless otherwise directed or approved by the *Engineer*, 4 horizontal to 1 vertical safety slopes shall be constructed and maintained where public traffic is exposed to longitudinal drop-offs greater than four inches during non-working hours. Unless otherwise directed or approved by the *Engineer*, safety slopes shall be constructed utilizing material conforming to Subsection 200.01.03 – “Crushed Aggregate Base” and/or Subsection 200.01.04 – “Recycled Aggregate Base”, except at driveway and/or intersection access points. At these locations, cold or hot bituminous plantmix shall be used.

300.02 THIS SUBSECTION INTENTIONALLY LEFT BLANK**300.03 CONSTRUCTION.**

300.03.01 INSPECTION AND TESTING. The *Contractor* shall accommodate inspection and testing in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable subsections of Section 336 – “Inspection and Testing”.

300.03.02 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of the Work”.

300.03.03 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

300.03.04 EXISTING IMPROVEMENTS AND SYSTEMS. The *Contractor* shall dispose unsuitable material, surplus material and/or materials not designated for reuse in accordance with Subsection 100.31.04 – “Material Disposal”.

300.03.04.01 Existing Improvements.**300.03.04.01.01 Visual Records.**

Unless otherwise directed or approved by the *Engineer*, the *Contractor* shall furnish visual records as follows:

The *Contractor* shall provide narrated visual records in a format approved by the *Engineer* of the total contract area showing: (1) pre-construction conditions (including adjacent property improvements such as sidewalks, walls, fences, landscaping, valves, and etc.) and (2) the completed construction (including adjacent property improvements). While recording, property addresses shall be included, either visually or by narration.

Pre-construction visual records shall be delivered to the *Engineer* 7 *Calendar Days* prior to commencing any construction work. The visual record of completed construction shall be delivered to the Agency with the final payment requisition.

300.03.04.01.02 Clearing. The existing ground surface shall be cleared of all man-made improvements as shown on the *Plans* and all organic materials, including, but not limited to, sod, brush, grass, weeds, trees, logs, stumps, roots which are 1-1/2 inches in diameter or larger, and all other deleterious materials within the limits of construction. Man-made improvements determined by the *Engineer* as not interfering with *Construction Activities* may, with the written approval of the *Engineer*, be abandoned in place. Unless otherwise directed or approved by the *Engineer*, materials shall be cleared to a depth of 36 inches below the existing ground surface or to subgrade, whichever is deeper. Clearing shall extend to the outside excavation and fill slope lines, except that, where slopes are to be rounded, clearing shall extend to the outside limits of slope rounding.

The *Contractor* shall clear the specified improvements to the required depth by a method that does not damage the *Subgrade*. Should the *Contractor* fail to utilize necessary caution to protect the *Subgrade*, all overexcavation and deep stabilization shall be by the *Contractor* at no additional cost to the *Agency/Owner*.

Unless otherwise directed or approved by the *Engineer*, all materials cleared, not designated for reuse, shall be immediately removed from the public right-of-way.

Unless otherwise directed or approved by the *Engineer*, *Excavations* resulting from the clearing of existing improvements shall be filled with material equivalent to the surrounding material and compacted in accordance with Section 304 – “Fill, Backfill and Riprap”.

300.03.04.01.02.01 Grubbing. Unless otherwise directed or approved by the *Engineer*, grubbing of native organic growth shall conform to Subsection 300.03.05.01.02 – “Clearing”.

300.03.04.01.02.02 Uncontrolled Fill. Unless otherwise directed or approved by the *Engineer*, *Uncontrolled Fill* within structural areas shall be removed for its full depth.

300.03.04.01.02.03 Bituminous Pavement. Bituminous pavement shall be removed to clean straight lines by saw cutting where the removal of existing improvements does not include the total amount of pavement encountered. Saw cutting of existing pavement shall be utilized whenever a pavement joint is to be made.

300.03.04.01.02.03.01 Partial Depth Removal. Where only a partial depth of the existing pavement is to be removed, a minimum laying depth of three times the nominal aggregate size of new pavement material shall be provided.

300.03.04.01.02.03.02 Adjacent to Trench. Where pavement adjoins a trench, the edges adjacent to the trench shall be trimmed to neat straight lines at least 9 inches wider than the trench on each side, before resurfacing, to insure that all areas to be resurfaced are accessible to the rollers used to compact the *Subgrade* or paving materials.

300.03.04.01.02.04 PCC. PCC shall be removed to clean straight lines by saw cutting where the removal of existing improvements does not include the total amount of PCC encountered. Saw cuts shall be made to a minimum depth of 1-1/2 inches. PCC to be removed shall be neatly sawed in straight lines either parallel to the curb or at right angles to the alignment. If the removal limit is within 36 inches of a construction joint, cold joint, expansion joint, crack, or edge, the PCC shall be removed to the joint, crack, or edge. No section to be replaced shall be smaller than 36 inches in length. Unless otherwise shown on the *Plans* and/or directed or approved by the *Engineer*, removal of the PCC shall include all existing composite material from back of the new improvement to 12 inches in front of the new improvement. The *Contractor* shall achieve a vertical, neat line in a location appropriate for the method of placement chosen.

300.03.04.01.02.04.01 Curbs. The *Contractor* shall match the existing top of curb and maintain a uniform flow line of the gutter. If a uniform flow line does not exist, the *Contractor* shall establish a uniform flow line as directed by the *Engineer*.

300.03.04.01.02.05 Trees, Tree Branches and Tree Roots. Trees and tree branches shall be removed in such a manner as not to injure surrounding trees, plants, and improvements which are not shown on the *Plans* to be removed. The *Contractor* shall remove tree branches and tree roots under the direction of a *Certified Arborist*, in such a manner that the health of the tree will be preserved and the remaining branches of the tree will present a balanced appearance. Tree branches shall be cut off close to the *Bole*. Scars resulting from the removal of branches shall be treated with an approved tree sealant, applied as directed by the *Certified Arborist*.

300.03.04.01.02.05.01 Tree Branches. Tree branches which hang within 162 inches above finished roadway grade or within 108 inches above finished sidewalk or parkway grade shall be removed.

300.03.04.01.03 Protection. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”.

300.03.04.02 Existing Systems. Remnants of existing systems determined by the *Engineer* as not interfering with *Construction Activities* may, with the written approval of the *Engineer*, be abandoned in place in accordance with the *Engineer*’s recommendations.

The *Contractor* shall notify the *Engineer* and all impacted individuals and entities including, but not limited to, the *Agency*, Utility Owner, Property Owners, and Railroad, prior to performing any work on existing systems.

300.03.04.02.01 Temporary Systems. The *Contractor* shall provide temporary systems needed during construction. Temporary systems shall be in place prior to modification or removal of the existing system.

300.03.04.02.02 Modification. Modifications to existing systems shall only be performed at the direction of the *Agency*.

300.03.04.02.03 Removal. Removal of existing systems shall conform to Subsection 300.03.05.01 – “Existing Improvements”, except as modified herein.

300.03.04.02.03.01 Removed Materials. Unless otherwise directed or approved by the *Engineer*, when not shown otherwise on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, materials removed from existing systems, not reused, shall become the property of the *Contractor*.

300.03.04.02.03.01.01 Traffic Control Signs. Where existing traffic control signs are removed, the *Contractor* shall immediately install temporary signs of the same designation as close as possible to the original location.

300.03.04.02.04 Salvage. The *Contractor* shall exercise caution when removing any existing system component to be salvaged so that it will remain in its original form and existing condition. The *Contractor* shall replace any of the above-mentioned salvaged components, which, as determined by the *Engineer*, have been damaged or destroyed by reason of the operations at no additional cost to the *Agency/Owner*.

300.03.04.02.04.01 Signs. The *Contractor* shall notify the *Engineer* prior to removal of any existing signs designated for salvage, which, in the *Contractor*’s opinion, are not suitable for reinstallation.

300.03.05 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”.

300.03.06 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

300.03.07 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”.

300.03.08 EXCAVATING. Excavating shall be performed in accordance with Section 303 - “Excavating”.

300.03.08.01 Maintenance of Surface Drainage. Site preparation shall not block or impede the existing surface drainage.

300.03.09 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”, except as modified herein.

300.03.09.01 Temporary Pavement Markings. The *Contractor* shall provide and maintain temporary pavement markings in accordance with the *MUTCD* Part VI. Unless otherwise directed or approved by the *Engineer*, temporary painted and/ or other pavement markings which conflict with the permanent pavement markings will be prohibited. Conflicting pavement markings shall be obliterated using methods that result in minimum pavement scar and completely remove marking materials. Obliterated markings shall be unidentifiable as pavement markings under day or night, wet or dry conditions. Temporary traffic paint shall not be applied to the final pavement surface.

300.03.10 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

300.04 ACCEPTANCE. Site preparation shall be complete and accepted by the *Engineer* prior to proceeding with subsequent related work.

301.01 GENERAL.

301.01.01 DESCRIPTION. This Section covers the protection and restoration of existing natural and man-made improvements and systems which are not designated on the *Plans* to be removed.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

301.01.02 DESIGN.**301.01.02.01 PCC.**

301.01.02.01.01 Composition of Mixtures. Unless otherwise provided in the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, a mix design shall be performed in accordance with Subsections 337.01.01 "Mix Design" and 337.10 – "PCC Flatwork, Curbs, Ditches and Slope Paving and Structures" to determine the composition of the mixture. Mixture properties shall conform to Table 337.10.01.01-I.

301.01.03 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 300.01.03 – "Safety".

301.02 THIS SUBSECTION INTENTIONALLY LEFT BLANK**301.03 CONSTRUCTION.****301.03.01 SUBMITTALS.**

301.03.01.01 Certificate of Compliance. The *Contractor* shall provide a *Certificate of Compliance* for each material in accordance with Subsection 100.31.01 – "Certificate of Compliance". The *Contractor* shall ensure that the certificates have been reviewed and accepted by the *Engineer* prior to unloading the associated material at the *Site of Work*.

301.03.01.02 Utility Inventory. The *Contractor* shall submit to the *Agency*, *Engineer* and each Utility Owner a utility inventory list prior to proceeding with the related *Construction Activity*. A copy of the list shall also be available within the *Work Zone* at all times.

301.03.01.03 Manhole Protection. The *Contractor* shall submit to the *Engineer* a document containing the procedure for protection of manholes including but not limited to:

- A. The course of action during all phases of construction including, but not limited to, protecting, restoring and grouting manholes;
- B. *Emergency* preparedness, including, but not limited to, the contact name and phone number and other contact information for the company the *Contractor* will use in case of an *Emergency*;
- C. And details for a debris catcher that will prevent any contaminants from entering into the manhole and associated system.

The *Contractor* shall ensure that the document has been reviewed and accepted by the *Engineer* prior to proceeding with the related *Construction Activity*.

301.03.01.04 PCC. The *Contractor* shall submit, in writing, the *PCC* mix design at least 30 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 14 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the *PCC*.

301.03.02 INSPECTION AND TESTING. The *Contractor* shall accommodate inspection and testing in accordance with Subsections 100.30 – "Inspection and Testing" and the applicable subsections of Section 336 – "Inspection and Testing".

301.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – "Location of Work".

301.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

301.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. The *Contractor* shall remove existing improvements and systems as indicated on the *Plans* in accordance with Section 300 – Site Preparation”.

The *Contractor* shall protect; maintain in a safe, operable condition; and restore existing improvements and systems. Where damage is caused to an existing improvement or system by the *Contractor*’s operations, the damaged item shall be promptly repaired or replaced at no cost to the *Agency/Owner*. Should the *Contractor* fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any moneys due, or to become due, the *Contractor*.

301.03.05.01 PCC. Unless otherwise directed or approved by the *Engineer*, whenever a part of a square or slab of existing *PCC* flatwork or length of curb or gutter is broken or damaged, the entire square, slab or length shall be removed to the nearest control joint and the *PCC* reconstructed in accordance with Section 312 – “*PCC* Flatwork, Curbs, Ditches, and Slope Paving”.

301.03.05.02 Protection and Maintenance. Existing improvements, adjacent property, utilities and other facilities, and trees and plants that are not to be removed shall be protected from injury or damage resulting from the *Contractor*’s operations.

301.03.05.02.01 Bituminous Pavement. The *Contractor* shall protect the integrity of the edge of bituminous pavement remaining adjacent to the removal section.

301.03.05.02.02 Fences. The *Contractor* shall protect all fences or, when the *Work* requires removal of the fence, provide temporary fencing prior to the removal of the existing fence and maintain until the completion of *Work*. The *Contractor* shall make accommodations for security and safety of the impacted area when working on fences. The *Contractor* shall be responsible for any damages or losses which occur as a result of inadequate security when working on fences.

301.03.05.02.03 Mailboxes. The *Contractor* shall preserve the areas surrounding the mailboxes and provide access to the mailboxes. In the event that construction activities hinder mail service, the *Contractor* shall relocate any impacted mailbox. The *Contractor* shall notify the *USPS* prior to removal of mailbox to coordinate relocation. Temporary mailbox stands shall be located and constructed in accordance with *USPS* requirements.

301.03.05.02.04 Pavement Markings. The *Contractor* shall provide and maintain temporary pavement markings until permanent pavement markings are placed.

301.03.05.02.05 Survey Monuments. Monuments shall be removed prior to *Construction Activities*.

301.03.05.02.06 Temporary Systems. The *Contractor* shall maintain temporary systems in effective operation during construction.

301.03.05.02.07 Traffic Signs. The *Contractor* shall install temporary signs of the same designation as close as possible to the original location of traffic signs which are removed to facilitate the *Contractor*’s operations. The *Contractor* shall provide safe storage and protection of all signs which are removed, but are not designated for replacement. The *Contractor* shall notify the *Engineer* prior to removal of any signs, which, in the *Contractor*’s opinion, are not suitable for reinstallation.

301.03.05.02.08 Utilities. The *Contractor* shall become informed of the exact location of all overhead and underground facilities and proceed in accordance with Section 100.26 – “Utilities”.

The *Contractor* shall protect all utilities. Before protecting utility facilities, the *Contractor* shall take inventory of all impacted utilities. The *Contractor* shall record the exact location and type of utility by labeling the assembly with numbers at locations visible for verification. The labeling shall include utility site, collar, and lid to ensure proper match of hardware when utility adjustment is completed at the conclusion of the project. The utility location inventory list shall be available on the *Site of Work* at all times for emergency shutoff purposes.

The *Contractor* shall not dispose or place debris or other unwanted material in any manhole, catch basin, vault or other utility facility.

301.03.05.02.09 Vegetation. The *Contractor* shall protect trees and other vegetation that are not to be removed from damage. If existing landscaping requires pruning, trimming or other modification, including removal, to accommodate a construction activity the *Contractor* shall notify the *Engineer*, adjacent property *Owner* and *Agency*'s Urban Forester before commencing the activity. The *Contractor* shall proceed in accordance with the Urban Forester's recommendations under the supervision of a *Certified Arborist*.

301.03.05.03 Restoration.

301.03.05.03.01 Fences. The *Contractor* shall construct new fencing and promptly remove any temporary fencing.

301.03.05.03.02 Mailboxes. The *Contractor* shall restore relocated mailboxes to the original location after construction in the area is completed.

301.03.05.03.02.01 NDCBU. When *NDCBUs* are installed, the *Contractor* shall notify *USPS* prior to the start of construction. The *Contractor* shall deliver keys for the new *NDCBU* to the *USPS* Postmaster and notify impacted residents in writing of the process to retrieve keys from the *USPS*. The *Contractor* shall coordinate inspection of the *NDCBU* prior to removal of existing mailboxes.

301.03.05.03.03 Pavement Markings. The *Contractor* shall promptly restore pavement markings.

301.03.05.03.04 Survey Monuments. Survey monuments shall be located and punched by a Professional Land Surveyor licensed by the *State* in accordance with *NRS Chapter 625* and replaced after completion of improvements.

PCC used for utility restorations shall conform to Subsection 337.10.01.01 – “*PCC Exposed to Freeze-Thaw Cycles*” and shall be protected until a minimum compressive strength of 3,000 *PSI* is attained.

301.03.05.03.05 Temporary Systems. The *Contractor* shall promptly remove temporary systems when no longer needed.

301.03.05.03.06 Traffic Signs. The *Contractor* shall promptly restore traffic signs.

301.03.05.03.07 Utilities. Certain manhole and vault numbers are specific to the locations. The *Contractor* shall replace each collar and lid at the location from which they were removed.

PCC used for utility restorations shall conform to Subsection 337.10.01.01 – “*PCC Exposed to Freeze-Thaw Cycles*” and shall be protected until a minimum compressive strength of 3,000 *PSI* is attained.

The *Contractor* shall remove all containment devices and vacuum clean all storm drain and sanitary sewer manholes upon completion of the project.

301.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “*Workers, Methods and Equipment*”.

301.03.07 CONSTRUCTION LOADS. The *Contractor*'s operations shall not produce a surcharge which would impact stability of adjacent improvements.

301.03.08 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “*Maintenance of Traffic*”.

301.03.09 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “*Protection of Work and Cleaning Up*”, except as modified herein.

301.04 ACCEPTANCE. Protection shall be complete and accepted by the *Engineer* prior to proceeding with subsequent related work. Restoration shall be complete and accepted by the *Engineer* prior to final payment.

302.01 GENERAL.

302.01.01 DESCRIPTION. This Section covers *Subgrade* preparation.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

302.01.02 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 300.01.03 – “Safety”.

302.02 MATERIALS.**302.03 CONSTRUCTION.**

302.03.01 INSPECTION AND TESTING. The *Contractor* shall accommodate inspection and testing in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable subsections of Section 336 – “Inspection and Testing”, except as modified herein.

302.03.01.01 Observation of Exposed Surface. The *Contractor* shall request observation of the exposed surface by the *Engineer* to document that suitable materials are present in the *Subgrade*. The *Contractor* shall ensure that the exposed surface has been accepted by the *Engineer* prior to proceeding with *Subgrade* preparation.

302.03.02 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

302.03.03 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

302.03.04 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”.

302.03.05 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”.

302.03.06 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

302.03.07 SUBGRADE PREPARATION.

302.03.07.01 Compaction.

302.03.07.01.01 Moisture Conditioning and Mixing. Unless otherwise directed or approved by the *Engineer*, water shall be applied as needed immediately prior to and during any preparation and placement operations, until a uniform mixture is obtained. Water shall be applied during the compaction and maintenance stages in sufficient amounts to facilitate and maintain compaction.

302.03.07.01.02 Specified Compaction. Unless otherwise directed or approved by the *Engineer*; shown on the *Plans*; and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, the upper 6 inches of *Subgrade* shall have a relative compaction of at least 90 percent of the maximum dry density, within 2 percent of optimum moisture content, determined in accordance with ASTM D1557, except as modified herein.

302.03.07.01.02.01 Roadway Pavement. Unless otherwise directed or approved by the *Engineer*; shown on the *Plans*; and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, the upper 6 inches of *Subgrade* within the alignment of a roadway which will support pavement shall have a relative compaction of at least 95 percent.

302.03.07.02 Finished Surface. Unless otherwise directed or approved by the *Engineer*, the finished surface shall be approximately level, but with a crown or crossfall of at least 50 horizontal to 1 vertical, but no more than 20 horizontal to 1 vertical.

302.03.07.03 Protection. The *Contractor* shall maintain the *Subgrade* in its finished condition until placement of subsequent material. The *Contractor* shall recompact any areas which have experienced a loss of density prior to placement of subsequent material.

302.03.07.03.01 Roadway Pavement. Unless waived by the *Engineer*, the *Contractor* shall roll the *Subgrade* with a smooth drum roller conforming to Subsection 320.03.06.04.01 – “Breakdown Rollers” immediately prior to placement of subsequent material to ensure a smooth unyielding surface. The *Contractor* shall remove any yielding materials to the depth directed by the *Engineer*. The *Contractor* shall replace the removed materials as directed or approved by the *Engineer* prior to placement of subsequent material.

302.03.08 EXCAVATING. Excavating shall be performed in accordance with Section 303 - “Excavating”.

302.03.08.01 Unsuitable Material. The *Contractor* shall remove any unsuitable material to the depth directed by the *Engineer*. The *Contractor* shall replace the removed materials as directed or approved by the *Engineer*.

If information regarding unsuitable materials was not available and no provisions for removal and replacement were included in the *Contract Documents*, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “Change Order”.

302.03.09 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

302.03.10 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

302.04 ACCEPTANCE. *Subgrade* preparation shall be complete and accepted by the *Engineer* prior to proceeding with subsequent related *Construction Activities*.

302.04.01 SURFACE TOLERANCE. The *Subgrade* surface shall not vary more than 0.1 foot from the specified grade and cross section. The *Contractor* shall regrade any areas which are out of tolerance and prepare.

EXCAVATING

303.00-1

303.01 GENERAL.

303.01.01 DESCRIPTION. This Section covers excavating.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

303.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

303.01.01.01.01 Terms.

Open. Not backfilled to final grade where exposed, or bottom of new improvements where covered.

303.01.02 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 300.01.03 – “Safety”.

303.02 MATERIALS.

303.03 CONSTRUCTION.

303.03.01 SUBMITTALS.

303.03.01.01 Haul Route. Unless waived by the *Engineer*, the *Contractor* shall submit to the *Engineer* a document designating the route to be used for transporting of materials. The *Contractor* shall ensure that the document has been reviewed and accepted by the *Engineer* prior to proceeding with the related *Construction Activity*.

303.03.02 INSPECTION AND TESTING. The *Contractor* shall accommodate inspection in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable subsections of Section 336 – “Inspection and Testing”, except as modified herein.

303.03.02.01 Observation of Exposed Surface. The *Contractor* shall request observation of the exposed surface by the *Engineer* to document that suitable materials are exposed. The *Contractor* shall ensure that the exposed surface has been accepted by the *Engineer* prior to proceeding with related *Construction Activities*.

303.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of the Work”.

303.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

303.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”.

303.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”.

303.03.07 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

303.03.08 EXCAVATING. The *Contractor*’s operations shall not create dust hazard or other nuisance. The *Contractor* shall immediately remove and dispose of any nuisance material and/or spillage within the *Site of Work* and/or any routes used for transport of materials.

303.03.08.01 Removed Material. The material generated shall not be placed in a position that will cause damage or obstruction to vehicular and pedestrian traffic or interfere with surface drainage.

Unless otherwise directed or approved by the *Engineer*, the material generated shall not be stored in the public right-of-way. Sufficient material may be temporarily stockpiled for immediate use, but shall not remain during non-working hours.

The *Contractor* shall immediately dispose unsuitable material, surplus material and/or materials not designated for reuse in accordance with Subsection 100.31.04 – “Material Disposal”. The *Contractor* shall ensure that there is sufficient material available for the completion of the *Work* before disposing of any as surplus material. Any shortage caused by unnecessary disposal of suitable material by the *Contractor* shall be replaced at no additional cost to the *Agency/Owner*.

303.03.08.02 Dewatering. Excavating shall include dewatering to a level below *Subgrade* prior to excavating and maintenance of the dewatered condition until completion of the related *Construction Activities*.

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EXCAVATING

303.03.08.03 Blasting. Excessive blasting shall not be permitted. The *Contractor* shall remove any material outside the authorized cross section which has been shattered or loosened because of blasting at no additional cost to the *Agency/Owner*. The *Contractor* shall discontinue any method of blasting which leads to overshooting, is hazardous to the public, or is destructive to property or natural features.

303.03.08.04 Bedrock. When foundation is *Bedrock*, the rock shall be fully uncovered and the surface thereof shall be removed to a depth sufficient to expose sound *Bedrock*. The rock shall be roughly leveled off or cut to approximate horizontal and vertical steps and roughened. Seams in the rock shall be grouted under pressure or treated as directed or approved by the *Engineer*.

If information regarding *Bedrock* was not available and no provisions for removal and preparation were included in the *Contract Documents*, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

303.03.08.05 Slopes. Excavation slopes shall be finished in conformance with the lines and grades shown on the *Plans*. The tops of excavation slopes and the ends of excavations shall be rounded.

303.03.08.06 Open Excavation. Unless otherwise directed or approved by the *Engineer* no *Excavation* shall remain open during non-working hours unless protected.

303.03.08.06.01 Maximum Length of Open Excavation.

303.03.08.06.01.01 Pipe Systems. Unless otherwise directed or approved by the *Engineer*, the maximum length of open *Excavation* for pipe systems shall be 500 feet, or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is the greater. The distance is the collective length at any location that has not been temporarily resurfaced, and includes pipe laying, and appurtenant construction and backfill.

With the approval of the *Engineer*, pipe laying may be carried on at more than one separate location with the restrictions on open trench applying to each location.

303.03.08.06.01.02 PCC Improvements. Unless otherwise directed or approved by the *Engineer*, the maximum length of open *Excavation* in any one location where *PCC* improvements are cast in place shall be that which is necessary to permit uninterrupted progress. Construction shall be advanced as follows: excavating, setting of reinforcing steel, placing of *PCC*. Each shall follow the other without any one operation preceding the next nearest operation by more than 200 feet.

303.03.08.06.02 Surface Water. Open *Excavations* shall be protected to prevent surface water from entering the *Excavation*. The *Contractor* shall remove any water accumulated in an *Excavation* as directed or approved by the *Engineer* at no additional cost to the *Agency/Owner*.

303.03.08.07 Depth and Width of Excavation. Unless otherwise directed or approved by the *Engineer*, the *Contractor* shall not excavate in excess of the depth and width shown on the *Plans*. Additional material needed to fill, bed and/or backfill areas of unauthorized excavating shall be furnished, placed and compacted by the *Contractor* at no additional cost to the *Agency/Owner*.

303.03.08.07.01 Void in Sidewall or Foundation. Unless otherwise directed or approved by the *Engineer*, voids in the sidewall or foundation of an *Excavation* shall be filled as directed or approved by the *Engineer*. If the void is a result of any action by the *Contractor* or any inaction in protecting the work during the course of the *Contract*, the *Contractor* shall fill the void at no additional cost to the *Agency/Owner*. If the void is a result of forces beyond the *Contractor*’s control and/or, if the result of removal of boulders, information regarding the presence of boulders was not available and no provisions for removal and replacement were included in the *Contract Documents*, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

303.03.08.08 Finished Surface. Unless otherwise directed or approved by the *Engineer*, the surface of finished surface shall be approximately level, but with a crown or crossfall of at least 50 horizontal to 1 vertical, but no more than 20 horizontal to 1 vertical, to provide adequate drainage at all times during the construction period.

303.03.09 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “*Maintenance of Traffic*”.

303.03.10 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “*Protection of Work and Cleaning Up*”.

303.04 ACCEPTANCE. Excavating shall be shall be complete and accepted by the *Engineer* prior to proceeding with subsequent related *Construction Activities*.

304.01 GENERAL.

304.01.01 DESCRIPTION. This Section covers the placement and compaction of fill, backfill and riprap.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

304.01.01.01 Design.

304.01.01.01.01 Slurry Backfill.

304.01.01.01.01.01 Composition of Mixtures. A mix design shall be performed in accordance with Subsections 337.01 "Mix Design" and 337.08 – "Slurry Backfill" to determine the composition of the mixture. The type of slurry backfill shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

304.01.02 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – "Safety".

304.02 MATERIALS. The materials used shall be determined and/or accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to placement.

304.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – "Inspection and Testing" and the applicable subsections of Section 336 – "Inspection and Testing".

304.02.02 CARE OF MATERIALS.

304.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.17.02, except as modified herein.

304.02.02.01.01 Aggregates. Sufficient storage space shall be provided for the aggregate required. The storage yard shall be maintained neatly and orderly and separate aggregate stockpiles shall be readily accessible for sampling.

304.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or methods except as provided in Subsection 100.17.03.

304.02.04 AGGREGATES. Aggregates shall conform to Section 200 – "Aggregates".

304.02.05 WET MATERIAL. If material generated by excavating is found to be unsatisfactory for the specified use on the project, solely because of high moisture content, the *Contractor* may be directed by the *Engineer* to either process the material to reduce the moisture content to an optimum or otherwise acceptable condition or to remove the material and replace it with suitable material.

If such high moisture content is a result of any action by the *Contractor* or any inaction in protecting the work during the course of the Contract, the *Contractor* shall process and/or remove and replace the material at no additional cost to the *Agency/Owner*. If information regarding high moisture content was not available and no provisions for removal and replacement were included in the *Contract Documents* and the high moisture content is a result of forces beyond the *Contractor*'s control, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – "Change Order".

304.02.06 MATERIAL GENERATED BY REMOVAL OF EXISTING IMPROVEMENTS. PCC and bituminous pavement generated by removal of existing improvements may be permitted in fill and backfill with the following limitations:

304.02.06.01 Maximum Dimension. The maximum dimension of any piece used shall be 6 inches.

304.02.06.01.01 Foundation. Unless otherwise directed or approved by the *Engineer*, pieces larger than 4 inches in any dimension shall not be placed within 12 inches of the *Foundation*.

304.02.06.01.02 Roadway Subgrade. Unless otherwise directed or approved by the *Engineer*, pieces larger than 3 inches in any dimension shall not be placed within 12 inches of the *Subgrade* for roadway pavement.

304.02.06.01.03 Ground Water. Bituminous materials recycled as backfill shall not be placed within 5 feet of the maximum seasonal ground water level.

304.02.07 ROCK FILL. Unless otherwise directed or approved by the *Engineer*, rock larger than 12 inches in greatest dimension shall not be permitted in fill and backfill.

304.02.07.01 Foundation. Unless otherwise directed or approved by the *Engineer*, rock larger than 4 inches in any dimension shall not be placed within 12 inches of the *Foundation*.

304.02.07.02 Roadway Subgrade. Unless otherwise directed or approved by the *Engineer*, rock larger than 6 inches in any dimension shall not be placed within 12 inches of the *Subgrade* for roadway pavement.

304.02.07.03 Trench Backfill.

304.02.07.03.01 Trench Width Narrower Than 4 Feet. Unless otherwise directed or approved by the *Engineer*, rock larger than 4 inches in any dimension shall not be permitted in *Trench* backfill placed within 2 feet of any pipe or box and/or within 2 feet of risers, valves, manholes, or other appurtenances in a *Trench* with a width less than 4 feet.

304.02.07.03.02 Trench Width 4 Feet or Greater. Unless otherwise directed or approved by the *Engineer*, rock larger than 12 inches in any dimension shall not be permitted in *Trench* backfill placed within 2 feet of any pipe or box and/or within 2 feet of risers, valves, manholes, or other appurtenances in a *Trench* with a width equal to or greater than 4 feet.

304.03 CONSTRUCTION.

304.03.01 SUBMITTALS.

304.03.01.01 Certificate of Compliance. The *Contractor* shall provide a *Certificate of Compliance* for each aggregate source in accordance with Subsection 100.17.01 – “*Certificate of Compliance*”, except as modified herein.

304.03.01.01.01 Test Results. Unless waived by the *Engineer*, the certificate shall also include the following information:

- A. Results of all tests required by the specifications;
- B. Laboratory name; and
- C. Website address of accreditation program.

304.03.01.02 Slurry Backfill. The *Contractor* shall submit, in writing, the slurry backfill mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the slurry backfill.

304.03.01.03 Haul Route. Unless waived by the *Engineer*, the *Contractor* shall submit to the *Engineer* a document designating the route to be used for transporting of materials. The *Contractor* shall ensure that the document has been reviewed and accepted by the *Engineer* prior to proceeding with the related *Construction Activity*.

304.03.02 INSPECTION AND TESTING. The *Contractor* shall accommodate inspection in accordance with Subsections 100.30 – “*Inspection and Testing*” and the applicable subsections of Section 336 – “*Inspection and Testing*”, except as modified herein.

304.03.02.01 Structures. The *Contractor* shall request observation of the structure footings or other portions of the structure or facility by the *Engineer*. The *Contractor* shall ensure that the structure footings or other portions of the structure or facility have been accepted by the *Engineer* prior to placing backfill.

304.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “*Location of the Work*”.

304.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “*Scheduling of Work*”.

304.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The Contractor shall protect items not removed in accordance with Section 301 – “Protection and Restoration”.

304.03.06 CONSTRUCTION EQUIPMENT. The Contractor shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers; Methods and Equipment”.

304.03.07 CONSTRUCTION LOADS. The Contractor’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

304.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”, except as modified herein.

304.03.08.01 Benching. When fill is to be placed on existing slopes that exhibit a slope in excess of 5 horizontal to 1 vertical, the existing slope shall be horizontally benched to insure an adequate bond between the fill and original ground. Original ground shall be stripped to sufficient depth to remove all loose surface soils. Horizontal benches shall be excavated in equipment-wide swaths.

304.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303- “Excavating”.

304.03.10 PLACING OF MATERIALS. The Contractor shall ensure that the preceding *Construction Activities* have been accepted by the *Engineer* prior to placing backfill.

304.03.10.01 Structures. Unless otherwise directed or approved by the *Engineer*, backfill shall not be placed until the *PCC* for the structure footings or other portions of the structure or facility has attained a minimum compressive strength of 3,000 *PSI*.

304.03.10.02 Lifts.

304.03.10.02.01 Thickness. Fill material shall be placed in horizontal lifts in the thickness compatible to the material being placed and the type of equipment being used. Each lift shall be evenly spread. Unless otherwise directed or approved by the *Engineer*, the compacted thickness of a single lift shall not exceed 8 inches.

304.03.10.02.01.01 Rock Fill. *Rock Fill* may be placed in lifts with a loose thickness equivalent to the maximum size of rock in the material, but not exceeding 18 inches in loose thickness. The interstices around the rock in each layer shall be filled with soil and compacted to prevent “nesting” of rocks.

304.03.10.02.02 Extent. Unless otherwise directed or approved by the *Engineer*, each lift shall cover the length and width of the area to be filled before the next higher lift of material is placed.

304.03.10.03 Compaction.

304.03.10.03.01 Moisture Conditioning and Mixing. Unless otherwise directed or approved by the *Engineer*, water shall be applied as needed immediately prior to and during any preparation and placement operations, until a uniform mixture is obtained. Water shall be applied during the compaction and maintenance stages in sufficient amounts to facilitate and maintain compaction; and to prevent raveling.

304.03.10.03.02 Compaction Methods. Unless otherwise directed or approved by the *Engineer*, fill and backfill shall be mechanically compacted. Mechanically compacted fill and backfill shall be by the use of tamping rollers, sheepfoot rollers, pneumatic tire rollers, vibrating rollers, or mechanical tampers. Water densifications methods shall only be utilized when directed or approved by the *Engineer*.

304.03.10.03.02.01 Water Densification. Water densification shall only be used when directed or approved by the *Engineer*. The Contractor shall demonstrate to the *Engineer* that the specified compaction can be obtained with the materials, equipment, and procedures to be used. Acceptance by the *Engineer* to use water densification methods shall not be construed as guaranteeing or implying that that adjacent ground and improvements will be unaffected by use of these methods.

304.03.10.03.03 Specified Compaction. Unless otherwise directed or approved by the *Engineer*; shown on the *Plans*; and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, fill and backfill shall have a relative compaction of at least 90 percent of the maximum dry density,

within 2 percent of optimum moisture content, determined in accordance with ASTM D1557, except as modified herein.

304.03.10.03.03.01 Roadway Pavement. Unless otherwise directed or approved by the *Engineer*; shown on the *Plans*; and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, the upper 6 inches of fill and backfill within the alignment of a roadway which will support pavement shall have a relative compaction of at least 95 percent.

304.03.10.03.03.02 Aggregate Base. Aggregate base shall have a relative compaction of at least 95 percent.

304.03.10.03.03.03 Bedding. Unless otherwise directed or approved by the *Engineer*, shown on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, bedding shall have a relative compaction of at least 95 percent.

304.03.10.04 Finished Surface. Unless otherwise directed or approved by the *Engineer*, the finished surface shall be approximately level, but with a crown or crossfall of at least 50 horizontal to 1 vertical, but no more than 20 horizontal to 1 vertical, except as modified herein.

304.03.10.04.01 Slopes. Fill slopes shall be finished in conformance with the lines and grades shown on the *Plans*.

304.03.10.05 Protection. The *Contractor* shall maintain the compacted surface in its finished condition until placement of subsequent material. The *Contractor* shall recompact any areas which have experienced a loss of density prior to placement of subsequent material.

304.03.10.05.01 Roadway Pavement. Unless waived by the *Engineer*, the *Contractor* shall roll the compacted surface with a smooth drum roller conforming to Subsection 320.03.06.04.01 – “Breakdown Rollers” immediately prior to placement of subsequent material to ensure a smooth unyielding surface. The *Contractor* shall remove any yielding materials to the depth directed by the *Engineer*. The *Contractor* shall replace the removed materials as directed or approved by the *Engineer* prior to placement of subsequent material.

304.03.11 WEATHER LIMITATIONS. Fill, bedding and backfill shall not be placed on a grade which is frozen or which has a moisture content which would be detrimental to the compaction or quality of the material placed.

304.03.11.01 Slurry Backfill. Slurry backfill shall not be placed when weather conditions prevent the proper handling or placement of the backfill. Unless otherwise directed or approved by the *Engineer*, slurry backfill shall not be mixed or placed while the ambient temperature is below 40°F.

304.03.11.01.01 Protection. Unless otherwise directed or approved by the *Engineer*, when the air temperature is anticipated to be lower than 40°F, slurry backfill shall be protected from freezing or frost for a minimum of 48 hours after placing.

304.03.12 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

304.03.13 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

304.04 ACCEPTANCE.

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.

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. 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 so as to interfere with the planned use of the facility.

305.01 GENERAL.

305.01.01 DESCRIPTION. This Section covers the design, provision, excavation, preparation for placement, placement and backfilling of pressure and non-pressure pipes⁽¹⁾, appurtenances, fittings and couplings, including hardware for the fittings and couplings, and the related materials.

1. **Potable water systems shall conform to AWWA and the governing regulations, standards and codes.** Potable water systems are not further addressed in this Section. Details and specifications for potable water systems shall be provided in the *Contract Documents*.

This Section is for construction specification only and is not intended to be a "qualified products list" nor intended to encourage or discourage the use of any product or construction method.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. Requirements of Subsection 305.01 – "General" shall apply to all pipes unless modified in the subsection specific to the pipe type.

305.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – "Abbreviations and Terms", except as modified herein.

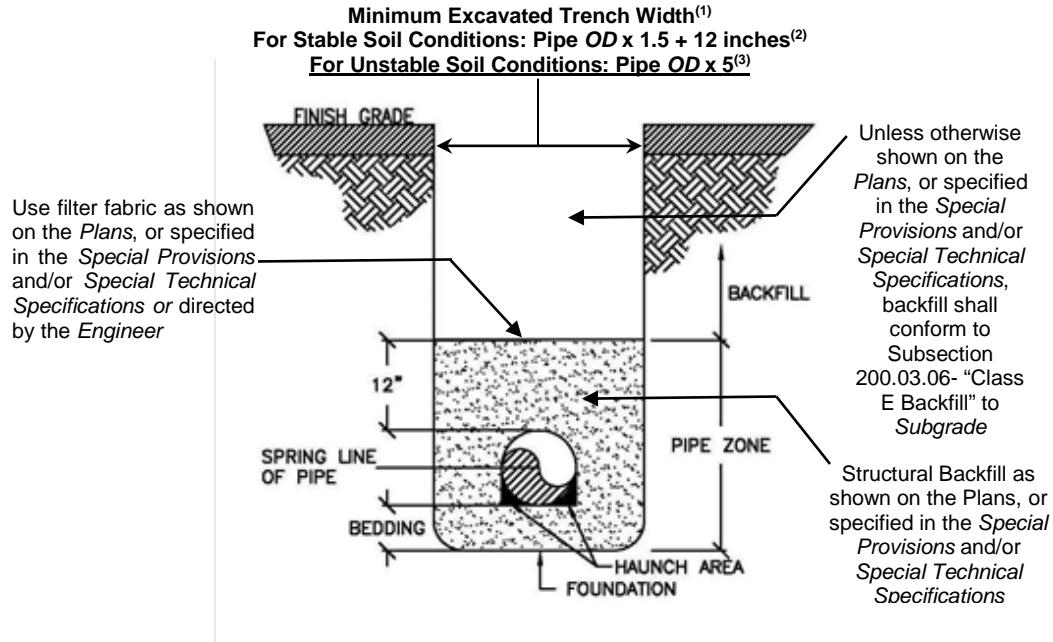
305.01.01.01.01 Terms.

Embankment. The material placed above the existing ground surface prior to construction.

Flowable Fill. Slurry backfill.

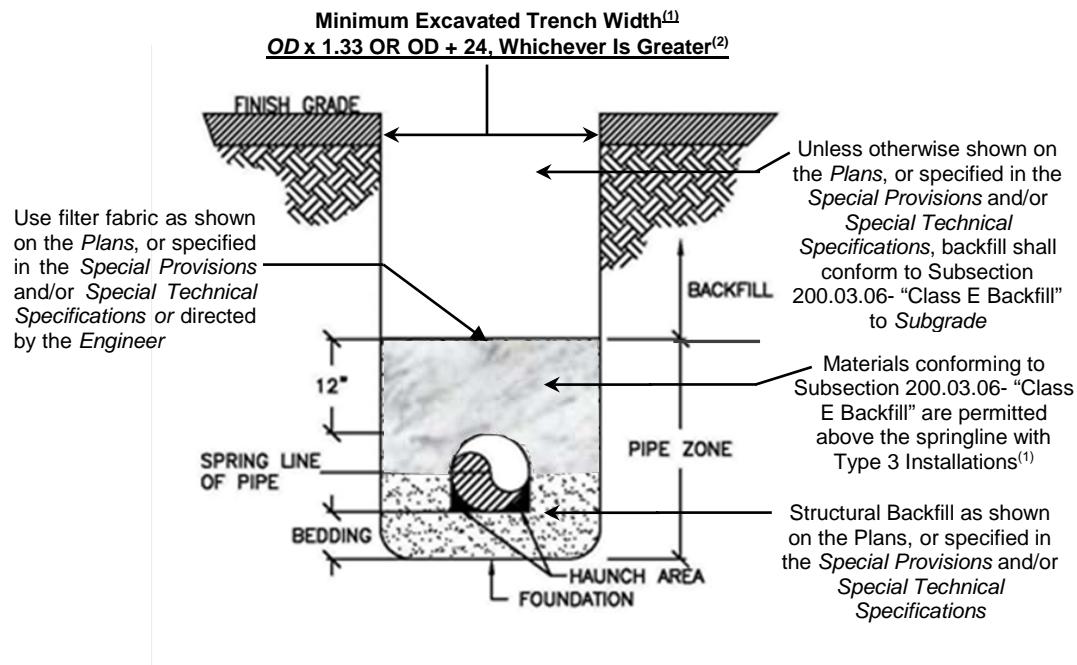
Trench. Typical *Trench* details for flexible and rigid pipes are illustrated by Figures 305.01.01.01-I and 305.01.01.01-II, respectively.

FIGURE 305.01.01.01-I: All Flexible Pipe



1. Unless otherwise directed or approved by the *Engineer*, the minimum clearance between pipe and the trench wall shall be 12 inches for up to 30 inch *OD* and 24 inches for *OD* 30 inches or greater.
2. Section 12 – "Buried Structures and Tunnel Linings" of the *AASHTO LRFD Bridge Design Specifications*. Note: Section as designated in the 7th Edition published in 2014. The *Current* edition shall be used.
3. *ASTM D2321*.

FIGURE 305.01.01.01- II: All Rigid Pipe (RCP and VCP)



1. Unless otherwise directed or approved by the Engineer, the minimum separation between outside of pipe and the trench side shall be 12 inches. The clearance between the outside of pipe and the trench side wall may be reduced to 3 inches when material conforming to Subsection 203.03.07 – "Slurry Backfill" is used.
2. Section 12 – "Buried Structures and Tunnel Linings" of the AASHTO LRFD Bridge Design Specifications. Note: Section as designated in the 7th Edition published in 2014. The Current edition shall be used.

Excavations for appurtenant structures, such as, but not limited to, manholes, transition structures, junction structures, vaults, valve boxes, catch basins, thrust blocks, and boring pits shall also be included in the definition of a trench.

The terms relating to a trench for a pipe system shall be defined as follows:

Bedding. The material in the bottom of the *Trench* on top of the foundation, which provides support for the pipe. Where *PCC* is specified to cover and/or encase the pipe, the top of the *PCC* shall be considered as the top of the bedding and pipe zone.

Foundation. The base of the *Excavation*.

Initial Backfill. The material placed between the spring line to 12 inches above top of pipe.

Pipe.

Crown. The highest interior level of the pipe.

Invert. The lowest inside point of the pipe.

Spring Line. The point of greatest horizontal dimension when viewed from an end cross section of the pipe.

Surcharge. Surcharge is defined as an additional vertical load or weight that may affect *Trench* stability and/or pipe integrity.

System, Protective. Protective system shall be defined as the method of protecting persons from cave-ins, from material that could fall or roll from an *Excavation* face or into an *Excavation*, and from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

System, Support. Support system shall be defined as the structures, including underpinning, bracing, and shoring, that provide support to an adjacent structure or underground installation or to the sides of an *Excavation or Trench*.

305.01.01.02 Design. This Section does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the resulting pipe and pipe system. Design requirements shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. If details are not provided by the *Agency*, the *Engineer* shall adhere to the standard installations in accordance with the applicable Article in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the *AASHTO LRFD Bridge Design Specifications*.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The *Current* edition shall be used.

305.01.01.02.01 Cover Limits. The cover material shall not cause the pipe to be loaded in excess of the design strength.

305.01.01.02.02 Grout.

305.01.01.02.02.01 Composition of Mixtures. Grout shall consist of one part by volume of Portland cement and three parts of clean sand shall contain only sufficient moisture to permit packing.

305.01.01.02.03 PCC.

305.01.01.02.03.01 Composition of Mixtures. A mix design shall be performed in accordance with Subsections 337.01 “Mix Design” and 337.10 – “PCC for Flatwork, Curbs, Ditches and Slope Paving and Structures” to determine the composition of the mixture. The compressive strength at 28 Days, slump, target air content, aggregate gradation and type of cementitious material shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.01.01.02.04 Slurry Backfill.

305.01.01.02.04.01 Composition of Mixtures. A mix design shall be performed in accordance with Subsections 337.01 “Mix Design” and 337.08 – “Slurry Backfill” to determine the composition of the mixture. The type of slurry backfill shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.01.01.03 Safety. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”, except as modified herein.

305.01.01.03.01 Trenches. Unless otherwise directed or approved by the *Engineer*, *Trenches* shall not be excavated until immediately before installation of pipe and other appurtenances.

305.01.02 MATERIALS. The materials used shall be determined and/or accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to unloading at the *Site of Work*.

305.01.02.01 Inspection of Materials. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”, except as modified herein.

305.01.02.01.01 Pipe. Pipe accepted shall be plainly marked by the *Inspector*.

305.01.02.02 Care of Materials. All pipe and related materials shall be manufactured, loaded, shipped, unloaded, stored, placed, handled, and installed in a manner which maintains an undamaged and sound condition. Pipes, appurtenances, fittings and couplings, including hardware for the fittings and couplings, and the related materials, shall be carefully inspected in the field upon arrival, before unloading, and before, during and after placing. Pipes which show defects upon arrival shall be rejected. Pipes which are damaged during unloading, and/or before, during and after placing, shall be rejected regardless of prior acceptance.

305.01.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage”, except as modified herein.

305.01.02.02.01.01 Gaskets. All gasket materials, including joint lubrication compounds, shall be stored in a cool, dry place to be distributed as needed. The temperature of the storage area shall not exceed 70° F. Gaskets shall not be exposed to the direct rays of the sun for more than 72 hours. Gaskets which have been exposed to the direct rays of the sun for more than 72 hours shall be removed and replaced. Gasket material shall be kept clean, and away from oil, and grease.

305.01.02.03 Use of Other Materials. The *Contractor* shall not use other materials and/or installations except as provided in Subsection 100.31.02 – “Use of Other Materials”.

305.01.02.04 Aggregates. Aggregates shall conform to Section 200 – “Aggregates”.

305.01.02.04.01 Pipe Zone. Unless otherwise directed or approved by the *Engineer*, pipe zone material shall conform to Subsections 200.03.02, 200.03.03, 200.03.04 or 200.03.05 – “Class A, Class B, Class C or Class D Backfill”.

305.01.02.04.02 Backfill. Unless otherwise directed or approved by the *Engineer*, backfill material shall consist of materials generated by trench excavation.

305.01.02.04.02.01 Initial Backfill. Initial backfill shall not contain material larger than 4 inches in any dimension.

305.01.02.04.02.02 Backfill in Narrow Trenches. Unless otherwise directed or approved by the *Engineer*, backfill in trenches with a width less than 12 inches shall conform to Subsection 337.08.01 – “Slurry Backfill”, Type A (Excavatable).

305.01.02.05 Pipe and Related Materials. Pipe and related materials shall conform to Section 203 – “Pipe and Related Materials”.

305.01.03 CONSTRUCTION.

305.01.03.01 Submittals.

305.01.03.01.01 Certificate of Compliance. The *Contractor* shall provide a *Certificate of Compliance* for each material in accordance with Subsection 100.31.01 – “*Certificate of Compliance*”, except as modified herein.

305.01.03.01.01.01 Required Information.

- A. A statement that the individual responsible for the affirmation has the legal authority to bind the supplier or manufacturer and/or fabricator;
- B. Quantity of pipe shipped; and
- C. The size, class and quantity of pipe shipped.

A certificate shall be sent with each shipment. The *Contractor* shall ensure that the *Certificates of Compliance* have been reviewed and accepted by the *Engineer* prior to unloading the associated material at the *Site of Work*.

305.01.03.01.02 PCC. The *Contractor* shall submit, in writing, the *PCC* mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the *PCC*.

305.01.03.01.03 Quality Control Program. Unless otherwise directed or approved by the *Engineer*, a written Quality Control Program shall be required for any pipe. This written program shall be provided to the *Engineer* upon request. The *Agency* and/or *Engineer* shall have the option to inspect production facilities.

305.01.03.01.04 Slurry Backfill. The *Contractor* shall submit, in writing, the slurry backfill mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the slurry backfill.

305.01.03.02 Inspection and Testing. The *Contractor* shall accommodate inspection in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable subsections of Section 336 – “Inspection and Testing”, except as modified herein.

305.01.03.02.01 Observation of Trench Foundation. The *Contractor* shall request observation of the *Trench Foundation* by the *Engineer* to document that suitable materials are present in the *Subgrade*. The *Contractor* shall ensure that the exposed surface has been accepted by the *Engineer* prior to proceeding with related *Construction Activities*.

305.01.03.02.02 Observation of Pipe Placement. The *Contractor* shall request observation of the pipe placement to document the grade and alignment of the pipe and that pipe is undamaged.

Backfill. If, in the opinion of the *Engineer*, the backfill cannot be satisfactorily tested to determine if compaction criteria is met, the *Engineer* may approve the use of a method specification based on the equipment and materials being used to document that adequate compaction is obtained.

305.01.03.03 Limit of Work. The limit of work shall be in accordance with Subsection 100.21 – “Location of the Work”.

305.01.03.04 Scheduling of Work. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

305.01.03.05 Existing Improvements and Systems.

305.01.03.05.01 Existing Improvements. Removal of existing improvements shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

305.01.03.05.01.01 Trenches Under Pavements or Structures. Bituminous pavement, PCC pavement, PCC curb, sidewalks, gutters, cross gutters, driveways, and alley intersections shall be replaced with materials equal to or better than the surrounding material. Replacement shall include compacted *Subgrade* and base material.

305.01.03.05.01.02 Temporary Resurfacing. Temporary resurfacing, when directed or approved by the *Engineer*, shall be maintained in a safe, rideable condition.

305.01.03.05.02 Existing Systems. Remnants of existing systems determined by the *Engineer* as not interfering with *Construction Activities* may, with the written approval of the *Engineer*, be abandoned in place in accordance with the *Engineer*’s recommendations. Unless directed or approved by the *Agency*, portions of existing systems which are to remain in place shall be protected in accordance with Section 301 – “Protection and Restoration”.

305.01.03.06 Construction Equipment. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers; Methods and Equipment”.

305.01.03.07 Construction Loads. The *Contractor*’s operations have the potential to induce higher loads during construction than those used for pipe design. The *Contractor* shall route heavy equipment movement, determine stockpile locations and take other precautions needed to protect the pipe from damage due to construction loads. Loads shall be evaluated in accordance with the applicable Article in Section 12¹ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The *Current* edition shall be used.

The *Contractor*’s operations shall not produce a surcharge which would impact stability of open trenches and/or adjacent improvements.

305.01.03.08 Subgrade Preparation. *Subgrade* preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”, except as modified herein.

305.01.03.08.01 Subgrade Void. Where a void exists in the *subgrade* below bedding, backfill shall be:

- A. Native material, when approved by the *Engineer*, compacted to at least 90 percent of the maximum dry density as determined in accordance with ASTM D1557

- B. Material conforming to Subsections 200.03.02, 200.03.03 or 200.03.04 – “Class B, Class C or Class D Backfill”, respectively, as directed or approved by the *Engineer*, compacted as directed by the *Engineer*.
- C. *PCC* or slurry backfill conforming to Subsection 337.08 – “Slurry Backfill” with a minimum compressive strength of 300 *PSI* at 28 *Calendar Days*.

305.01.03.09 **Excavating.** Excavating shall be performed in accordance with Section 303 - “Excavating”, except as modified herein.

305.01.03.09.01 Embankment and Trench Conditions.

305.01.03.09.01.01 Maximum Length of Open Trench. Unless otherwise directed or approved by the *Engineer*, the maximum length of open *Trench* where prefabricated pipe is used shall be 500 feet, or the distance necessary to accommodate the amount of pipe installed in a single shift, whichever is the greater. The distance is the collective length at any location that has not been temporarily resurfaced, and includes open *Excavation* pipe laying, and appurtenant construction and backfill.

305.01.03.09.01.02 Trench Width. For pipe, the minimum and maximum width of *Trench* permitted shall be as shown on the *Plans* or *Standard Details* or specified in the *Special Provisions* and/or *Special Technical Specifications*, and shall be of such a width to allow placement proper construction of joints and compaction of bedding and backfill. Unless otherwise directed or approved by the *Engineer*, trenches shall be excavated to a width that will provide adequate working space for mechanical compaction equipment, but not less than required by Figures 305.01.01.01-I – “All Flexible Pipe” or 305.01.01.01-II – “All Rigid Pipe” nor more than the design width. *Trench* walls shall not be undercut.

If the maximum *Trench* width is exceeded, the *Contractor* shall provide additional bedding, another type of bedding, or a higher strength of pipe, as directed by the *Engineer*, at no additional cost to the *Agency/Owner*.

305.01.03.09.01.02.01 Narrow Trenches. Narrow trenches may be allowed by the *Engineer* provided the clearance between the pipe and *Trench* wall is adequate to allow compaction of the backfill.

305.01.03.09.01.03 Trench Foundation. The *Foundation* shall be accurately graded to provide uniform bearing and support for each section of the pipe at every point along its entire length, except for portions of the pipe where it is necessary to excavate for bells and for proper sealing of the pipe joints.

When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavating, the *Contractor* shall excavate and expose the existing improvement before trenching for or laying any pipe or conduit on the project. Any adjustments in line or grade which may be necessary to accomplish the intent of the *Plans* will then be made.

305.01.03.09.01.03.01 Oversize Material or Bedrock. Unless otherwise directed or approved by the *Engineer*, rocks larger than 4 inches in any dimension or *Bedrock*, exposed by excavating, shall be removed to a minimum depth of 6 inches below the *OD* of the pipe. The *Contractor* shall replace the removed materials as directed or approved by the *Engineer*.

If information regarding oversize materials or *Bedrock* was not available and no provisions for removal and replacement were included in the *Contract Documents*, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

305.01.03.09.01.03.02 Unsuitable Material. The *Contractor* shall remove any material unsuitable for pipe support to the depth directed by the *Engineer*. The *Contractor* shall replace the removed materials as directed or approved by the *Engineer*.

If information regarding unsuitable materials was not available and no provisions for removal and replacement were included in the *Contract Documents*, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

305.01.03.09.01.03.03 Manholes, Valves, Inlets, Catch Basins and Other Appurtenances.

The Contractor may excavate to place the *PCC* for the structure directly against the excavated surface, provided that the excavated surfaces are firm and unyielding and are at all points outside the structure lines shown on the *Plans*. If any excavated surface will not stand without sloughing or if precast structures are used, the *Contractor* shall excavate to a sufficient width to place the structure and compact the backfill as directed or approved by the *Engineer*. Unless otherwise directed or approved by the *Engineer*, backfill shall consist of the same material specified for backfilling the adjoining pipe line *Trench*.

305.01.03.09.01.04 Void in Trench Sidewall. Where the void is in the side of the trench, backfill shall be as approved by the *Engineer*.

305.01.03.09.01.04.01 Void Left by Removal of Protection Systems. Unless otherwise directed or approved by the *Engineer*, voids left by the removal of sheeting, piles, and similar sheeting supports shall be immediately backfilled with clean sand which shall be jetted into place to assure dense and complete filling of the voids.

305.01.03.10 Placing of Materials. Placing of material shall be performed in accordance with Section 304 – “Fill, Backfill and Riprap”, except as modified herein.

305.01.03.10.01 Bedding. Bedding material shall be placed so that the pipe is supported for the full length of the barrel and structures will be continuously in contact with the material on which it is being placed.

305.01.03.10.01.01 Haunches. Material shall be placed such that the haunch is completely supported, the pipe remains true to grade, and the pipe is completely encased to the limits shown on the *Plans* or *Standard Details*.

Extreme care will be taken to prevent damage to or movement of the conduit by the compaction equipment.

305.01.03.10.01.02 Embedment. The embedment materials shall be placed to 1 foot over the top of the pipe for flexible pipes and to the springline for rigid pipes.

305.01.03.10.01.03 Compaction Methods. Unless otherwise directed or approved by the *Engineer*, bedding shall be mechanically compacted or vibrated.

305.01.03.10.01.04 Specified Compaction. Compaction shall be as shown on the *Plans* or *Standard Details* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Unless otherwise shown on the *Plans* or *Standard Details* or specified in the *Special Provisions* and/or *Special Technical Specifications*, the middle of the bedding equal to one-third the pipe outside diameter should be loosely placed, while the remainder shall have a relative compaction of at least 90 percent of the maximum dry density, within 2 percent of optimum moisture content, determined in accordance with *ASTM D1557*.

305.01.03.10.02 Pipe. Unless otherwise directed or approved by the *Engineer*, pipe placement shall begin at the downstream end of the pipeline except for extensions of existing pipes. The bottom of the pipe shall be placed in contact with the shaped bedding throughout its full length. When pipe having bells is used, bell holes (cross trenches) shall be excavated to prevent non-uniform loading of the joints.

The first section of pipe shall be firmly placed to the designated line and grade at the outlet end with the groove end or bell end pointing in the direction to be followed by the pipe laying.

305.01.03.10.02.01 Coatings and Linings. The *Contractor* shall install pipe coatings and linings when shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* or directed by the *Engineer*. When no direction is provided, pipe coatings and linings shall be installed in accordance with the applicable section of the *Greenbook*.

Pipe sections shall be checked for alignment and grade at the time of joining the sections. Alignment and grade shall be as specified on the *Plans* or *Standard Details* or specified in the *Special Provisions* and/or *Special Technical Specifications* and shall not exceed the tolerances contained in Subsection 336.xx.xx.xx – “?”.

305.01.03.10.02.02 Slurry Backfill. When slurry backfill is used, pipe shall be placed on two soil pads. Slurry backfill shall be vibrated or rodded during placement. The *Contractor* shall ensure that provisions are in place to prevent the pipe from floating.

The interior of the pipe shall be kept free of dirt, and other foreign material as the pipe laying progresses, and left clean at the completion of the work.

Alternate methods of pipe laying which are recommended by the pipe manufacturer may be used if approved by the *Engineer*.

Any pipe which is not in true alignment or which shows any undue settlement after laying, or is damaged, shall be removed and re-laid at no additional cost to the *Agency/Owner*.

305.01.03.10.03 Backfill. Backfill shall be placed so that the pipe is not damaged or displaced.

Unless otherwise directed or approved by the *Engineer*, if the pipe is embedded in *PCC*, backfill above the embedment shall not be placed nor sheeting pulled until at least 40 hours after *PCC* placement.

305.01.03.10.03.01 Compaction Methods. Unless otherwise directed or approved by the *Engineer*, backfill material shall be hand or mechanically compacted using equipment such as rollers, pneumatic tamps, and hydro-hammers or other approved devices which facilitate uniform compaction to the specified density without damage to the pipe or related structures. Impact-type pavement breakers (stompers) shall not be permitted until sufficient cover for the pipe material type has been achieved to avoid pipe damage.

The *Contractor* shall demonstrate to the *Engineer* that the specified compaction can be obtained with the trench width, and materials, equipment, and procedures to be used. Acceptance by the *Engineer* to use specific compaction equipment or procedures shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the *Contract*.

Hand tamping compactors or rollers shall be used to obtain compaction within 24 inches of risers, valves, manholes, or other structures, and to assist in obtaining compaction along the edges of the trenches. However, they will not be permitted to be used in lieu of the equipment specified if rock larger than 4 inches in any dimension is used as backfill.

Backfill shall not be compacted utilizing water densification methods.

305.01.03.10.03.02 Specified Compaction. Specified compaction shall be as shown on the *Plans* or *Standard Details* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.01.03.10.04 Cover Limits. The material placement shall not exceed the cover limits shown on the *Plans* or cause the pipe to be loaded in excess of the design strength.

305.01.03.11 Maintenance of Traffic. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

305.01.03.12 Protection of Work and Cleaning Up. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

305.01.04 ACCEPTANCE. The *Contractor* shall ensure that the pipe has been inspected and accepted by the *Engineer* prior to placing backfill.

Pipe will be carefully inspected in the field before and after laying. If any cause for rejection is discovered in a pipe after it has been laid, it shall be subject to rejection. Any corrective work shall be approved by the *Engineer* and shall be at no additional cost to the *Agency/Owner*.

305.02 CM PIPE.

305.02.01 DESCRIPTION. This Subsection covers pipe systems utilizing pipe, pipe-arches, slotted pipe, and spiral rib pipe constructed from corrugated metal.

305.02.01.01 Design. The pipe zone material; pipe, including material type, gage and/or thickness, nominal diameter and dimensions; appurtenances; and fittings to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.03 THIS SUBSECTION INTENTIONALLY LEFT BLANK.**305.04 SP PIPE.**

305.04.01 DESCRIPTION. This Subsection covers pipe systems utilizing pipe, pipe-arches, and horizontal and vertical ellipses constructed from corrugated metal plates that are field assembled into their design shape.

305.04.01.01 Design. The pipe zone material; pipe, including material type, gage and/or thickness, nominal diameter, and rise and span dimensions of the structure; appurtenances; and fittings to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.05 C/ SOIL PIPE.

305.05.01 DESCRIPTION. This Subsection covers pipe systems utilizing C/ pipe.

305.05.01.01 Design. The pipe zone material; and pipe, including material type, ASTM designation, strength, and nominal diameter to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.06 DI PIPE.

305.06.01 DESCRIPTION. This Subsection covers pipe systems utilizing DI pipe.

305.06.01.01 Design. The pipe zone material; and pipe, including material type, ASTM or AWWA designation, strength, pressure class, wall and nominal diameter, to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.06.01.01.01 Coating and Lining. Unlined pipe and fittings shall not be used. Pipe coating and lining shall be shown on the *Plans* or specified in the *Special Technical Specifications*.

305.06.01.01.02 Pipe Joints. Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged for exposed service and restrained push-on for buried service. Joint type and material shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.06.02 CONSTRUCTION.**305.06.02.01 Placing of Materials.**

305.06.02.01.01.01 Joints. The joint assembly shall conform to AWWA C600 and manufacturer's recommendations. Unless otherwise directed or approved by the *Engineer*, the *Contractor* shall not cut restrained pipe.

305.06.02.01.01.02 Coatings and Linings. Unless otherwise directed or approved by the *Engineer*, the internal surfaces of pipe and fittings shall be lined and coated in accordance with AWWA C 104 and the external surfaces of pipes and fittings shall be coated in accordance with AWWA C 151 or AWWA C 110.

305.06.03 ACCEPTANCE.

305.06.03.01 Joints. Unless otherwise specified, joints shall have an allowable deflection up to 5 degrees at specified pressures.

305.07 STEEL PIPE.

305.07.01 DESCRIPTION. This Subsection covers pipe systems utilizing steel plates or steel sheets.

305.07.01.01 Design. The pipe zone material; and pipe, including material type, strength designation, nominal diameter, to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.08 VC PIPE.

305.08.01 DESCRIPTION. This Subsection covers pipe systems utilizing VC Pipe.

305.08.01.01 Design. The pipe zone material; pipe, including material type, strength designation, thickness, nominal diameter and dimensions; bends; bevels; and fittings to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.08.02 MATERIALS.

305.08.02.01 Care of Materials. Pipe shall be handled and stored in a manner which prevents premolded jointing surfaces or attached couplings to become damaged by dragging, contact with hard materials or by use of hooks. Pipe shall be handled and stored in a manner which prevents the weight of the pipe from being supported by the jointing surfaces or attached couplings.

305.08.02.02 Aggregates. Aggregates shall conform to *ASTM C12*.

305.08.03 CONSTRUCTION. Construction shall conform to *ASTM C12*.

305.08.03.01 External Loads. The external loads on installed VC pipe are of two general types:

- A. Dead loads; and
- B. Live loads.

305.08.03.01.01 Dead Loads. The dead load increases as the depth of pipe, measured to the top of the pipe, and trench width, measured at the top of the pipe, increases. The trench width at the top of the pipe shall be kept as narrow as possible and, to prevent pipe failure, shall not exceed the design width. When the design width is exceeded, design parameters, including pipe strength and bedding class, shall be re-evaluated.

305.08.03.01.02 Live Loads. Live loads that act at the ground surface are partially transmitted to the pipe. Live loads may be produced by wheel loading, construction equipment or by compactive effort. Compaction of embedment and backfill materials, beside and above the sewer pipe, produces a temporary live load on the pipe. The magnitude of the live load from compactive effort varies with soil type, degree of saturation, degree of compaction and depth of cover over the pipe. Care must be used in selection of compaction methods so that the combined dead load and live load does not exceed the field supporting strength of the pipe, or cause a change in its line or grade.

305.08.03.02 Excavating.

305.08.03.02.01 Trench Width. The trench walls can be sloped to reduce trench wall failure provided the measured trench width at top of pipe does not exceed the design trench width. This sloping will not increase the load on the pipe.

305.08.03.02.02 Bell Holes. Bell holes shall be excavated to prevent point loading of the bells or couplings of laid pipe, and to establish full-length support of the pipe barrel.

305.08.03.03 Placing of Materials.

305.08.03.03.01 CLSM. CLSM shall be directed to the top of the pipe to flow down on both sides to prevent misalignment. CLSM shall be placed to the top of the pipe. The initial backfill may be placed when the pour is capable of supporting the backfill material without intermixing.

305.08.03.03.02 Pipe. The *Contractor* shall adhere to the manufacturer's recommendations for pipe assembly.

The *Contractor* shall wipe the mating surfaces clean before joining, lubricate both joint surfaces, line up the bell and spigot, and shove the pipe together with a steady pressure. For small diameter pipe, the assembly can be done by hand.

The *Contractor* shall ensure that the joint is completely assembled.

For large diameter pipe, a sling or other device approved by the *Engineer* can be used to lower the pipe and aid in assembly.

305.08.03.03.03 Joints. VC pipe joints shall conform to *ASTM C425* and *ASTM C1208*.

305.08.03.03.04 Connections. Unless otherwise directed or approved by the *Engineer*, connections of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or structure, shall be made by cutting in manufactured wye or tee. The wye or tee shall be of the same

material as the conduits to which they are joined, and shall have the same or greater strength as the pipe.

305.09 NRC PIPE.

305.09.01 DESCRIPTION. Circular and *NRC* pipe shall conform to Subsection 203.09 and *ASTM C14* or *ASTM C505* for the specified diameters.

Precast fared end sections shall conform to the details and dimensions shown on the *Plans* except for shape, shall conform to the requirements of Subsection 305.10 – “RC Pipe”.

305.09.01.01 Design. The pipe zone material; and pipe, including material type, strength designation, nominal diameter and dimensions, to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.09.01.01.01 Pipe Design Verification. Pipe design verification is required for each size and class of pipe in accordance with *ASTM C14*, Section 10, for the initial submittal and no less than once every 365 *Calendar Days* thereafter or when there is a change to material suppliers, materials, mix design, equipment or manufacturing operations. Design verification records shall be maintained by the manufacturer and made available upon request.

305.09.01.01.02 Strength Class. The strength class required for a project is dependent on the bedding and backfill material, the depth of cover and the loading conditions. The bedding and backfill requirements used by the *Engineer* to determine the class of pipe required should be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

The *Engineer* may refer to the standard installations, as defined in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the *AASHTO LRFD* Bridge Design Specifications, which provide flexibility in selecting the installation that best meets the projects unique combination of site conditions, available backfill materials and desired construction and inspection materials. Once the type of installation is selected the correct strength class of *RC* pipe can be determined.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

305.09.01.01.03 Cover Limits. The class of the pipe should be determined based on the specified depth of cover and loading conditions.

305.09.01.01.04 PCC.

305.09.01.01.04.01 Composition of Mixtures. The mix design shall comply with *ASTM C14*.

305.09.02 MATERIALS.

305.09.02.01 Care of Materials. Small diameter pipe can be layered for storage in the same manner as loaded on the truck. The bottom layer should be placed on a flat base, adequately blocked to prevent shifting as more layers are added. Each layer of bell and spigot pipe should be arranged so that all the bells are at the same end. The bells in the next layer should be at the opposite end, and projecting beyond the spigots of the pipe sections in the lower layer. Where only one layer is being stockpiled, the bell and spigot ends should alternate between the adjacent pipe sections. All pipes should be supported by the pipe barrel so that the joint ends are free of load concentrations. Unless otherwise directed or approved by the *Engineer*, pipe sections shall not be stockpiled at the job site in a greater number of layers than would result in a height of 6 feet.

305.09.02.01.01 Bedding. Bedding material shall conform to Subsection 200.03.02 – “Class A Backfill”.

305.09.02.01.01.01 Haunches. The material placed in the haunch area, from top of the foundation bedding to the springline of the pipe, shall conform to Subsection 200.03.02 – “Class A Backfill”. Slurry backfill, when directed or approved by the *Engineer* or shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, shall conform to Subsection 200.03.07 – “Slurry Backfill”.

305.09.02.01.02 Backfill. Backfill shall conform to Subsection 200.03.06 – “Class E Backfill”.

305.09.02.01.01.02 Slurry Backfill. Slurry backfill, when directed or approved by the *Engineer* or shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, shall conform to Table 337.08.01-1, Type A (Excavatable), of Subsection 337.08 – “Slurry Backfill”.

305.09.02.02 Mortar. Mortar shall conform to Subsection 337.09.01 – “Mortar”.

305.09.02.03 Grout. Grout shall conform to Subsection 337.09.02 – “Grout”.

305.09.03 CONSTRUCTION.

305.09.03.01 Submittals.

305.09.03.01.01 Quality Control Program. Manufacturer shall maintain a quality control program which is certified annually. At the time of this publication *ACPA Q-Cast* and *NPCA* are the most widely recognized national certification programs. A comparable internal certification program may be submitted to the *Agency* for review and approval.

305.09.03.01.02 Joint Gaps. The *Contractor* shall submit joint gap details for review and acceptance by the *Engineer*.

305.09.03.02 Construction Loads. Any proposed construction loads that were not specifically identified in the design process shall be reviewed and approved by the *Engineer*.

305.09.03.03 Excavating. The bed for the end section shall be excavated to the required width and grade. When elliptical pipe is used, which require metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate to be against the inner face of the trench in its final position.

305.09.03.03.01.01 Pipe Culverts. The minimum *Trench* widths for *PCC* culverts shall not be less than the *OD* of the pipe divided by 6, on each side, and adequate to enable compaction.

305.09.03.01.03 Embankment Conditions. Where pipes are to be installed in new embankment (projection), the embankment shall be constructed to the required elevation as follows:

- A. In the case of pipes 24 inch or less in diameter or rise, construct the roadway embankment to an elevation of 6 inches above the grade proposed for the top of the pipe, after which excavate the *Trench* and install the pipe.
- B. In the case of pipes more than 24 inch in diameter or rise, construct the roadway embankment to an elevation of 30 inches above the grade proposed for the bottom of the pipe, after which excavate the *Trench* and install the pipe.

The height of new embankments may be varied as directed before installing pipes in new embankments on a steep slope or in a difficult location.

305.09.03.01.04 Cover Limits. In no instance shall the cover limits of the pipe class be exceeded.

305.09.03.04 Placing of Materials.

305.09.03.04.01 Bedding. Bedding shall be placed on a stable foundation. The *Contractor* shall ensure that no rocks greater than 3 inches in any dimension or other rigid or jagged material is present in the bedding material where pipe will be laid directly on the material.

305.09.03.04.02 Pipe. Unless otherwise directed or approved by the *Engineer* or shown on the *Plans* or specified in the *Special Provisions* or *Special Technical Specifications*, installation shall conform to Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the *AASHTO LRFD* Bridge Design Specifications and *ASTM C1479*.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

The precast *PCC* end section shall be placed with its tongue (or groove) fully entered in the groove (or tongue) of the successive section.

Prior to placing backfill material, all lifting holes in *PCC* culverts shall be completely filled with grout.

305.09.03.04.02.01 Joints. NRC pipe may be supplied with a *T & G* joint, or a gasketed joint. For non-pressure applications requiring silt tight joints, the installed joint should be capable of testing to a pressure of 2.0 *PSI*. For leak resistant joint applications, the installed joint should be capable of testing to a pressure of 10.8 *PSI*. The joint type shall be as shown on the *Plans* or specified in the *Special Provisions* or *Special Technical Specifications* and constructed by one of the following methods:

305.09.03.04.02.02 T&G Joints. *T & G* joints may be sealed using cement mortar or mastic material in the joint gap.

305.09.03.04.02.03 Mortared Joints. After the ends of the sections of pipe are cleaned and wetted, soft workable mortar shall be placed firmly into the lower half of the groove end of the previously laid section. Mortar shall be placed firmly on the top half of the tongue end of the section to be joined. The tongue end shall be snugly placed into the groove end of the section previously laid. The mortar shall completely fill the joint.

Brush the interior joint. Trowel or brush smooth the inside joints and remove excess mortar from the interior pipe joint. Fill the outside joint recesses with mortar. Firmly fill the external space between the ends of the jointed pipe from the outside with laying mortar.

Backfill of the pipe trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before backfilling, do not backfill until 16 hours after jointing the pipe sections. When the pipe is not backfilled while the mortar is plastic, cure the mortar using a method approved by the *Engineer*. Do not allow free water to come in contact with the pipeline until the mortar in the joints has set at least 24 hours.

305.09.03.04.02.04 Mastic Joints. Wrap mastic joint sealant around the tongue and snugly insert tongue end into the groove end of the section previously laid. Alternately, Contactor may place mastic firmly into the lower half of the groove end of the previously laid section and firmly place mastic on the top half of the tongue end of the section to be jointed. Snugly insert the tongue end into the groove end of the section previously laid.

305.09.03.04.02.05 Gasketed Joints. When gasketed joints are specified, they shall be sealed using a rubber gasket. Install gasket on spigot end of pipe section per manufacturer's recommendations and insert the spigot into the bell end of the section previously laid. Lubricate gaskets requiring lubricant with the lubricant recommended by the manufacturer of the pipe. The gasket shall be the sole element depended upon to make the joint watertight.

305.09.03.04.02.06 Connections. All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or *PCC* junction structure, shall be made by either grouting the lateral in to a fabricated reinforced opening, connecting the lateral with an approved cast-in-place *PCC* field collar, or in a manufactured wye or tee. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater strength as the pipe.

305.09.03.04.03 Backfill. Backfill shall conform to Section 304 – “Fill, Backfill and Riprap”, except as modified herein.

305.09.03.04.03.01 Mechanically Compacted Backfill. Mechanically compacted backfill shall be layered in lifts not exceeding 12 inches in loose thickness. Impact tampers shall not be used directly above the pipe until the full loose layer backfill depth above the pipe is obtained.

305.09.03.04.03.02 Slurry Backfill. When used, slurry backfill conforming to Subsection 337.08 – “Slurry Backfill”, Type A (Excavatable) shall be placed under the pipe haunches and from the top of the foundation bedding to the springline. The balance of the trench backfill shall conform to Subsection 200.03.06 - “Class E Backfill”.

305.09.04 ACCEPTANCE.

305.09.04.01 Damaged Work.

305.09.04.01.01 Repair. Fractures or cracks passing through the wall or the joints of *NRC* pipe are generally cause for rejection, except that a single crack not exceeding 2 inches in length at either end of the pipe or a single fracture or spall in the joint not exceeding 3 inches around the circumference of the pipe, nor 2 inches in length into joint shall not be considered cause for rejection unless these defects exist in more than 5% of the entire shipment or delivery.

Damaged ends, chips or cracks, which do not pass through the wall, can be patched using Speed Crete Red Line concrete patching material or equal.

305.09.04.02 Tolerance.

305.09.04.02.01 Joint Gaps. The Contractor shall provide a concrete-to-concrete connection and pull the pipe completely home. The Contractor shall provide a sealed connection. The recommended joint gap is one that does not exceed $\frac{1}{2}$ of the length where the gasket seats within the pipe or $\frac{1}{2}$ of the T&G joint length.

Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps should not exceed the gap tolerances indicated in Table 305.09.04.02.01-I and II.

Table 305.09.04.02.01-I
Joint Gaps for Gasketed Circular NRC Pipe

| Pipe ID | Recommended Joint Gap | Maximum Joint Gap (with Grouting) |
|-----------|-----------------------|-----------------------------------|
| 12" - 30" | 5/8" | 3/4" |
| 36" | 3/4" | 7/8" |

Table 305.09.04.02.01-II
Joint Gaps for T&G Circular NRC Pipe*

| Pipe ID | Allowable Joint Gap (with Grout or Mastic) |
|-----------|--|
| 12" - 18" | 1-14" |
| 21" - 30" | 1-1/2" |
| 36" | 1-5/8" |

*Consult the manufacturer for joint gap information prior to construction

305.09.04.02.01.01 MITIGATION. If gasketed pipes are laid that exceed the recommended joint gap, the inner annular space between the pipe sections shall be completely filled with cement mortar (where pipe diameters allow for entry). If gasketed pipes are laid that exceed the maximum joint gap, the pipe will need to be removed and re-laid or an acceptable PCC collar will need to be installed. If T&G pipe is laid that exceeds the allowable joint gap in the below tables, the pipe will need to be removed and re-laid or an acceptable PCC collar will need to be installed.

305.10 RC PIPE.

305.10.01 DESCRIPTION. Circular and horizontal elliptical RC pipe shall conform to Section 203.10 and ASTM C76 or ASTM C655 for the specified diameters and strength classes.

Arched RC pipe shall conform to Section 203.10 and ASTM C506 for the specified diameters and strength classes.

Elliptical RC pipe shall conform to Section 203.10 and ASTM C507 for the specified rise and span for either vertical or horizontal elliptical pipe classes.

Flared end sections (precast) shall conform to the details and dimensions shown on the *Plans* and except for shape, shall conform to the requirements of this Section for RC pipe.

305.10.01.01 Terms.

Acceptable Crack. A crack width less than 0.1 inch and located in a non-corrosive environment (pH >5.5).

Slabbing. The separation of PCC from the reinforcing steel.

305.10.01.02 Design. The pipe zone material; and pipe, including material type, strength designation, nominal diameter and dimensions, to be furnished shall be shown on the *Plans* or specified in the *Special Technical Specifications* and/or *Special Technical Specifications*.

305.10.01.02.01 Cover Limits. The class of the pipe should be determined based on the specified depth of cover and loading conditions. ACPA Fill Height Tables summarize the required strength class of *RC* pipe for a given installation type and amount of earth cover and can be found at <http://www.concretepipe.org/pipe-box-resources/fill-height-tables>.

305.10.01.02.01.01 Construction Loads. Any known construction loading should be shown on the *Plans* taken into account in the design.

305.09.01.02.02 PCC.

305.10.01.02.02.01 Mix Design. The mix design shall comply with ASTM C76 or ASTM C655 with required strength for any specific pipe design verified by cylinder breaks.

305.10.01.02.03 Pipe Design Verification. Pipe design verification is required for each size and class of pipe in accordance with ASTM C76, Section 5.1.1, or ASTM C655, Section 4.1.1, for circular reinforced concrete pipe; ASTM C506, Section 5.1.1, for arch reinforced concrete pipe; or ASTM C507, Section 5.1.1, for elliptical reinforced concrete pipe, for the initial submittal and no less than once every 365 *Calendar Days* thereafter or when there is a change to material suppliers, materials, mix design, equipment or manufacturing operation,. Design verification records shall be maintained by the manufacturer and made available upon request.

305.10.01.02.04 Strength Class. The strength class required for a project is dependent on the bedding and backfill material, the depth of cover and the loading conditions. The bedding and backfill requirements used by the *Engineer* to determine the class of pipe required should be called out on the *Plans*.

The *Engineer* may refer to the standard installations, as defined in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications, which provide flexibility in selecting the installation that best meets the project’s unique combination of site conditions, available backfill materials and desired construction and inspection materials. Once the type of installation is selected the correct strength class of *RC* pipe can be determined.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

305.10.01.02.05 Foundation and Bedding. The bedding and backfill requirements used by the *Engineer* to determine the class of pipe required shall be shown on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.10.02 MATERIALS.

305.10.02.01 Care of Materials.

305.10.02.01.01 Storage.

305.10.02.01.01.01 RC Pipe. Any stockpiling of pipe should be as near as possible to where the pipe will be installed. Small diameter pipe could be layered for storage in the same manner as they were loaded on the truck. The bottom layer should be placed on a flat base, adequately blocked to prevent shifting as more layers are added. Each layer of bell and spigot pipe should be arranged so that all the bells are at the same end. The bells in the next layer should be at the opposite end, and projecting beyond the spigots of the pipe sections in the lower layer. Where only one layer is being stockpiled, the bell and spigot ends should alternate between the adjacent pipe sections. All pipes should be supported by the pipe barrel so that the joint ends are free of load concentrations.

Pipe sections generally should not be stockpiled at the job site in a greater number of layers than would result in a height of 6 feet.

305.10.02.01.02 Handling. Carefully handle concrete pipe in unloading, transporting, and laying. Pipe shall be carefully inspected in the field upon arrival, before it is unloaded, and before, during, and after laying. Pipes which show defects due to handling will be rejected at the site of the installation regardless of prior acceptance.

Damaged ends, chips or cracks, which do not pass through the wall, can usually be repaired. Do not lay pipe which is cracked, checked, spalled, or otherwise damaged.

305.10.03 CONSTRUCTION.

305.10.03.01 Submittals.

305.10.03.01.01 Quality Control Program. Manufacturer shall maintain a quality control program which is certified annually. At the time of this publication *ACPA Q-Cast* and *NPCA* are the most widely recognized national certification programs. A comparable internal certification program may be submitted to the Agency for review and approval.

305.10.03.01.02 Connections. When not shown on the Plans, the *Contractor* shall submit connection details for review and acceptance by the *Engineer* prior to fabrication.

305.10.03.02 Construction Loads. Any proposed construction loads that were not specifically identified in the design process shall be reviewed and approved by the *Engineer*.

305.10.03.03 Excavating.

305.10.03.03.01.01 Trench Width. The minimum trench for *PCC* culverts to be not less than the *OD* divided by 6, on each side (Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the *AASHTO LRFD* Bridge Design Specifications).

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

If special circumstances exist, narrower trench widths may be used as approved by *Engineer*.

Excavate the bed for the end section to the required width and grade. When elliptical pipe is used, which require metal end sections with toe plates, excavate a *Trench* for the toe plate in a manner to permit the toe plate to be against the inner face of the trench in its final position.

305.10.03.03.01.02 Embankment Conditions. Where pipes are to be installed in new embankment (projection), construct the embankment to the required elevation as follows:

- A. In the case of pipes 24 inch or less in diameter or rise, construct the roadway embankment to an elevation of 6 inches above the grade proposed for the top of the pipe, after which excavate the *Trench* and install the pipe.
- B. In the case of pipes more than 24 inch in diameter or rise, construct the roadway embankment to an elevation of 30 inches above the grade proposed for the bottom of the pipe, after which excavate the *Trench* and install the pipe.

The height of new embankments may be varied as directed before installing pipes in new embankments on a steep slope or in a difficult location.

305.10.03.03.01.03 Cover Limits. In no instance shall the cover limits of the pipe class be exceeded.

305.10.03.04 Placing of Materials.

305.10.03.04.01.01 Bedding. Bedding shall be placed on a stable *Foundation*. The minimum depth of the bedding shall be 3 inches from the top of the *Foundation* to the bottom of the pipe *OD*. The *Contractor* shall ensure that no rocks greater than 1 inch in any dimension or other rigid or jagged material are present in the bedding material where pipe will be laid directly on the material.

305.10.03.04.02 Pipe. Unless otherwise directed or approved by the *Engineer* or shown on the *Plans* or specified in the *Special Provisions* or *Special Technical Specifications*, installation shall conform to Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the *AASHTO LRFD* Bridge Design Specifications and *ASTM C1479*.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

Prior to placing backfill material, all lifting holes in *PCC* culverts shall be completely filled with grout. Pipe with elliptical reinforcing shall be set with the top and bottom of the pipe in the correct orientation.

305.10.03.04.02.01 **Joints.** RC pipe and horizontal elliptical RC pipe may be supplied with a *T&G* Joint, or a Gasketed Joint. The joint type and pressure resistance shall be as designated in the project specifications and constructed by one of the following methods:

305.10.03.04.02.01.01 **T&G Joints.** *T & G* joints may be sealed using cement mortar or mastic material in the joint gap.

305.10.03.04.02.01.01.01 **Mortared Joints.** After the ends of the sections of pipe are cleaned and wetted, place mortar firmly into the lower half of the groove end of the previously laid section. Firmly place mortar on the top half of the tongue end of the section to be jointed. Snugly insert the tongue end into the groove end of the section previously laid. Use enough mortar to completely fill the joint.

Brush or point the interior joint. Trowel or brush smooth the inside joints and remove excess mortar from the interior pipe joint. Fill the outside joint recesses with mortar. Firmly fill the external space between the ends of the jointed pipe from the outside with laying mortar.

Backfill of the pipe trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before backfilling, do not backfill until 16 hours after jointing the pipe sections. When the pipe is not backfilled while the mortar is plastic, cure the mortar using a method approved by the *Engineer*. Do not allow free water to come in contact with the pipeline until the mortar in the joints has set at least 24 hours.

305.10.03.04.02.01.01.02 **Mastic Joints.** Wrap mastic joint sealant around the tongue and snugly insert tongue end into the groove end of the section previously laid. Alternately, Contractor may place mastic firmly into the lower half of the groove end of the previously laid section and firmly place mastic on the top half of the tongue end of the section to be jointed. Snugly insert the tongue end into the groove end of the section previously laid.

305.10.03.04.02.01.02 **Gasketed Joints.** Gaskets shall conform to Subsection 203.10.07.03. Gasketed joints are to be sealed using a rubber gasket. Install gasket on spigot end of pipe section per manufacturer's recommendations and insert the spigot into the bell end of the section previously laid. Lubricate gaskets requiring lubricant with the lubricant recommended by the manufacturer of the pipe. The gasket shall be the sole element depended upon to make the joint watertight. Gasketed joints are mandatory for reinforced concrete pipe used in sanitary sewer lines.

305.10.03.04.02.02 **Connections.** All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or PCC junction structure, shall be made by either grouting the lateral in to a fabricated reinforced opening, connecting the lateral with an approved Cast in Place field collar, or in a manufactured wye or tee. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater strength as the pipe.

305.10.03.04.02.03 **Junctions.** All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater strength as the pipe.

305.10.03.04.03 **Backfill.** Backfill shall conform to Section 304 – “Fill, Backfill and Riprap”, except as modified herein.

305.10.03.04.03.01 **Mechanically Compacted Backfill.** Mechanically compacted backfill shall be layered in lifts not exceeding 12 inches in loose thickness. Impact tampers shall not be used directly above the pipe until the full loose layer backfill depth above the pipe is obtained.

305.10.03.04.03.02 **Slurry Backfill.** When used, slurry backfill conforming to Subsection 337.08 – “Slurry Backfill”, Type A (Excavatable) shall be placed under the pipe haunches and from the top of the foundation bedding to the springline. The balance of the trench backfill shall conform to Subsection 200.03.06 - “Class E Backfill”.

305.10.04 ACCEPTANCE.

305.10.04.01 Damaged Work.

305.10.04.01.01 Repair. Cracks in pipes (both longitudinal and circumferential) that are less than 0.10 inch in width in a non-corrosive environment ($\text{pH} > 5.5$) are generally considered non-structural flaws and need not be repaired.

Cracks that are equal to or exceed 0.10 inch in width shall require an evaluation by a *Professional Engineer*.

Damaged ends, chips or cracks, which do not pass through the wall, can be patched using Speed Crete Red Line concrete patching material or equal.

305.10.04.02 Tolerance. The Contractor shall make every effort to provide a concrete-to-concrete connection and pull the pipe completely home. Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps should not exceed the gap tolerances indicated in the below tables.

The recommended joint gap is a one that does not exceed $\frac{1}{2}$ of the length where the gasket seats within the pipe or $\frac{1}{2}$ of the T&G joint length.

Note that odd number *ID* pipes may be encountered in existing storm drain lines however these pipes are no longer manufactured locally. Consult the original manufacturer for joint gap information on odd number ID pipes.

Joint Gaps for Gasketed Circular Concrete Pipe (RCP) and Gasketed Elliptical Concrete Pipe (HERCP)

| Pipe ID | Recommended Joint Gap | Maximum Joint Gap (with Grouting) |
|-----------|-------------------------------|-----------------------------------|
| 12" - 30" | 5/8" | 3/4" |
| 36" | 3/4" | 7/8" |
| 42" | 7/8" | 1-1/8" |
| 48"-78" | 1-1/8" | 1-1/4" |
| 84" | 1-1/4" | 1-3/8" |
| 90" | 1-1/2" | 1-5/8" |
| 96" | 1-5/8" | 1-7/8" |
| >96" | Manufacturer's Recommendation | Manufacturer's Recommendation |
| | | |

Joint Gaps for T&G Circular Concrete Pipe

| Pipe ID | Allowable Joint Gap (with Grout or Mastic) |
|-----------|--|
| 12" - 18" | 1-1/4" |
| 24" | 1-1/2" |
| 30" | 1-5/8" |
| 36" | 1-1/2" |
| 42" | 1-5/8" |
| 48" | 1-7/8" |
| 54" | 2" |
| 60" | 2-1/8" |
| 66"-84" | 2-1/4" |
| 90"-96" | 2-3/4" |
| >96" | Manufacturer's Recommendation |
| | |

Joint Gaps for T&G Elliptical Concrete Pipe

| Equivalent Pipe ID | Span x Rise | Allowable Joint Gap (with Grout or Mastic) |
|--------------------|---------------|--|
| 18" | 23"x14" | 1-1/4" |
| 24" | 30"x19" | 1-1/4" |
| 30" | 38"x24" | 1-1/2" |
| 36" | 45"x29" | 1-3/4" |
| 42" | 53"x34" | 1-3/4" |
| 48" | 60"x38" | 1-7/8" |
| 54"-60" | 68"x43" | 2" |
| 60" | 76"x48" | 2" |
| 66" | 83"x53" | 2-1/2" |
| 72" | 91"x58" | 2-3/4" |
| 78" and > | 98"x63" and > | 3" |

305.10.04.02.01.01 MITIGATION. If gasketed pipes are laid that exceed the recommended joint gap, the inner annular space between the pipe sections shall be completely filled with cement mortar (where pipe diameters allow for entry). If gasketed pipes are laid that exceed the maximum joint gap, the pipe will need to be removed and re-laid or an acceptable PCC collar will need to be installed. If *T&G* pipe is laid that exceeds the allowable joint gap in the below tables, the pipe will need to be removed and re-laid or an acceptable *PCC* collar will need to be installed.

305.11 THIS SUBSECTION INTENTIONALLY LEFT BLANK.

305.12 RC PRESSURE PIPE.

305.12.01 DESCRIPTION. Circular *RC* pressure pipe shall conform to Subsection 203.12 and ASTM C 361, AWWA C300, C301, or C302 as appropriate for the specified diameters and strength.

305.12.01.01.02. Terms.

Acceptable Crack. A crack width less than 0.1 inch and located in a non-corrosive environment (pH >5.5).

Slabbing. The separation of *PCC* from the reinforcing steel.

Spalling. The peeling, popping-out and flaking off of a *PCC* surface.

305.12.01.02 Design. The material type, strength designation, nominal diameter and dimensions of the pipe to be furnished shall be shown on the Plans or specified in the Special Technical Specifications.

305.12.01.02.01 Cover Limits. The class of the pipe should be determined based on the specified depth of cover and loading conditions. *ACPA* Fill Height Tables summarize the required strength class of *RC* pipe for a given installation type and amount of earth cover and can be found at <http://www.concretelife.org/pipe-box-resources/fill-height-tables>.

305.12.01.02.01.01 Construction Loads. Any known construction loading should be shown on the *Plans* taken in to account in the design.

305.12.01.02.01.02 Mix Design. The mix design shall comply ASTM C361, AWWA C300, C301 or C302 with required strength for any specific pipe design verified by cylinder breaks.

305.12.01.02.02 Pipe Design Verification. Pipe design verification when there is a change to material suppliers, materials, mix design, equipment or manufacturing operation, but no less than once every 12 months for each size and strength of pipe in accordance with ASTM C361, AWWA C300, C301 or C302 as appropriate.

Design verification records shall be maintained by the manufacturer and made available upon request.

305.12.01.02.03 Strength Class. The strength class required for a project is dependent on the bedding and backfill material, the depth of cover and the loading conditions. The bedding and backfill requirements used by the *Engineer* to determine the class of pipe required should be called out on the Plans.

The *Engineer* may refer to the standard installations, as defined in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications, which provide flexibility in selecting the installation that best meets the projects unique combination of site conditions, available backfill materials and desired construction and inspection materials. Once the type of installation is selected the correct strength class of RC pipe can be determined.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

305.12.01.02.04 Foundation and Bedding. The bedding and backfill requirements used by the *Engineer* to determine the class of pipe required shall be shown on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*.

305.12.01.03 Care of Materials. Small diameter pipe could be layered for storage in the same manner as they were loaded on the truck. The bottom layer should be placed on a flat base, adequately blocked to prevent shifting as more layers are added. Each layer of bell and spigot pipe should be arranged so that all the bells are at the same end. The bells in the next layer should be at the opposite end, and projecting beyond the spigots of the pipe sections in the lower layer. Where only one layer is being stockpiled, the bell and spigot ends should alternate between the adjacent pipe sections. All pipes should be supported by the pipe barrel so that the joint ends are free of load concentrations. Pipe sections generally should not be stockpiled at the job site in a greater number of layers than would result in a height of 6 ft. (2 m).

Damaged ends, chips or cracks, which do not pass through the wall, can usually be repaired. Do not lay pipe which is cracked, spalled, or otherwise damaged. Reference Repair section 305.xx below for additional information.

305.12.02 CONSTRUCTION.

305.12.02.01 Submittals.

305.12.02.01.01 Quality Control Program. Manufacturer shall maintain a quality control program which is certified annually. At the time of this publication ACPA Q-Cast and NPCA are the most widely recognized national certification programs. A comparable internal certification program may be submitted to the *Agency* for review and approval.

305.12.02.01.02 Connections. When not shown on the *Plans*, the *Contractor* shall submit connection details for review and acceptance by the *Engineer* prior to fabrication.

305.12.02.02 Construction Loads. Any proposed construction loads that were not specifically identified in the design process shall be reviewed and approved by the *Engineer*.

305.12.02.03 Excavating.

305.12.02.03.01.01 Trench Width. The minimum trench for PCC culverts to be not less than the *OD* divided by 6, on each side (Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications).

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

If special circumstances exist, narrower trench widths may be used as approved by *Engineer*.

Excavate the bed for the end section to the required width and grade. When elliptical pipe is used, which require metal end sections with toe plates, excavate a *Trench* for the toe plate in a manner to permit the toe plate to be against the inner face of the trench in its final position.

305.12.02.03.01.02 Embankment Conditions. Where pipes are to be installed in new embankment (projection), construct the embankment to the required elevation as follows:

- A. In the case of pipes 24 inch or less in diameter or rise, construct the roadway embankment to an elevation of 6 inches above the grade proposed for the top of the pipe, after which excavate the trench and install the pipe.
- B. In the case of pipes more than 24 inch in diameter or rise, construct the roadway embankment to an elevation of 30 inches above the grade proposed for the bottom of the pipe, after which excavate the trench and install the pipe.

The height of new embankments may be varied as directed before installing pipes in new embankments on a steep slope or in a difficult location.

305.12.02.03.01.03 Cover Limits. In no instance shall the cover limits of the pipe class be exceeded.

305.12.02.04 Placing of Materials.

305.12.02.04.01.01 Bedding. Bedding shall be placed on a stable *Foundation*. The minimum depth of the bedding shall be 6 inches from the top of the Foundation to the bottom of the pipe *OD*. The *Contractor* shall ensure that no rocks greater than 3 inches in any dimension or other rigid or jagged material are present in the bedding material where pipe will be laid directly on the material.

305.12.02.04.02 Pipe. Unless otherwise directed or approved by the *Engineer* or shown on the *Plans* or specified in the *Special Provisions* or *Special Technical Specifications*, shall conform to Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the *AASHTO LRFD Bridge Design Specifications* and *ASTM C1479* or *AWWA M9* as applicable.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

Prior to placing backfill material, all lifting holes in *PCC* culverts shall be completely filled with grout. Pipe with elliptical reinforcing shall be set with the top and bottom of the pipe in the correct orientation.

305.12.02.04.02.01 Joints. Joints. The joint type shall be as designated in the project specifications and constructed by the following method:

305.12.02.04.02.01.01 Gasketed Joints. Install gasket on spigot end of pipe section per manufacturer's recommendations and insert the spigot into the bell end of the section previously laid. Lubricate gaskets requiring lubricant with the lubricant recommended by the manufacturer of the pipe. The gasket shall be the sole element depended upon to make the joint watertight.

305.12.02.04.02.02 Connections. All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or concrete junction structure, shall be made by either grouting the lateral in to a fabricated reinforced opening, connecting the lateral with an approved Cast in Place field collar, or in a manufactured wye or tee. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater strength as the pipe.

305.12.02.04.03 Backfill. Backfill shall conform to Section 304 – “Fill, Backfill and Riprap”, except as modified herein.

305.12.02.04.03.01 Mechanically Compacted Backfill. Mechanically compacted backfill shall be layered in lifts not exceeding 12 inches in loose thickness. Impact tampers shall not be used directly above the pipe until the full loose layer backfill depth above the pipe is obtained.

305.12.02.04.03.02 Slurry Backfill. When used, slurry backfill conforming to Subsection 337.08 – “Slurry Backfill”, Type A (Excavatable) shall be placed under the pipe haunches and from the top of the foundation bedding to the springline. The balance of the trench backfill shall conform to Subsection 200.03.06 - “Class E Backfill”.

305.12.03 ACCEPTANCE.

305.12.03.01 Damaged Work.

305.12.03.01.01 Repair. Cracks in pipes (both longitudinal and circumferential) that are less than 0.10 inch in width in a non-corrosive environment ($pH > 5.5$) are generally considered non-structural flaws and need not be repaired.

Cracks that are equal to or exceed 0.10 inch in width shall require an evaluation by a *Professional Engineer*.

Damaged ends, chips or cracks, which do not pass through the wall, can be patched using Speed Crete Red Line concrete patching material or equal.

305.12.03.02 Tolerance. The *Contractor* shall make every effort to provide a concrete-to-concrete connection and pull the pipe completely home.

Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps should not exceed the gap tolerances indicated in the below tables.

The recommended joint gap is a one that does not exceed $\frac{1}{2}$ of the length where the gasket seats within the pipe.

If gasketed pipes are laid that exceed the tolerances of column 1, the inner annular space between the pipe sections shall be completely filled with cement mortar (where pipe diameters allow for entry). If gasketed pipes are laid that exceed the tolerances of Column 2, the pipe will need to be removed and re-laid or an acceptable concrete collar will need to be installed.

Note that odd number ID pipes may be encountered in existing storm drain lines however these pipes are no longer manufactured locally. Consult the original manufacturer for joint gap information on odd number ID pipes.

Joint Gaps for Gasketed Circular Concrete Pipe (RCP)

| Pipe ID | Recommended Joint Gap | Maximum Joint Gap (with Grouting) |
|-----------|-------------------------------|-----------------------------------|
| 12" - 30" | 5/8" | 3/4" |
| 36" | 3/4" | 7/8" |
| 42" | 7/8" | 1-1/8" |
| 48"-78" | 1-1/8" | 1-1/4" |
| 84" | 1-1/4" | 1-3/8" |
| 90" | 1-1/2" | 1-5/8" |
| 96" | 1-5/8" | 1-7/8" |
| >96" | Manufacturer's Recommendation | Manufacturer's Recommendation |

305.13 CORRUGATED HDPE PIPE.

305.13.01 DESCRIPTION. This specification covers the requirements and methods of tests for Corrugated HDPE pipe, couplings, and fittings for use in subsurface drainage (storm and culvert) applications. Corrugated HDPE pipe shall conform to Subsection 203.17 - "HDPE Pipe" and ASTM F2306, AASHTO M 252 or AASHTO M 294.

305.13.02 MATERIALS

305.13.02.01 Care of Materials. Pipe shall be handled and stored in a manner which prevents damage to the pipe. Pipe shall not be dragged or dropped during handling process. Storage recommendations shall include stacking pipe no more than 6 feet, and while supporting lengths of pipe evenly, alternate bells for each row of pipe.

Pipe should be stored in a cool, dry place to be distributed as needed. The temperature of the storage area should not exceed 70° F. Pipes should not be exposed to the direct rays of the sun for more than 72 hours. Pipes which have been exposed to the direct rays of the sun for more than 72 hours shall be removed and replaced.

305.13.03 CONSTRUCTION.

305.13.03.01 Bedding, Haunching, Backfilling, and Compaction. Requirements shall be as shown on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, unless noted otherwise in this specification, or at a minimum in accordance with ASTM D2321.

305.13.03.02 Pipe Assembly. Lower pipe into the trench, remove protective wrap from the gaskets, and lubricate exposed gaskets. While keeping lubricated section free from dirt or backfill, place the spigot into the bell and align. Assemble joint using one of the following Bar and Block method, backhoe method, or backhoe and sling method per manufacturers recommendations.

305.13.03.03 Connections. All connections shall be in accordance with Subsection 203.19.05 – “Fittings”.

305.13.03.04 Taps. All tap connections shall be made with Inserta Tee’s in accordance with ASTM F2946.

305.14 PP PIPE.

305.14.01 DESCRIPTION. This specification covers the requirements and methods of tests for *PP* pipe, couplings, and fittings for use in subsurface drainage (sanitary, storm, culvert and industrial waste) applications. Polypropylene pipe shall conform to Subsection 203.19 – “*PP* Pipe” and ASTM F2736, ASTM F2764, ASTM F2881, or AASHTO M 330.

Nominal sizes of 300 to 1500 mm are included.

305.14.02 MATERIALS

305.14.02.01 Care of Materials. Pipe shall be handled and stored in a manner which prevents damage to the pipe. Pipe shall not be dragged or dropped during handling process. Storage recommendations shall include stacking pipe no more than 6 feet, and while supporting lengths of pipe evenly, alternate bells for each row of pipe.

305.14.03 CONSTRUCTION.

305.14.03.01 Bedding, Haunching, Backfilling, and Compaction. Requirements shall be in accordance with the project plans/specifications, unless noted otherwise in this specification, or at a minimum in accordance with ASTM D2321. Material placed below springline shall be “knifed” into haunch zones and in between corrugations; material shall also be compacted in lifts not exceeding 6 inch compacted thickness.

305.14.03.02 Pipe Assembly. Lower pipe into the trench, remove protective wrap from the gaskets, and lubricate exposed gaskets. While keeping lubricated section free from dirt or backfill, place the spigot into the bell and align. Assemble joint using one of the following Bar and Block method, backhoe method, or backhoe and sling method per manufacturers recommendations.

305.14.03.03 Connections. All connections shall be in accordance with Subsection 203.19.05 – “Fittings”.

305.14.03.04 Taps. All tap connections shall be made with Inserta Tee’s in accordance with ASTM F2946.

305.15 CENTRIFUGALLY CAST *FRPM* PIPE.

305.15.01 DESCRIPTION. This Subsection covers centrifugally cast pipe constructed from *FRPM*. Pipe covered by this Subsection is intended for use in sanitary sewers, drainage applications, and other conveyance systems. Centrifugally cast *FRPM* pipe conforming to ASTM D3262, or as modified herein, may be used for direct bury installation, jacking installation, and sliplining installation in gravity service applications. Centrifugally cast *FRPM* pipe conforming to ASTM D3754, or as modified herein, may be used in pressure applications.

The material type, strength designation, nominal diameter and dimensions of the pipe to be furnished shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. Unless otherwise specified, pipe shall be manufactured by the centrifugal casting process.

305.16 STEEL REINFORCED HDPE PIPE.

305.16.01 DESCRIPTION. This specification covers the requirements of Steel Reinforced *HDPE* pipe manufactured in accordance with *ASTM F2562* or *ASTM A978*, as appropriate, for storm drains, irrigation and sanitary sewer systems.

305.16.01.01 Terms.

Acceptable Deflection. Acceptable deflection shall be defined as having 5 percent deflection when compared to manufacturer's nominal diameter.

Rib Lean. Rib lean shall be defined as deflection of outside ribs as a result of backfill materials lodging between ribs.

Crack. Any break or split that extends through the wall.

Crease. An irrecoverable indentation, generally associated with a loss in shape stability.

Delamination. A gap extending through the welded lap seam between two adjacent wrap widths.

Slow Crack Growth. A phenomenon by which a stress crack may form. A stress crack is an external or internal crack in plastic caused by tensile stresses less than its short-term mechanical strength.

305.16.01.02 Design. The pipe stiffness class shall conform to *ASTM F2562*, Class 4.

When Steel Reinforced *HDPE* pipe is to be used in locations where the ends may be exposed, the design shall provide for protection of the exposed portions due to combustibility and the effects of prolonged exposure to ultraviolet radiation.

When multiple pipes will be installed in a single *Trench*, the design shall provide details for pipe layout and configuration and distances between pipes and trench walls

305.16.02 MATERIALS.

305.16.02.03 Care of materials. Particular effort shall be exercised to protect the ends of the pipe. Damaged ends, deflected ribs, deflected pipe, will be rejected and replaced. Do not lay damaged pipe. Damaged pipe shall be removed from the project site.

305.16.02.04 Certification. The certification shall 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.

305.16.03 CONSTRUCTION.

305.16.03.01 Construction Loads. Any proposed construction loads that were not specifically identified in the design process shall be reviewed and approved by the *Engineer*.

305.16.03.01.01.01 Bedding. Bedding shall be placed on a stable *Foundation*. For all pipe 12 inches or greater in diameter, minimum depth of the bedding shall be at least 4 inches thick or 1/12 the *OD* of the pipe, whichever is greater from the top of the *Foundation* to the bottom of the pipe *OD*. The *Contractor* shall ensure that no rocks greater than 3 inches in any dimension or other rigid or jagged material are present in the bedding material where pipe will be laid directly on the material.

The *Contractor* shall excavate for and provide an initial granular bedding. This bedding material shall be placed at a uniform density with minimum compaction and fine graded as specified below.

305.16.03.01.01.02 Embankment Conditions. Where pipes are to be installed in new embankment (projection), construct the embankment to the required elevation as follows:

- A. In the case of pipes 24 inch or less in diameter, construct the roadway embankment to an elevation of 24 inches above the grade proposed for the top of pipe, after which excavate the trench and install the pipe.
- B. In the case of pipes more than 24 inch in diameter, construct the roadway embankment to an elevation of 48 inches above the grade proposed for the bottom of the pipe, after which excavate the trench and install the pipe

The height of new embankments may be varied as directed before installing pipes in new embankments on a steep slope or in a difficult location.

305.16.03.01.01.03 In no instance shall the cover limits of the pipe be exceeded.

305.16.03.02 Excavating.

305.16.03.02.01.01 Trench Grade Bell or coupling holes shall be dug after the trench bottom has been graded. Such holes shall be of sufficient width to provide ample room for caulking, banding, or bolting. Holes shall be excavated only as necessary to permit accurate work in the making of the joints and to insure that the pipe will rest upon the prepared bottom of the trench, and not be supported by any portion of the joint.

Depressions for joints, other than bell-and-spigot, shall be made in accordance with the recommendations of the joint manufacturer for the particular joint used.

305.16.03.02.01.02 Specified Compaction. Unless otherwise directed or approved by the Engineer or shown on the *Plans* or specified in the *Special Provisions* or *Special Technical Specifications*, compaction shall be as specified in Table 305.16.03.02.01.02-I when tested and determined by AASHTO T 99, Method A or B, and T 191 or ASTM D6938 are used for density determination. All compaction discussed within this section shall be performed within 2 percentage points of optimum moisture content unless otherwise noted in the project plans or project specifications.

Table 305.16.03.02.01.02-I
Steel Reinforced HDPE Pipe 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 Trench |
|---------------|--|---|---|---|
| I | Under any existing or proposed pavement, curb, gutter, sidewalk, or such construction included in the contract, or when any part of the trench excavation is within 2-feet of the above. | 100% for granular 95% for non-granular | 95% | 95% |
| II | On any utility easement street, road or alley right-of-way outside limits of Backfill Type (I). | 85% | 85% | 90% |
| III | Around any structures (manholes, etc.) or exposed utilities. | 100% in all cases or CLSM | | |

The *Contractor* may use a half sack mix of CLSM for the entire pipe embedment zone to 1 foot over the outside top of pipe.

306.01 GENERAL.

306.01.01 DESCRIPTION. This Section covers general, materials, construction and acceptance standards specific to gravity lines for culverts, and sanitary sewer and storm sewer systems and related structures.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. Culverts, and sanitary sewer and storm sewer systems shall conform to Section 305 – “Pipe Systems”, except as modified herein.

306.01.02 CONSTRUCTION.**306.01.02.01 Placing of Materials.**

306.01.02.01.01 Gravity Lines. Gravity pipe lines for culverts, and sanitary sewer and storm sewer systems shall be constructed in accordance with the following Specifications, where applicable:

Pipe shall be laid upgrade with the socket or collar ends of the pipe upgrade unless otherwise authorized by the Engineer.

RC pipe with elliptical reinforcement shall be laid with the minor axis of the reinforcement cage in a vertical position.

CM pipe shall be laid with the external laps of the circumferential seams toward the inlet end.

Before backfilling around circular CM pipes 48 inches in diameter and larger, the full length of pipe shall be elongated vertically. When shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, circular pipes smaller than 48 inches in diameter shall also be elongated vertically.

Unless otherwise directed or approved by the *Engineer*, pipes shall be vertically elongated from a true circle to provide an increase in the vertical diameter of approximately 5 percent for the full length.

Pipes may be vertically elongated at the fabricating shop by any of the following methods:

- A. By fabricating the plates so that the vertical elongation is obtained after assembly.
- B. By mechanical pressure sufficient to introduce a permanent vertical elongation in the pipe.

Suitable excavation shall be made to receive the socket or collar, which shall not bear upon the subgrade or bedding.

Pipe sections shall be laid and joined in such a manner that the offset of the inside of the pipe at any joint will be held to a minimum at the invert. The maximum offset at the invert of pipe shall be 1 percent of *ID* of the pipe or 3/8 inch, whichever is smaller.

In joining, socket and spigot of each pipe shall be so seated in the socket of the adjacent pipe as to give a minimum of 3/8 inch annular space all around the pipe in the socket. Unavoidable offsets shall be distributed around the circumference of the pipe in such a manner that the minimum offset occurs at the invert.

When pipe is laid in a sheeted trench, all sheeting against which a concrete cradle is to be placed shall be faced with at least one thickness of building paper and the sheeting shall be withdrawn without displacing or damaging the cradle.

After the joints have been made, the pipe shall not be disturbed in any manner.

Test for watertight joints shall conform to the requirements of Section 336 – “Inspection and Testing”.

Unless otherwise directed or approved by the Engineer, the end of the pipe shall be securely closed during non-working hours.

306.01.02.01.01.01 Field Jointing of CM Pipe. The pipe shall be laid so that the seams are not on the bottom. The inside circumferential seams shall be placed pointing downstream. Care shall be taken to insure that dirt or other particles do not get between the outside of the pipe and the pipe coupling. Paved inverts shall be placed and centered on the bottom of the trench. Any damage to the protecting lining and coating shall be repaired prior to the backfilling around the pipe.

The spigot end shall be inserted to the proper depth of the socket as indicated by the home mark.

306.01.02.01.01.02 Field Jointing of C/Pipe. Synthetic rubber rings shall be used.

306.01.02.01.01.03 Field Jointing of VC Pipe. Unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, any of the following joints may be used for sewers constructed of VC pipe.

- A. **Type "C" Joints (Couplings For Plain End VC Pipe).** Pipe joints shall be made with sewer pipe couplings. Each coupling shall be sealed with Class "C" mortar which shall be sufficiently fluid to insure free flow in the annular space between the housing and the sleeve. Steel bands on couplings shall be tightened as soon as pipe is placed. No joint shall be sealed with mortar until the next two adjoining pipes are in place.
- B. **Type "D" Joints (Rubber Sleeve Coupling For Plain End VC Pipe).** Unless otherwise specified, pipe shall be delivered to the job site with the rubber sleeve applied at the factory on one end of the pipe or fitting. The spigot end of the pipe to be joined shall be inserted in the sleeve and the steel compression band shall be tightened sufficiently to achieve the test results as specified herein.
- C. **Type "E" Joints (PVC Compression Joints).** Type "E" joints shall be as specified in Subsections 307.08.05 – "Joint Assembly" – and 307.08.06 – "Solvent-Welded Joint Assembly". Upon installation, the meeting surfaces shall be wiped clean of dirt and foreign matter, then an approved lubricant shall be applied to the joint surfaces. The spigot shall be positioned inside the socket and the joint shoved home. For large diameter pipe, a lever attachment or bar cushioned with a wooden block shall be used to shove the joint into place. In no case shall a bar be used on an unprotected joint surface. Mating surfaces shall be in tight contact with each other upon completion of the joint installation.
- D. **Type "F" Joints (Polyurethane Compression Joints).** The method of installation of Type "F" joints shall be as Type "E" Polyvinyl Chloride joints. Type "F" joints may be permitted for use on curves, provided that the radius of curvature is not less than shown on the *Plans* unless beveled pipe or shorter lengths are provided.

306.01.02.01.01.03.01 Straight Non-beveled Pipe on Curves. Straight nonbeveled pipe with Type "D" or "G" joints is permitted for pipelines on curves, provided the radius of curvature is not less than that shown in Table 306.01.02.01.01.03.01-I. For radius of curvature less than that shown, beveled pipe or shorter lengths shall be provided.

Table 306.01.02.01.01.03.01-I
STRAIGHT PIPE ON CURVES — TYPE "D" & "G" JOINTS
(All deflections are based on ASTM C425)

| D Pipe Size (Inches) | For Pipe Length (Feet) | Minimum Radius of Curvature (Feet) | Maximum Deflection per Joint (Degrees) | Maximum Deflection per Length (Inches) |
|----------------------|------------------------|------------------------------------|--|--|
| 6 - 12 | 5 | 120 | 2.4 | 2-1/2 |
| | 5-1/2 | 132 | 2.4 | 2-3/4 |
| | 6 | 144 | 2.4 | 3 |
| 15 - 24 | 5 | 160 | 1.8 | 1-7/8 |
| | 5-1/2 | 176 | 1.8 | 2-1/16 |
| | 6 | 192 | 1.8 | 2-1/4 |
| 27 - 36 | 7-1/2 | 240 | 1.8 | 2-13/16 |
| | 5 | 240 | 1.2 | 1-1/4 |
| | 5-1/2 | 264 | 1.2 | 1-3/8 |
| 39 - 42 | 6 | 288 | 1.2 | 1-1/2 |
| | 7-1/2 | 360 | 1.2 | 1-7/8 |
| | 5 | 320 | 0.9 | 15/16 |
| | 5-1/2 | 352 | 0.9 | 1-1/16 |
| | 6 | 384 | 0.9 | 1-1/8 |

306.01.02.01.01.04 Field Jointing of NRC Pipe.

- A. Tongue and Groove Joints. The grooved end of the pipe shall be buttered with a stiff mixture of mortar prior to jointing pipe. The pipe joint shall then be carefully wiped on the inside.
- B. Socket and Spigot Mortar Joints. In making the joints, the entire annular space shall be completely and compactly filled with mortar.

Mortar placed in the joint to assist in the assembling and centering of the pipe shall not be considered as filling that portion of the joint in which it is placed. The mortar shall be beveled on a 1:1 slope from the outer edge of the socket, and the interior of the pipe cleaned of surplus mortar or other foreign material.

When approved by the *Engineer*, a narrow gasket of oakum or lead may be caulked into each joint in wet trenches, after which the joint shall be thoroughly mortared. Interior joints in pipe shall be neatly wiped on the inside.

- C. Socket and Spigot Gasket Joints. The outside of the spigot and the inside of the socket of the pipe shall be thoroughly cleaned prior to laying. The gasket and the socket interior shall be lubricated with a soft vegetable soap compound before the pipes are jointed.

306.01.02.01.01.05 Field Jointing of RC Pipe.

- A. Mortar Type Joints. All joints shall be cleaned with a wire brush and wetted before mortaring. All mortar shall conform to the applicable provisions of Subsection 203.19 – “Solid Wall HDPE Pipe”.
- B. T & G Self-Centering Joints. Pipe used on curves shall have one or both ends beveled or shall be pulled to provide a smooth curve. If the resulting space between the extremities (outermost elements) of adjacent pipe is more than 1/8 inch, #4 reinforcement steel shall be placed circumferentially on 3 inch centers in the gap between the lip of one pipe and the seat of the other, and the space filled with mortar (or concrete) for the full thickness of the barrel of the pipe. If the space is greater than 1 inch as defined herein, a reinforced concrete collar shall be provided as directed by the Plans.

When pipe is under 21 inches in diameter, the joints shall be made by filling the outer joint space completely and the lower half of the inner joint space with mortar.

When the pipe is 21 inches or greater in diameter, jointing shall be made by completely filling both inner and outer joint spaces with mortar. No backfill shall be placed until joint mortar is allowed to thoroughly set.

- C. Collar Joints. Pipe with collar joints shall be laid with the collar end up-grade. The pipes shall be tightly butted together and uniform caulking space left between the pipe and the collar. When the entering pipe has been placed and checked for line and grade, the body of the pipe shall be backfilled with earth on both sides to hold the pipe firmly in place. The caulking space then shall be completely filled with stiff increments by means of caulking tool and hammer.
- D. Gasket-Type Joints. The ends of the pipe shall be so formed that, when the pipes are laid together and joined, they shall make a continuous and uniform line of pipe with a smooth and regular surface.

Joints shall be water-tight and flexible. Each joint shall contain a solid gasket of neoprene or other material approved by the *Engineer*, which shall be the sole element responsible for water-tightness of the joint. This gasket shall be of circular cross section, unless otherwise approved by the *Engineer*. The length and cross sectional diameter of the gasket, and all other joint details shall be such as to produce a water-tight joint. The slope of the longitudinal gasket contact surfaces of the joint with respect to the longitudinal axis of the pipe shall not exceed 2 degrees.

Under ordinary laying conditions, the work shall be scheduled so that the socket end of the pipe faces in the direction of laying. Prior to placing the spigot into the socket of the pipe previously laid, the spigot groove, the gasket, and the inside of the socket shall be thoroughly cleaned. Then the spigot groove, the gasket, and the first 2 inches of the inside surface of the socket shall be lubricated with a soft vegetable soap compound. The gasket, after lubrication, shall be uniformly stretched when placing it in the spigot groove so that the gasket is distributed evenly around the circumference.

For pipe in which the inside joints are to be pointed, suitable spacers shall be placed against the inside shoulder of the socket to provide the proper space between abutting ends of the pipe.

After the joint is assembled, a thin metal feeler gauge shall be inserted between the socket and the spigot and the positions of the gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked.

Where steel joint rings are used, a suitable cloth, plastic or paper band shall be placed around the outside and centered over the joint to prevent dirt from entering the joint recess. The joint band shall be bound to the pipe by the use of steel box strapping or by an equivalent method, and shall completely and snugly encase the outside joint except for an opening near the top where grout is to be poured into the joint recess. Grout shall be poured and allowed to set before densification of bedding and backfill materials by jetting or flooding methods. In any case, joints shall be grouted before backfill is placed over the top of the pipe. With the jointing band properly secured, the joint recess shall be moistened with water and then filled with mortar. The mortar grout shall completely fill the outside annular space between the ends of the pipe and around the complete circumference. After the recess has been filled, the jointing band shall be replaced over the opening left for pouring and the mortar allowed to set. After the bedding and backfill have been densified, the inside joint recess shall first be moistened, then filled with stiff mortar. The finished joint shall be smooth and flush with the adjacent pipe surfaces.

306.01.02.01.01.06 Field Jointing of HDPE Pipe. Jointing of HDPE shall be in accordance with the approved manufacturer's printed instructions. Joints will be Bell and Spigot type with gaskets made of a properly cured high grade elastomeric compound meeting the requirements of ASTM F477.

The spigot end shall be inserted to the proper depth of the socket as indicated by the home mark.

306.01.02.01.01.07 Field Jointing of Injection Sealed PVC Pipe. Injection seal jointing of PVC pipe shall be in accordance with the approved manufacturer's printed instructions, which shall be furnished to the *Engineer*.

The spigot end shall be inserted to the full depth of the socket as indicated by the home mark and driven into the locking taper as recommended by the manufacturer.

The ports in the socket end shall be positioned so as to allow observance of flow of the adhesive from the exhaust port. The adhesive compound shall be injected until air is no longer observed to bubble from the exhaust port. Escape of adhesive compound beyond the retainer ring shall be cause for rejection of the joint.

306.01.02.01.02 Culverts.

306.01.02.01.02.01 Headwalls. Where shown on the *Plans*, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the *Engineer*. Headwalls are to be constructed to conform to the applicable requirements of Section 311 – "PCC."

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay as shown on the *Plans*.

306.01.02.01.02.02 End Sections. The bed for the end section shall be excavated to the required width and grade. For metal end sections with plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate being against the inner face of the trench when the end section is in its final position. After end sections have been properly secured to the pipe, this trench shall be backfilled and firmly compacted.

Precast concrete end section shall be placed with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.

306.01.02.01.02.03 Structural Steel and Aluminum Plate Pipe and Arches. Plates for a pipe arch shall form a cross section made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than 180

degrees nor less than 155 degrees. The bottom shall be an arc of not more than 50 degrees nor less than 10 degrees. The top shall be joined at each end to the bottom by an arc having a radius between 16 and 21 inches and of not more than 87 1/2 degrees nor less than 75 degrees.

When shown on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, plates for pipes and pipe arches shall be bituminous coated in accordance with AASHTO M 190, Type A, B, or C.

When bituminous coating is applied to plates for structural steel plate pipe, arches and pipe arches, each plate shall have the thickness painted on the inner surface so that the plate thickness can be readily identified.

All portions of all nuts and bolts used for assembly of bituminous coated structural steel plate pipes, arches, and pipe arches projecting outside the pipe shall be bituminous coated after installation. The portion of the nuts and bolts projecting inside the pipe need not be bituminous coated.

Damaged bituminous coating shall be repaired by the *Contractor* by applying bituminous material conforming to the provisions of AASHTO M 190 or other approved material.

The bottom plates of structural plate pipes and arches shall be one gauge heavier than the gauge specified in the bid schedule, which will apply to top and side plates. When gauge one is specified, the bottom plates shall also be gauge 1.

Plates shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating, in lieu of the requirements of AASHTO M 36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating, after which the cleaned area shall be painted with two coats of zinc oxide-zinc dust point conforming to the requirements of Federal Specification MIL-P-15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

Planned lengths and sizes are approximate. The Contractor shall not order and deliver the plates until a list of sizes and lengths is furnished to him by the Engineer.

Plates shall consist of structural units of galvanized corrugated metal structural steel or aluminum. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet. (Plates have approximately a 2 inch lip beyond each end crest, which results in the actual length of a given structure being approximately 4 inches longer than the nominal length, except when skewed or beveled.)

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three plates come together at any one point. Each plate shall be curved to one or more circular arcs.

Plates shall be formed to provide lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure will be as specified.

Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows 2 inches apart, with one row in the valley and one in the crest of the corrugations. Bolt holes along these edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of plate shall be not less than 1 3/4 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch.

Burnt edges shall be free from oxide and burrs and shall present a workmanlike finish. Damaged spelter on the surface of the plates and the edges of cuts shall be repaired within 24 hours after the cuts are made. Each cut plate shall be legibly identified to designate its proper position in the finished structure.

The *Engineer* shall be furnished with an itemized statement of the number and length of the plates in each shipment by the manufacturer. Each plate included in a shipment shall conform to the

requirements of these Specifications. If 25 percent or more of the plates in any shipment fail to conform to the requirements, the entire shipment may be rejected.

The structural plate structures shall be assembled in accordance with the manufacturer's assembly instructions. The unsupported edges of all plates shall extend far enough to support the plate above until the first complete ring has been assembled. A sufficient number of bolts shall be progressively installed to hold the plates in position. Bolts shall not be tightened until tightening will not interfere with the adjustment and matching of additional plates and sections. Special care shall be exercised in the use of drift pins or pry bars to prevent chipping or injury to the galvanized or other protective coating, and such injury shall be repaired at the Contractor's expense. After all plates are in place, the bolts shall be progressively and uniformly tightened from one end of the structure and the tightening operation repeated to be sure that all bolts are tight. Bolts shall be tightened to a minimum of (a) 100 foot-pounds of torque for plates of seven gauge and lighter, and (b) 150 foot-pounds of torque for plates of five gauge and heavier, and shall be rechecked and retightened as necessary just prior to backfilling.

The elliptical-shaped pipes shall be installed with their long diameter vertical, and pipe arches shall be installed with their span width horizontal.

When specified, structural plate pipes which are not fabricated out of round before erection shall be timber strutted vertically before placement of the embankment.

The pipe shall be deformed to the required degree by means of suitable jacks. The method of jacking shall meet with the approval of the *Engineer*. A tolerance of 25 percent above or below the specified elongation will be permitted.

The method for distorting plates in the field shall conform to details shown on the *Plans*. The vertical diameter throughout that portion of the pipe between outer shoulder lines of the roadway shall be increased to the approximate percentages listed in the following table:

| | Percent Increase |
|---|------------------|
| Pipes using 0.280 inches or 0.249 inches top and side plates | 1 |
| Pipes using 0.218 inches or 0.188 inches top and side plates | 2 |
| Pipes using 0.168 inches, 0.138 inches, or 0.109 inches top & side plates | 3 |

Between the outer shoulder lines of the roadway and the outer ends of the pipe, the distortion may be decreased uniformly to zero.

The struts shall be left in place until the embankment is complete and compacted, unless otherwise directed or approved by the *Engineer*.

In lieu of strutting structural plate pipe, the *Contractor* may furnish structural plate pipe with the vertical axis fabricated out of round 5 percent of the nominal diameter from end to end of the pipe. A tolerance of 25 percent above or below the specified elongation will be permitted. The elongation shall be made by approved shop methods, and any coating damaged or destroyed shall be repaired or replaced satisfactorily.

Structural plates on which the spelter coating has been bruised or broken, or which shows defective workmanship, shall be rejected, except as herein otherwise specified. The requirement applies not only to the individual plates, but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship and the presence of any or all of them in any individual culvert plate, or in general in any shipment, shall constitute sufficient cause for rejection:

- A. Uneven laps.
- B. Variation from a straight center line.
- C. Ragged edges.
- D. Loose, unevenly lined or spaced bolts.
- E. Bruised, scaled or broken spelter coating.
- F. Dents or bends in the metal itself.

Where shown on the *Plans*, inlet and outlet headwalls shall be constructed or installed in connection with structural plate pipe. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the *Engineer*. Headwalls are to be constructed to conform to the applicable requirements of Section 311 – “PCC” and Section 315 – “PCC Structures”.

In case the *Plans* provide for the extension of any old or existing structural plate pipe or pipe arch culverts, the connection of the old and new sections shall be made by punching any necessary bolt holes, furnishing bolts, nuts and washers, changing location of individual plates on pipe arches, and any other work required in the completion of the connection in a workmanlike manner. In all cases where an existing headwall is in place, the concrete shall be completely removed.

306.01.02.01.02.04 Field Jointing of Precast Concrete Box Culverts. Jointing of box culverts shall be according to manufacturer's recommendations using a pre-formed joint material meeting AASHTO M 198 Type B. A double application of joint material shall be used; one application shall be applied to the tongue and the other to the groove. The minimum size of joint material shall be 1 1/4 inches. Any joint material extruding from the interior of the joint shall be removed flush with the box culvert.

For multiple box installations, a space of 3 inches shall separate each line of boxes. The space between the box lines shall be filled solidly with grout. The grout shall be a workable mix suitable for pumping without segregation and shall be thoroughly mixed. The grout shall be placed by pumping or an approved alternate method. The grout shall be consolidated by mechanical vibration or rodding during placing. The grouting shall be done in a continuous pour in lifts not exceeding 6 feet. Vertical grout barriers may be used to control the flow of grout horizontally. The grout shall attain a minimum compressive strength of 2,500 PSI at 28 Days when tested in accordance with Nev. T475.

307.01 GENERAL.

307.01.01 DESCRIPTION. This Section covers general, materials, construction and acceptance standards specific to installation of fire hydrants.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. Pipe systems for fire hydrants shall conform to Section 305 – “Pipe Systems”, except as modified herein.

307.01.02 DESIGN.

307.01.02.01 Hydrant Wall Thickness. The thickness of the wall of the barrel shall not be less than the thickness specified for Class 250 pit-cast iron water pipe of like diameter produced in accordance with ASA A-212 and Table 2.3 thereof. The wall thickness of barrels of fractional-inch diameter shall be that for the next larger diameter.

307.01.02.02 Access to Moveable Parts. The hydrant shall be so designed that when it is in place, no excavation will be required to remove the main valve and the moveable parts of the drain valve.

307.01.02.03 Operating Threads. The operating threads of the hydrant shall be so designed as to avoid the working of any iron or steel parts against either iron or steel. Either the operating stem or its threaded stem nut (or sleeve) shall be of non-corrosive metal. The operating stem and nut shall have Acme threads unless otherwise directed or approved by the governing Agency. The design factor of safety of the operating mechanism shall be five and shall be based on the foot-pounds torque required for the closing and opening of the individual hydrant at 150 *PSI* working water pressure. Hydrants shall be capable of being subjected to an operating torque of 200 foot-pounds applied at the operating nut. The torque requirements apply only to hydrants of 5 foot bury and under.

307.01.02.04 Operating Mechanism. The operating mechanism, particularly the lead of the thread of the operating stem, shall be so designed that when the operating nut is turned at the fastest possible rate using a 15 inch wrench to shut off the flow of water, the resulting pressure in the system shall not exceed twice the static pressure if the static pressure averages 60 *PSI* or greater. If the static pressure averages less than 60 *PSI*, the pressure shall not be raised more than 60 *PSI* above the static.

307.01.02.05 Hydrant Top. The hydrant top or bonnet shall be shall be free-draining and of a type that will maintain the operating mechanism in readiness to use under freezing conditions. It shall be so designed as to make tampering difficult and shall be provided with convenient means to afford lubrication to insure ease of operation and the prevention of wear and corrosion.

307.01.03 SAFETY. The Contractor shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”.

307.02 MATERIALS. The Contractor shall ensure that the certificate has been reviewed and accepted by the Engineer prior to transport.

307.02.01 INSPECTION OF MATERIALS. The Contractor shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

307.02.02 CARE OF MATERIALS.

307.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage”, except as modified herein.

307.02.03 USE OF OTHER MATERIALS. The Contractor shall not use other materials and/or methods except as provided in Subsection 100.31.02.

307.02.04 FIRE HYDRANTS. Materials for fire hydrant installation shall conform to Section 217 – “Fire Hydrants”.

307.03 CONSTRUCTION.**307.03.01 SUBMITTALS.**

307.03.01.01 Certificate of Compliance. The Contractor shall provide a certificate of compliance for each aggregate source in accordance with Subsection 100.31.01 – “Certificate of Compliance”, except as modified herein.

307.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

307.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

307.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

307.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”.

307.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”, except as modified herein.

307.03.07 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

307.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”.

307.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303- “Excavating”.

307.03.10 PLACING OF MATERIALS.**307.03.10.01 Setting Hydrants.**

307.03.10.01.01 Location and Position. Hydrant location shall be established or approved by the Agency. Hydrant position in respect to fences, walls, intersections, and any other confining structure shall be in accordance with requirements of the Agency.

All hydrants shall stand plumb and shall have their nozzles parallel with or at right angles to the curb with the pumper nozzle facing the curb, except that hydrants having two-hose nozzles 90 degrees apart shall be set with each nozzle facing the curb at an angle of 45 degrees.

307.03.10.01.02 Connection To Main. Each hydrant shall be connected to the main with a 6 inch *DI* pipe or *PVC* branch controlled by an independent 6 inch gate valve, unless otherwise specified.

307.03.10.01.03 Hydrant Drainage. Whenever a hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand from the bottom of the trench to at least 6 inches above the waste opening in the hydrant and to a distance of 1 foot around the elbow.

Wherever a hydrant is set in clay or other impervious soil, a drainage pit 2 feet in diameter and 3 feet deep shall be excavated below each hydrant and filled compactly with coarse gravel or crushed stone mixed with coarse sand under and around the elbow of the hydrant and to a level of 6 inches above the waste opening. No drainage pit shall be connected to a sewer.

307.03.10.01.04 Anchorage. The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with a concrete thrust block or it shall be tied to the pipe with suitable restrained joints, as directed by the *Engineer*. Thrust blocks shall be placed so that the pipe and fitting joints will be accessible for repair. *PCC* for thrust blocks shall have a minimum compressive strength of 3000 *PSI* at 28 *Days*.

307.03.10.02 Joints. All joints shall be faced true and shall be watertight when subjected to the water pressure for which the hydrant is designed.

307.03.10.03 Waterway. Changes in the shape or size of the waterway shall be accomplished by means of easy curves. The junctions of hose and pumper nozzles with the barrel shall be rounded to ample radii. Exclusive of the main valve opening, the net area of the waterway of the barrel and footpiece at the smallest part shall not be less than 120 percent of that of the net opening of the main valve.

307.03.10.04 Inlet and Connection. The base of the hydrant, known as the footpiece or elbow, shall have a side or bottom inlet provided with a bell, a flange, or other type of connection as directed or approved by the governing Agency for connecting the hydrant to the branch from the main. In a hydrant provided with bell type connections, the bell dimensions shall conform to those shown in Standard for Cast Iron Pressure Fittings — AWWA C-100 (Class D). In a hydrant provided with flange type connections, the flange dimensions shall conform to ASA B16.1 (Cast Iron Pipe Flanges and Flanged Fittings, Class 125). When a hydrant is to be connected to mechanical joint pipe, the dimensions shall conform to Table 11.1 of ASA A-21.11.

307.03.10.05 Lugs. Lugs, if required, for harnessing the hydrant to the connecting pipe from the street main shall be provided on the bell of the elbow.

307.03.10.06 Nozzles. Hose nozzles shall be of Grade I bronze and shall be fastened into the barrel by a fine thread or by leading. If lead is used, an adequate recess shall be provided for the lead. All nozzles shall be safeguarded against blowing out. For screwed-in nozzles, a pin or other approved method shall be employed to prevent the nozzle from turning or backing out.

307.03.10.06.01 Nozzle Caps. Nozzle caps shall be cast iron and shall be provided for all outlets. The threads shall conform to those of the nozzle. The cap nut shall have dimensions similar to those of the operating nut. Caps shall be securely chained to the barrel with a metal non-kinking chain having links made from stock not less than 1/8 inch in diameter, or of equivalent cross sectional area. A recess shall be provided at the inner end of the threads to retain a gasket.

307.03.10.07 Iron Parts and Bronze Mounting. All iron parts receiving bronze mounting shall be made true and smooth, and the bronze mounting shall be finished to fit.

307.03.10.08 Castings. All castings shall be clean and sound, without defects which will impair their service. No plugging, welding, or repairing of such defects will be allowed.

307.03.11 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

307.03.12 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”, except as modified herein.

307.04 ACCEPTANCE.

307.04.01 HYDROSTATIC TEST. Hydrants shall be subjected, after assembly, to two tests under a hydraulic pressure of 300 PSI. One test shall be made with the whole interior of the hydrant under pressure; and another with the main valve closed and the footpiece under pressure from the inlet side. Under the above test procedure, there shall be no leakage through the main valve, or stuffing box, nor through the castings or the joints of the assembled hydrant. Leakage or other imperfections found in either test shall be corrected before the hydrant is accepted.

308.01 GENERAL.

308.01.01 DESCRIPTION. This Section covers the production, provision, preparation for placement and placement of untreated aggregate base.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

308.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

308.01.01.01.02 Terms.

Production. Production shall be defined as mining, crushing, screening and stockpiling the materials.

Placement. Placement shall be defined as transferring, spreading, compacting and grading to specified line and grade of the aggregate base.

308.01.02 SAFETY. The Contractor shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”.

308.02 MATERIALS. The materials used shall be determined and/or accepted by the *Engineer*. The Contractor shall ensure that the certificate has been reviewed and accepted by the *Engineer* prior to transport.

308.02.01 INSPECTION OF MATERIALS. The Contractor shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

308.02.02 CARE OF MATERIALS.

308.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage”, except as modified herein.

308.02.02.01.01 Aggregates. Sufficient storage space shall be provided for the aggregate required. The storage area shall be maintained neatly and orderly and separate aggregate stockpiles shall be readily accessible for sampling.

308.02.03 USE OF OTHER MATERIALS. The Contractor shall not use other materials and/or methods except as provided in Subsection 100.31.02.

308.02.04 AGGREGATES. Aggregates shall conform to Subsection 200.01 – “Aggregates for Base Course”.

308.03 CONSTRUCTION.**308.03.01 SUBMITTALS.**

308.03.01.01 Certificate of Compliance. The Contractor shall provide a certificate of compliance for each aggregate source in accordance with Subsection 100.31.01 – “Certificate of Compliance”, except as modified herein.

308.03.01.02 Additional Information. Unless waived by the *Engineer*, the certificate shall also include the following information:

- A. Results of all tests required by the specifications;
- B. *Accredited Laboratory* name and website address of accreditation program; and
- C. Personnel name(s) and website address of qualification program.

308.03.01.03 Haul Route. Unless waived by the *Engineer*, the Contractor shall submit to the *Engineer* a document designating the route to be used for transporting of materials. The Contractor shall ensure that the document has been reviewed and accepted by the *Engineer* prior to proceeding with the related Construction Activity.

308.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

308.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

308.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

308.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”.

308.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”, except as modified herein.

308.03.06.01 Grading. The *Contractor* shall provide a motor grader for grading of the aggregate base in areas with a width of 12 feet or greater. Cutting edges on the required grading equipment shall be checked from end to end for straightness prior to the equipment use. All cutting edges which deviate more than 0.25% from a straight line shall be replaced.

308.03.07 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

308.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”.

308.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303- “Excavating”.

308.03.10 PLACING OF MATERIALS. The *Contractor*’s operations shall not create dust hazard or other nuisance. The *Contractor* shall immediately remove and dispose of any nuisance material and/or spillage within the *Site of Work* and/or any routes used for transport of materials.

308.03.10.01 Placing and Spreading. Aggregate base shall be placed uniformly on the approved subgrade by means of a hauling vehicle with or without spreading devices.

Spreading shall be done in such a manner as to minimize segregation of the material.

308.03.10.02 Moisture Conditioning and Mixing. Water shall be applied as needed immediately prior to and during all placement operations, until a uniform mixture is obtained. The aggregate base shall be moistened sufficiently to prevent segregation of the fine and coarse particles. Water shall be applied during the compaction and maintenance stages in sufficient amounts to assist in compaction and to prevent raveling.

308.03.10.02.01 Lift Thickness. Where the required compacted thickness is 6 inches or less, the base materials may be spread in one layer. Where the required compacted thickness is more than 6 inches, the base material shall be spread for compaction in each layer not to exceed 6 inches. When large compaction equipment is utilized, base materials can be spread for compaction in 8 inch lifts if it can be demonstrated that adequate compaction can be attained.

308.03.10.03 Compaction. Aggregate base shall be compacted to at least 95 percent maximum dry density, within 2 percent of optimum moisture content. The maximum dry density and optimum moisture content shall be determined in accordance with ASTM D1557

308.03.10.03.01 On-Site Recycled Aggregate Base. On-site recycled aggregate base shall be compacted as specified above or densified utilizing a rolling pattern with the number of passes established by measurement of peak wet density.

308.03.10.04 Protection. Exposed surfaces shall be maintained in its finished condition until the succeeding material is placed. Any loss of density and/or moisture content shall require moisture conditioning and recompaction to the specified density prior to placement of any subsequent layer with no additional compensation for such recompaction.

308.03.11 WEATHER LIMITATIONS. Aggregate base shall not be placed on a grade which is frozen or which has a moisture content which would be detrimental to the compaction or quality of the aggregate base.

308.03.12 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

308.03.13 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”, except as modified herein.

308.04 ACCEPTANCE. Aggregate base shall be accepted based on the surface tolerance, density and thickness.

308.04.01 TOLERANCE. Waves, corrugations, and ruts will not be allowed to form and the base shall be bladed as often as necessary, rewatered, and recompacted to maintain a true cross section. When a 12 foot straightedge is laid in any direction, the finished surface shall not deviate at any point more than $\frac{1}{2}$ inch from the bottom of the straightedge or from plan grade.

309.01 GENERAL.

309.01.01 DESCRIPTION. This Section covers the production, provision, preparation for placement and placement of one or more lifts of a mixture of aggregate and cementitious material on a prepared surface.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

309.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

309.01.01.01.02 Terms.

309.01.02 DESIGN. This Subsection does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the resulting composite section. The *Engineer* shall show specific design requirements on the *Plans* or specify these requirements in the *Special Provisions* and/or *Special Technical Specifications*.

309.01.02.01 CTB.

309.01.02.01.01 Composition of Mixtures. A mix design shall be prepared in accordance with Subsection 337.01 “Mix Design” and the applicable requirements of Subsections 337.02 – “Cement Treated Crushed Aggregate Base” or 337.03 – “Cement Treated Recycled Aggregate Base” to determine the composition of the mixture.

309.01.03 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”.

309.02 MATERIALS. The materials used shall be determined and/or accepted by the *Engineer*. The *Contractor* shall ensure that the certificate has been reviewed and accepted by the *Engineer* prior to transport.

309.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

309.02.02 CARE OF MATERIALS.

309.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage”, except as modified herein.

309.02.02.01.01 Aggregates. Sufficient storage space shall be provided for the aggregate required. The storage area shall be maintained neatly and orderly and separate aggregate stockpiles shall be readily accessible for sampling.

309.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or methods except as provided in Subsection 100.31.02.

309.02.04 AGGREGATES. Aggregates shall conform to Subsection 200.01 – “Aggregates for Base Course”.

309.03 CONSTRUCTION.**309.03.01 SUBMITTALS.**

309.03.01.01 Certificate of Compliance. The *Contractor* shall provide a certificate of compliance for each aggregate source in accordance with Subsection 100.31.01 – “Certificate of Compliance”, except as modified herein.

309.03.01.02 Additional Information. Unless waived by the *Engineer*, the certificate shall also include the following information:

- A. Results of all tests required by the specifications;
- B. *Accredited Laboratory* name and website address of accreditation program; and
- C. Personnel name(s) and website address of qualification program.

309.03.01.03 Haul Route. Unless waived by the *Engineer*, the *Contractor* shall submit to the *Engineer* a document designating the route to be used for transporting of materials. The *Contractor* shall ensure that the document has been reviewed and accepted by the *Engineer* prior to proceeding with the related *Construction Activity*.

309.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

309.03.02.01 Initial Cementitious Content. Immediate control of the cementitious content shall be accomplished by testing the fresh, moist *CTB* in accordance with Nev. T239.

309.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

309.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

309.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”.

309.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”, except as modified herein.

309.03.06.01 Roadmixng Machine. The roadmixing machine shall be of the pugmill or auger type. The machine shall be designed to pick up the material to be mixed from the windrow or blanket, so that during at least 50 percent of the mixing cycle all the material is picked up and mixed while separated from the mixing table.

309.03.07 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

309.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”.

309.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303- “Excavating”.

309.03.10 PLACING OF MATERIALS. The *Contractor* may elect to the *CTB* on the roadbed or at a location off the roadbed by the roadmix method or the plantmix method

309.03.10.01 Roadmix Method.

Untreated aggregate shall be deposited on the prepared area by means of spreader boxes equipped with a readily adjustable strike-off device resulting in a uniform windrow or a uniform spread. Aggregate to be treated shall not be mixed with roadbed material that is not to be treated.

If the *Contractor* elects to use the roadmix method, all the requirements in Subsection 309.03.10.02 – “Mixing - Plantmix Method” – will apply, except the following:

The 0.4 of a percentage point variation in the cement content as provided in Subsection 309.03.10.02 – “Plantmix Method” – will be increased to 0.6 of a percentage point as specified in this Subsection.

If the *Contractor* elects to use the roadmix method, the roadmixing machine shall be of the pugmill or auger type, or other type meeting the approval of the *Engineer*. The machine shall be designed to pick up the material to be mixed from the windrow or blanket, so that during at least 50 percent of the mixing cycle all the material is picked up and mixed while separated from the mixing table.

Cement to be mixed with aggregate may be furnished in sacks or in bulk. If sacked cement is used, the sacks shall be distributed on the aggregate at the required intervals and then be emptied by hand methods, following which the cement from each sack shall be distributed in a layer of uniform thickness. If the cement is furnished in bulk, it shall be spread by mechanical equipment. Each load in the spreading equipment shall be calibrated so the average rate of spread can be determined by the *Engineer*. The rate of cement spread per lineal foot of windrow or blanket shall not vary more than 10 percent from the designated rate. The tops of windrowed aggregate shall be flattened or slightly trenched to receive the cement. The distance which cement may be spread upon the aggregate ahead of the roadmixing operations will be determined by the *Engineer*.

The roadmixing machine shall have provisions for introducing water at the time of mixing, through a metering device or by other approved methods. The water shall be applied by means of controls that will supply the correct quantity of water to produce a completed mixture with a uniform moisture content. Leakage of water from equipment will not be permitted. Care shall be exercised to avoid the addition of any excessive water. The quantity of water added to the mixture will be determined by the *Engineer*.

Where the material is to be spread and compacted in two or more layers, material for each layer shall be mixed separately.

The resulting mixture shall be uniform and more than one pass of the mixer through the material may be required. If equipment is used that requires more than one pass of the mixer, at least one pass shall be made before any water is added to the material.

At the time mixing is completed, the moisture content of the mixture shall not be in excess of 3 percent over optimum as determined by Nev. T-236.

The cement content of samples taken from time to time from the product of the roadmixing machine, or from mixtures spread on the roadbed, shall not have a variation above or below the cement content designated by the *Engineer* or more than 0.6 of a percentage point based on the weight of the aggregate as determined by Nev. T239.

The lengths of treated sections shall be regulated to permit completion within the time requirements provided in Subsection 309.03.10.06 – “Time Requirements.”

Should the *Contractor* elect to perform roadmixing operations off the roadbed, the provisions specified in this Subsection for mixing on the roadbed shall apply.

309.03.10.02 Plantmix Method.

CTB shall be mixed at a central mixing plant by either batch mixing using revolving blade or rotary drum mixers or continuous mixing at the option of the *Contractor*. The aggregate and cement may be proportioned either by weight or volume.

In all plants, the water shall be proportioned by weight or volume and there shall be means by which the *Engineer* may readily verify the amount of water per batch or the rate of flow for continuous mixing. The time of the addition of water, or the points at which it is introduced into the mixer, shall be determined by the *Engineer*. The quantity of water added to the mixture will be determined by the *Engineer*.

At the time mixing is completed, the moisture content of the mixture shall not exceed optimum as determined by Nev. T236.

In all plants, cement shall be added in such a manner that is uniformly distributed throughout the aggregates during the mixing operation.

The charge in a batch mixer, or the rate of feed to a continuous mixture, shall not exceed that which will permit complete mixing of all of the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by either a reduction in the volume of material or by other adjustment.

In all plants, the proportioning of materials designated by the *Engineer* shall be within the following tolerances:

| | |
|--|--------------|
| Aggregate weights or rate of feed | ±5.0 percent |
| Cement content of the completely dry mixture | ±0.4 percent |
| Moisture content of the completed mixture | ±1.0 percent |

In batch-type mixers, the mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall be accurate to within 2 seconds. The plant shall be equipped with a suitable automatic device for counting the number of batches.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

Cement for each batch shall be weighed on scales separate and distinct from the aggregate batching scales.

If volumetric proportioning is used, means shall be provided for accurately calibrating the amount of material in each measuring bin.

If the continuous-type mixture is used, the correct proportion of each aggregate size introduced into the mixer shall be drawn from the storage facility by an approved type of feeder, which will continuously supply the correct amount of aggregate in proportion to the cement, and so arranged that the proportion of each aggregate size can be separately adjusted. The plant shall be equipped with metering devices of an approved type that will introduce the cement and water into the mixer in specified proportions. The metering devices and feeder shall be interlocked and so synchronized as to maintain a constant rate of cement and water to the aggregate. When storage bins are used, they shall be equipped with overflow chutes for each compartment. A positive signal system shall be provided that will automatically close down the plant when the level of material in any bin approaches the strike-off capacity of the feed gate. The plant shall not be permitted to operate unless the signal system is in good working condition. The feeder for the aggregate shall be mechanically or electrically driven. Aggregate feeders that are mechanically driven or electrically driven shall be directly connected with the drive on the cement feeder. The plant shall be equipped with facilities satisfactory to the Engineer for calibrating gate openings and metering devices by weighing check samples. Aggregated feeders that are electrically driven shall be actuated from the same circuit that serves the motor driving the cement feeder.

Mixing shall continue until a homogenous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

The cement feeder shall be equipped with a device by which the rate of cement feed can be determined while the plant is in full operation.

The drive shaft of the cement feeder shall be equipped with a revolution counter reading to 1/100 of a revolution, and of sufficient capacity to register the total number of revolutions in a day's run.

309.03.10.03 Spreading.

The area to be covered with cement treated base shall be prepared and compacted to the grade and cross section for the bottom surface of the cement treated base. Any material cut away in trimming for such grade and cross section shall be disposed of in a manner satisfactory to the *Engineer*.

Materials mixed at a location off the roadbed shall be protected against moisture loss while being transported to the spreading site, with a method approved by the *Engineer*, and shall be spread without segregation. Immediately prior to spreading, the area to be covered shall be moistened and kept moist, but not excessively wet.

Where the required thickness is 6 inches or less, the mixture may be spread and compacted in one layer. Where the required thickness is more than 6 inches, the mixture shall be spread and compacted in two or more layers of approximately equal thickness and the maximum compacted thickness of any one layer shall not exceed 6 inches. Work on each layer shall be performed in a similar manner, and the surface of the compacted material shall be kept moist or prevented from drying by some method approved by the *Engineer* until covered with the next layer.

CTB to be placed in inaccessible areas may be spread by approved methods in one course. After spreading, the material shall be thoroughly compacted to the required lines, grades, and cross section by means of pneumatic tampers or with other compacting equipment which consistently obtains equal or better compaction than that provided in Subsection 309.03.10.05 – “Compaction.”

The mixture produced by plantmixing shall be deposited on the roadbed at a uniform quantity per lineal foot, which quantity will provide the required compacted thickness without resorting to spotting, picking up, or otherwise shifting the mixture.

The mixture shall be spread in one operation with a self-propelled mechanical spreader ready for compaction without further shaping. Segregation shall be avoided and the base shall be free from pockets of coarse or fine material. Equipment not propelled by the unloading vehicle will be considered self-propelled. The spreader shall be provided with a screed that strikes off and distributes the material to the required cross section. Screed action includes any cutting, oscillating or other practical motion that produces a finished surface texture of uniform appearance. If the spreader leaves ridges, indentations, or other objectionable marks in the surface that cannot be eliminated by rolling, or prevented by adjustments in operation, its use shall be discontinued.

Except as otherwise provided in this Subsection, the use of motor graders will not be permitted during spreading and compacting operations, except that motor graders may be used to trim the edges and

surface of the cement treated base after compaction in order to finish the base within the tolerances specified.

A motor grader will be considered to be a self-propelled mechanical spreader if it has been equipped with end wings on the blade, and with cross slope and automatic grade controls.

The mixed materials shall be spread for the full planned width, either by one spreader or by several spreaders operating in a staggered position across the subgrade, unless otherwise permitted by the *Engineer* or if traffic conditions require part width construction. Should permission be granted or part width construction be required for the use of one spreader operating alternately on contiguous lanes, not more than any 1 hour shall elapse between the time of placing material in adjacent lanes at any location. If longitudinal construction joints are necessary, they shall fall on lane lines.

309.03.10.04 Compaction. The provisions contained in this Subsection apply to both plantmix and roadmix methods.

Compacting equipment shall produce the required compaction within the operation time limit specified in Subsection 309.03.10.06 – “Time Requirements.”

Initial rolling of *CTB* shall be performed with steel-tired rollers.

Rolling shall be performed in such a manner that bumps and irregularities will be eliminated and finished surface shall be true to the required grade and cross section within the surface tolerances specified in Subsection 309.03.10.05 – “Finished Surface Tolerances.”

Water shall be applied without driving equipment over the uncompacted material.

Rolling shall commence by completely covering the outer edge of the material. Subsequent rolling shall lap at least 25 percent of previously compacted material.

Pneumatic-tired rollers shall be used following completion of initial rolling.

Areas inaccessible to rollers shall be compacted to the required compaction by other means.

The density of compacted *CTB* shall not be less than 95 percent of the maximum density as determined by test procedures set forth by ASTM D558. Test procedures set forth in ASTM D1556, ASTM D2922, Method B, or ASTM D3017 may be used to determine the in-place density.

309.03.10.05 Finished Surface Tolerances. The finished surface of *CTB* shall be uniform and shall not deviate at any point more than 0.05 foot from the bottom of a 12 foot straightedge laid in any direction.

The surface of the finished *CTB* at any point shall not vary more than 0.05 foot above or below the grade established by the *Engineer*, except that when Portland Cement Concrete pavement is to be placed on cement treated base, the surface of the finished cement treated base at any point shall not extend above the grade established by the *Engineer*.

When the finished surface of *CTB* is outside the specified tolerances, and before placing any course of material thereon, all high spots on the finished surface shall be trimmed off to within the specified tolerance. The excess material shall be removed and disposed of in a manner approved by the *Engineer* immediately after trimming and no loose material shall be left on the base and the area shall then be rolled again. Full compensation for trimming high spots and disposing of the trimmed material shall be considered as included in the prices paid for the contract items involved in constructing the cement treated base and no additional compensation will be allowed therefor.

Cleated equipment shall not be allowed on new *CTB* unless street pads are used on cleats.

309.03.10.06 Time Requirements. Any mixture of aggregate, cement, and water that has not been compacted shall not be left undisturbed for more than 30 minutes. Not more than 2 hours shall elapse between the time water is added to the aggregate and cement and the time of completion of initial rolling. Not more than 3 hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final compaction after trimming.

309.03.10.07 Construction Joints. At the end of each day's work and when cement treated base operations are delayed or stopped for more than 2 hours, a construction joint shall be made in thoroughly compacted material, normal to the centerline of the roadbed with a vertical face. Additional mixture shall not be placed until the construction joint has been approved by the *Engineer*.

Where cement treated base has cured for at least 1 hour, longitudinal joints shall be constructed. Longitudinal joints shall be constructed by cutting vertical lines into the existing edge for a depth of approximately 3 inches. The material cut away may be disposed of in the adjacent lane to be constructed. The face of the cut joints shall be moistened in advance of placing the adjacent base section.

309.03.10.08 Protection and Curing. The surface shall be kept moist at all times until the curing seal is applied. Water equipment shall be of a type which will apply moisture in a fog or mist type application free of pressure at the surface being treated.

The completed *CTB* shall be covered with a bituminous curing seal as protection against drying. Curing seal will be required only for the top layer of *CTB*. The curing seal shall be applied as soon as possible, but not later than 24 hours after the completion of final rolling. The surface shall be kept moist until the seal is applied. Curing seal shall be Asphalt Emulsion Type SS-1, unless otherwise specified, and shall be applied at a rate of between 0.15 gallon and 0.25 gallon per square yard of surface. The exact amount is to be determined by the *Engineer*. The curing seal shall be applied in accordance with the requirements of Section 340 – “HMA Pavement Preservation” – and in sufficient quantity to provide a continuous membrane over the base. At the time of application of the curing seal, the surface shall be tightly knit, free from all loose material, and shall contain sufficient moisture to prevent excessive penetration of the asphalt. If necessary to insure sufficient moisture content, sufficient water to fill the surface voids shall be applied immediately before the asphalt is applied.

Equipment or traffic shall not be permitted on the *CTB* during the first 3 days after applying the curing seal, unless otherwise permitted by the *Engineer*. After traffic is allowed on the *CTB*, and there is danger of excessive surface abrasion, sand blotter may be required as determined by the *Engineer*.

When equipment or traffic is permitted on the *CTB* and such permission is granted for the sole convenience of the *Contractor*, the curing seal shall be protected at no additional cost to the *Agency/Owner*.

All loose sand shall be completely removed from the *CTB* before any surfacing material is placed thereon. Full compensation for furnishing, spreading, and removing sand, as specified above, shall be considered as included in the contract price paid for sand blotter and no additional allowance will be made therefor.

309.03.11 WEATHER LIMITATIONS. *CTB* shall not be placed on a grade which is frozen or which has a moisture content which would be detrimental to the compaction or quality of the *CTB*. *CTB* shall not be mixed or placed while the atmospheric temperature is below 35 degrees Fahrenheit, or when conditions indicate that the temperature will fall below 35 °F for a sustained period of 4 hours. *CTB* shall be protected from freezing and frost for a period of 5 days after placing

309.03.12 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

309.03.13 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”, except as modified herein.

309.04 ACCEPTANCE. *CTB* shall be accepted based on the surface tolerance, density and thickness.

309.04.01 FINISHED SURFACE TOLERANCES. The finished surface of *CTB* shall be uniform and shall not deviate at any point more than 0.05 foot from the bottom of a 12 foot straightedge laid in any direction.

The surface of the finished *CTB* at any point shall not vary more than 0.05 foot above or below the grade established by the *Engineer*, except that when *PCCP* is to be placed on *CTB*, the surface of the finished cement treated base at any point shall not extend above the grade established by the *Engineer*.

When the finished surface of *CTB* is outside the specified tolerances, and before placing any course of material thereon, all high spots on the finished surface shall be trimmed off to within the specified tolerance. The excess material shall be removed and disposed of in a manner approved by the *Engineer* immediately after trimming and no loose material shall be left on the base and the area shall then be rolled again. Full compensation for trimming high spots and disposing of the trimmed material shall be considered as included in the prices paid for the contract items involved in constructing the cement treated base and no additional compensation will be allowed therefor.

Cleated equipment shall not be allowed on new *CTB* unless street pads are used on cleats.

311.01 GENERAL.

311.01.01 DESCRIPTION. This Section covers the design, production, preparation for placement, and placement of *PCC*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

311.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

311.01.01.01.02 Terms.

Production. Production shall be defined as furnishing, proportioning, combining and mixing all materials in accordance with approved *PCC* mix design(s).

Ready-mix. Ready-mix shall be defined as *PCC* that is manufactured in a fixed location batch plant and transported to the Site of Work.

Placement. Placement shall be defined as transferring, consolidating, finishing to a specified line and grade, and curing of the *PCC*.

311.01.02 DESIGN. This Subsection does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the *PCC* improvement. The *Engineer* shall show specific design requirements on the *Plans* or specify these requirements in the *Special Provisions* and/or *Special Technical Specifications*.

311.01.02.01 PCC.

311.01.02.01.01 Composition of Mixtures. A mix design shall be submitted to the *Engineer* in accordance with Subsection 337.01 - “Mix Design”. The compressive strength at 28 Days, slump, target air content, aggregate gradation and type of cementitious material shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

311.01.02.02 Forms. Forms shall be of suitable material and of a type, size, shape, quality, and strength to ensure construction as designed and, unless otherwise directed or approved by the Agency, shall conform to ACI 347 – “Recommended Practice for Concrete Forming.”

311.01.03 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”.

311.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to transport.

311.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

311.02.02 CARE OF MATERIALS.

311.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage.” except as modified herein.

311.02.02.01.01 Aggregates. Sufficient storage space shall be provided for the aggregate required. The storage yard shall be maintained neatly and orderly and separate aggregate stockpiles shall be readily accessible for sampling.

Aggregates shall be stored at SSD or above moisture condition.

311.02.02.01.01.01 Process Control Plan. A written process control plan shall be required from any aggregate supplier. This written plan shall be provided to the *Engineer* upon request. The *Agency* and/or *Engineer* shall have the option to inspect aggregate processing facilities and/or request representative samples of processed aggregate for properties verification.

311.02.02.01.01.02 Process Control Testing. A summary of the results of all process control test data shall be included with the process control plan.

311.02.02.01.02 Cementitious Materials. Cementitious materials shall be stored in a sealed, waterproof environment to prevent wind damage and moisture intrusion. Unless otherwise directed or approved by the *Engineer*, cementitious materials used in *PCC* shall not have been stored for more than 750 *Calendar Days* after date of manufacture.

311.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or methods except as provided in Subsection 100.31.02 – “Use of Other Materials”.

311.02.04 READY-MIX PCC. Ready-mix *PCC* shall conform to ASTM C94.

311.02.05 AGGREGATES. Aggregates shall conform to Section 200 – “Aggregates”.

311.02.06 CEMENTITIOUS MATERIALS. Cementitious materials shall conform to Subsection 202.02 – “Cementitious Materials”.

311.02.07 ADMIXTURES. Admixtures shall conform to Subsection 202.03.01 – “Admixtures”.

311.02.08 FIBERS. Fibers shall conform to Subsection 202.03.02 – “Fibers”.

311.02.09 CURING MATERIALS. Curing materials shall conform to Subsection 202.03.05 – “Curing Materials”.

311.02.10 WATER. Water shall conform to Section 205 – “Water”.

311.02.11 REINFORCING STEEL. Reinforcing steel shall conform to Section 206 – “Reinforcing Steel”.

311.02.12 FORMS. Forms shall be of suitable material and of a type, size, shape, quality, and strength to ensure construction as designed and, unless otherwise directed or approved by the *Agency*, shall conform to ACI 347 – “Recommended Practice for Concrete Forming.”

311.03 CONSTRUCTION.

311.03.01 SUBMITTALS.

311.03.01.01 Certificate of Compliance. The *Contractor* shall provide a certificate of compliance for each material in accordance with Subsection 100.31.01 – “Certificate of Compliance”.

311.03.01.02 PCC. The *Contractor* shall submit, in writing, the *PCC* mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the *PCC*.

311.03.01.02.01 Quality Control Program. Unless otherwise directed or approved by the *Engineer*, a written Quality Control Program shall be required for ready-mix production. This written plan shall be provided to the *Engineer* upon request. The *Agency* and/or *Engineer* shall have the option to inspect production facilities and/or request representative samples of mixture components or produced *PCC* for properties verification.

The overall plan shall address the individual elements which affect the quality of the *PCC* including, but not limited to, mix design; aggregate gradation; quality of materials; stockpile management; proportioning; mixing; and transporting.

311.03.01.03 Forms. When requested by the *Engineer*, the *Contractor* shall submit detailed plans of formwork for examination by the *Engineer*. If such plans are not satisfactory to the *Engineer*, the *Contractor* shall make such changes as may be required, but it is understood that the *Engineer's* concurrence in the use of the Plans as submitted or corrected shall in no way relieve the *Contractor* of responsibility in obtaining satisfactory results.

311.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

311.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

311.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

311.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

311.03.05.01 Aggregate Base. Aggregate Base shall be prepared in accordance with Section 308 – “Untreated Aggregate Base” or Section 309 – “Cement Treated Aggregate Base” as applicable.

311.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers; Methods and Equipment”, except as modified herein.

311.03.06.01 Batch Plant and Delivery Fleet. Unless otherwise directed or approved by the *Engineer* plants used for the ready-mix production of *PCC* shall be of sufficient capacity and coordinated to adequately handle the proposed construction. The plant, including the delivery fleet, shall hold a current *NRMCA* certification.

Information regarding certification, including a complete list of the related tests, and an electronic directory of *NRMCA* certified plants are available at www.nrmca.org.

The plant shall include satisfactory equipment or use other methods which will meet local conditions, city, county, state, and federal laws pertinent to air pollution.

311.03.07 CONSTRUCTION LOADS. The *Contractor's* operations shall not produce a surcharge which would impact stability of adjacent improvements.

311.03.08 SUBGRADE PREPARATION. *Subgrade* preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”, except as modified herein.

311.03.08.01 Ground Water. Ground water shall be kept below *Subgrade* until the concrete has set.

311.03.08.02 Moisture Conditioning. Prior to *PCC* placement, the *Subgrade* shall be thoroughly damped with water. Standing water shall not be permitted.

311.03.08.03 Bedrock. When *PCC* is to be placed on *Bedrock*, the surface shall be removed to a depth sufficient to expose the solid material. *Bedrock* shall be roughly leveled off or cut to approximately horizontal and vertical steps. Loose or deleterious material shall be removed from the prepared *Bedrock* surface. Seams in the *Bedrock* shall be grouted under pressure or otherwise treated as directed or approved by the *Engineer*.

311.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303 - “Excavating”. The *Contractor* shall dispose unsuitable material, surplus material and/or materials not designated for reuse in accordance with Subsection 100.31.04 – “Material Disposal”.

311.03.10 PLACING OF MATERIALS.

311.03.10.01 Forms. The *Contractor* shall ensure that the surface has been accepted by the *Engineer* prior to placing forms for *PCC*. Unless otherwise directed or approved by the *Engineer* forms shall be constructed in accordance with ACI 347 – “Recommended Practice for Concrete Forming.”

311.03.10.01.01 PCC Placed Without Forms.

311.03.10.01.01.01 PCC Placed Against Excavation Surfaces. When *PCC* is placed directly against the faces of the excavation, the faces must be firm, compact, able to stand without sloughing, and must be outside the concrete lines shown on the *Plans* at all points. The entire faces of excavation, against which concrete is to be placed without the use of outside forms, shall be gunited to sufficient thickness to prevent raveling of the exposed earth faces during the placing of reinforcing steel, forms, and concrete.

311.03.10.01.01.02 PCC Placed Against Sheeting. When *PCC* is placed against sheeting, such sheeting shall be closely fitted on all points outside the concrete lines shown on the *Plans*. Those surfaces against which the *PCC* is to be placed shall be faced with building paper. Except as otherwise specified herein, all sheeting shall be removed, but not until at least 7 *Days* after placing concrete, or until the concrete has attained a strength in compression of 2,000 *PSI*.

Care shall be used in removing sheeting so as to avoid damaging the concrete. When field conditions or the type of sheeting or methods of construction used by the *Contractor* are such that the removal of sheeting is impracticable, that portion of the sheeting against which *PCC* has been placed may be left in place.

311.03.10.02 PCC Temperature. The temperature of the *PCC* at delivery shall not exceed 90°*F*.

311.03.11 WEATHER LIMITATIONS.

311.03.11.01 Surface Moisture. *PCC* shall not be placed on a grade which is frozen or which has a moisture content which would be detrimental to the quality of the *PCC*.

311.03.11.02 Temperature.

311.03.11.02.01 Cold Weather. *PCC* shall not be mixed or placed while the ambient temperature is below 35°*F*, or when conditions indicate that the temperature may fall to 35°*F* within 24 hours of placement unless adequate means are employed to heat the aggregates and water, and satisfactory provisions have been made for protecting the work. Placement of concrete in cold weather conditions shall be performed in accordance with Paragraph 12.3.1 of ACI 301, and the recommendations of ACI 306.

311.03.11.02.01.01 Protection. *PCC* shall be protected from freezing or frost for a period of 5 *Calendar Days* after placing.

311.03.11.02.02 Hot Weather. *PCC* shall not be mixed or placed while the ambient temperature is above 115°*F* unless adequate means are employed to cool the aggregate and water and satisfactory provisions have been made for protecting the work. Placement of concrete in hot weather conditions shall be performed in accordance Paragraph 12.3.2 of ACI 301, and the recommendations of ACI 305.

311.03.11.02.02.01 Evaporation. When the evaporation rate at the fresh *PCC* surface exceeds 0.15 pounds per square foot per hour, mitigation measures shall be implemented in accordance with ACI 305. If plastic shrinkage cracking is observed after mitigation measures have been utilized, *PCC* placement shall be suspended until resumption is approved by the *Engineer*.

311.03.11.02.03 Precipitation. *PCC* placement shall be stopped when precipitation is sufficient to cause damage to the work.

311.03.12 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

311.03.13 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up” except as modified herein.

311.03.13.01 Protection. Protect concrete from direct rays of sun or drying effect of wind.

311.03.13.01.01 Cold Weather Concreting. Placement of concrete in cold weather conditions shall be performed in accordance with Paragraph 12.3.1 of ACI 301, and the recommendations of ACI 306.

311.03.13.01.02 Hot Weather Concreting. Placement of concrete in hot weather conditions shall be performed in accordance Paragraph 12.3.2 of ACI 301, and the recommendations of ACI 305.

311.04 ACCEPTANCE. *PCC* shall be accepted based on the following criteria:

- A. Compressive strength;
- B. Air Content;
- C. Unit Weight;
- D. Surface tolerance; and
- E. Documentation of placement, finishing, curing and protection in accordance with Subsections 318.03.10 – “Placing of Materials” and 318.03.11 – “Weather Limitations”.

Any *PCC* which is defective or damaged shall be repaired or replaced by the *Contractor* with no additional compensation.

312.01 GENERAL.

312.01.01 DESCRIPTION. This Section covers the design, production, preparation for placement, and placement of *PCC*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. *PCC* flatwork, curbs, ditches and slope paving shall conform to the applicable Subsections of Section 311 – “*PCC*”, except as modified herein.

312.01.02 DESIGN.

312.01.02.01 Thickness. Unless otherwise shown on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, the minimum *PCC* thickness for sidewalks shall be 4 inches. Where sidewalk is to be constructed across driveways the *PCC* thickness shall be a minimum of 6 inches.

312.02 MATERIALS.**312.03 CONSTRUCTION.**

312.03.01 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

312.03.01.01 Slope Paving. Prior to placing the slope paving, the Engineer may require the Contractor to construct sufficient test panels to assure the Engineer that the proper color has been obtained. The final panel shall be at least 4 x 6 feet in size. The panels shall be constructed at the construction site and shall be placed by the method to be used in placing slope pavement.

312.03.02 PLACING OF MATERIALS.

312.03.02.01 Drainage Outlets. The *Contractor* shall provide suitable outlets through new curb and/or sidewalks for any existing building drains conflicting with new construction. The *Contractor* shall place similar outlets opposite any low area on adjacent property such that the drainage of the adjacent property will not be affected by the new work.

The full depressed curb opening at driveway entrances shall be a minimum of 1 inch above gutter flow line at the curb face. The top of the fully depressed portion of the curb shall be finished to a transverse 1/2 inch drop toward the gutter.

312.03.02.02 Finishing. Finishing of the *PCC* shall be performed in accordance in with the PCA's Concrete Finisher's Guide. No water shall be added during finishing. Steel finishing tools, with the exception of edging tools, shall not be used. **All air entrained PCC for exterior improvements placed January 1, 2018 and after shall be by, or under the direct supervision of a Superintendent who is certified by the ACI as a Concrete Flatwork Finisher.**

Information regarding certification including a complete list of the related tests, and an electronic registry of ACI Concrete Flatwork Finishers is available at www.concrete.org.

312.03.02.02.01 Face and Top of Curb. The front forms may be stripped as soon as the concrete has set sufficiently.

The face and top of the curb shall then be carefully finished to a smooth and even finish, the top with a transverse slope of 1/4 inch toward the gutter, and both edges rounded to a radius of 3/4 inch. The surface shall be finished as prescribed.

312.03.02.02.02 Sidewalk Surface. When a 10 foot straightedge is placed on the sidewalk, the surface shall not vary more than 1/8 inch from the edge of the straightedge, except at grade changes.

312.03.02.02.03 Edging and Jointing. Edging and jointing should not be done until all bleed water and excess moisture have left or have been removed from the surface.

312.03.02.02.03.01 **Isolation Joints.** Unless otherwise shown on the *Plans* and/or specified in the *Special Provisions* and/or *Special Technical Specifications*, isolation joints shall be constructed in curbs, sidewalks, and gutters. Such joints shall be filled with premolded joint filler, conforming to the requirements of Subsection 202.02.03 – “Expansion Joint Materials”.

312.03.02.02.03.01.01 **Placement.** The joint filler shall be placed with the top edge 1/4 inch below the surface and shall be held in place by means of steel pins driven into the base course and spaced sufficiently close to prevent warping of the filler during floating. Upon completion of floating, the pins shall be removed and, when finishing operations have been completed, the joint shall be edged with an edging tool with a radius of 1/2 inch.

312.03.02.02.03.01.01.01 **Curb and Gutter Joints.** Isolation joints 1/2 inch wide shall be located in curbs and gutters at each side of structures, and at the ends of all curb returns, and abutting hardened in-place curbs and gutters, except that isolation joints shall not be installed within 20 feet of an island nose. Isolation joints shall be 1/2 inch thick, shaped to the cross section of the curbs and gutters, and shall be constructed at right angles to the curbs and gutters.

312.03.02.02.03.01.01.02 **Sidewalk Isolation Joints.** Transverse isolation joints 1/2 inch wide shall be constructed at all sidewalk returns, opposite isolation joints in adjacent curbs, and as shown on *Plans*. Isolation joints shall be installed around all structures. Isolation joints shall be filled with joint filler strips 1/2 inch thick.

312.03.02.02.03.02 **Weakened Plane Joints.** Weakened plane joints shall be straight. Headers shall be marked to locate the weakened plane for final joint finishing, which shall be accomplished with a jointer tool having a depth of 1/2 inch and a radius of 1/4 to 1/2 inch. The finished joint opening shall not be wider than 1/8 inch.

312.03.02.02.03.02.01 **Sidewalks.** Weakened plane joints shall be located at regular intervals not exceeding 1.2 times the width and no more frequently than 0.8 times the width, but in no case shall regular intervals of weakened plane joints in either direction exceed 10 feet.

312.03.02.02.03.03 **Texturing.** After edging and jointing operations, the surface shall be slightly roughened by brooming, with the exception of the flow line of the gutter which should be left smooth.

312.03.02.03 **Curing.** Unless otherwise directed or approved by the *Engineer*, curing compound conforming to the requirements of Subsection 202.03.05.04.02 shall be used. The curing compound shall be uniformly applied to all fresh PCC surfaces in accordance with the manufacturer's recommendations. The curing compound shall be applied immediately after completion of final finish or texturing.

312.03.03 **PROTECTION OF WORK AND CLEANING UP.** Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”

No equipment causing jarring of the concrete shall be permitted adjacent to concrete curbs, gutters, or alley intersections until the fourth day following placement of concrete. The placement of bituminous pavement adjacent to concrete curbs, gutters, or alley intersections shall not be permitted until the seventh day following the placement of concrete, nor shall concrete paving operations be permitted until the seventh day where placing or finishing equipment will ride on the previously placed concrete.

313.01 GENERAL.

313.01.01 DESCRIPTION. This Section covers the design, production, preparation for placement, and placement of specialized *PCC*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. Specialized *PCC* shall conform to the applicable Subsections of Section 311 – “*PCC*”, except as modified herein.

313.02 PERVERIOUS CONCRETE.

313.02.01 DESCRIPTION. This Section covers the design, production, preparation for placement, and placement of Portland cement pervious concrete pavement for streets, parking and pedestrian areas.

313.02.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

313.02.01.01.02 Terms.

Pervious Concrete. Concrete paving containing little or no fine aggregate, creating an open matrix that allows water to pass through it.

Raveling. Contiguous dislodging of the surface layer of aggregate.

313.02.02 MATERIALS.

313.02.02.01 Aggregates. Aggregates shall conform to Section 200 – “Aggregates”, except as modified herein.

Aggregate shall have a minimum specific gravity of 2.60, a minimum rodded void content of 36 percent in accordance with ASTM C29, and a maximum absorption rate of 3 percent. The aggregate size shall not exceed 1/2 inch nominal.

313.02.02.02 Reinforcing Steel. Reinforcing steel shall not be utilized.

313.02.02.03 Subgrade. Subgrade shall have a minimum permeability of 0.5 inch per hour determined in accordance with ASTM D3385. The top 6 inches shall be composed of granular or gravelly soil that is predominantly sandy with no more than a moderate amount of silt or clay that will have no adverse effect on the subgrade permeability.

313.02.02.04 Filter Fabric. The filter fabric shall conform to ASTM D6767.

313.02.03 CONSTRUCTION.

The pervious paving *Contractor/Subcontractor* shall be certified by *NRMCA* in pervious concrete paving and the work shall be performed and/or directly supervised by the certified individual(s).

Information regarding certification, including a complete list of the related tests, and an electronic directory of *NRMCA* certified pervious concrete paving contractors are available at www.nrmca.org.

313.02.03.01 Scheduling of Work.

313.02.03.01.01 Pre-Activity Meeting. Before commencement of pile construction, a pre-activity meeting shall be scheduled by the *Engineer* a time and place satisfactory to the *Contractor*. At a minimum, the pre-activity meeting shall be attended by the *Contractor*, pervious paving *Subcontractor*’s *Superintendent* and *NRMCA* Certified Craftsman or Installer and the *Engineer*. Pile construction shall not be commenced until all action items resulting from the pre-activity meeting have been satisfactorily addressed.

313.02.03.02 Placing of Materials.

Internal vibration of the mixture is prohibited.

PCC shall not be pumped.

Water addition is permitted at mixing drum to maintain wet metallic sheen.

313.02.03.02.01 Edging and Jointing.

313.02.03.02.01.01 Transverse Construction Joints. Transverse construction joints shall be installed whenever placing is suspended for 20 minutes or whenever concrete is no longer workable.

313.02.03.02.01.02 Dowels. Do not dowel longitudinal joints between successive placements.

313.02.03.02.01.03 Isolation Joints: Isolation joints shall be used when abutting fixed structures. Place isolation material before concrete is placed and to the depth of the pavement section.

313.02.03.02.01.04 Control Joints. Control (contraction) joints shall be installed at regular intervals not to exceed 20 feet, or two times the width of the placement. The control joints shall be installed at 1/4 to 1/3 the depth of the thickness of the pavement.

Saw cutting after the *PCC* has hardened will not be permitted due to potential joint raveling.

313.02.03.03 Weather Limitations.**313.02.03.03.01 Temperature.**

313.02.03.03.01.01 Cold Weather. Unless otherwise directed or approved by the *Engineer*, *PCC* shall not be mixed or placed while the ambient temperature is below 45°*F*, or when conditions indicate that the temperature may fall to 32°*F* within 48 hours of placement.

313.02.03.03.01.02 Hot Weather. *PCC* shall not be mixed or placed while the ambient temperature is above 95°*F*.

313.03 RCC. This Section covers the design, production, preparation for placement, and placement of *RCC*.

313.03.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

313.03.01.01.02 Terms.

Production. Production shall be defined as furnishing, proportioning, combining and mixing all materials in accordance with approved *RCC* mix design(s).

Pugmill Plant. Pugmill Plant shall be defined as a horizontal twin shaft mixing plant capable of producing a homogeneous *RCC* mixture in the proportions defined in the approved mixture design and conforming to the tolerances specified in *ASTM C94* for batch mixing plants or *ASTM C685* for continuous mixing plants.

Placement. Placement shall be defined as transferring, consolidating, finishing to a specified line and grade, and curing of the *RCC*.

High-Density Paver. High-Density Paver shall be defined as an asphalt type paver equipped with 2 or more compacting devices including tamping bars or pressure bars subject to approval by the *Engineer*.

313.04 CONSTRUCTION.

313.04.01.01 Construction Equipment. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers; Methods and Equipment”, except as modified herein.

313.04.01.01.01 Mixing Plant. The *Contractor* shall obtain the *Engineer*’s approval of the mixing plant before starting *RCC* production.

313.04.01.01.01.01 Location of Plant. The mixing plant shall be located within a 30 minute haul time from the *RCC* placement. With prior testing and *Engineer*’s approval, a set retarding admixture may be used to extend the haul time.

313.04.01.01.01.02 Plant Capacity. The plant shall be capable of producing an *RCC* mixture in the proportions defined by the final approved mix design and within the specified tolerances. The

capacity of the plant shall be sufficient to produce a uniform mixture at a rate compatible with the placement equipment. The minimum homogeneous production rate of any acceptable plant shall be 300 tons per hour. For batch mixers, the volume of *RCC* material in the mixing chamber shall not be more than the rated capacity for dry concrete mixtures. Multiple plants shall not be used to supply *RCC* material to the paver. The *Engineer* can halt operations if the plant is unable to produce the *RCC* mixture sufficiently in quality or quantity, until a plant meeting all requirements is obtained.

313.04.01.01.01.03 **Pugmill Plant.** A pugmill plant is required and shall match that listed during the prequalification process unless a substitute is made which meets these specifications and is approved by the *Engineer*. It shall be a central plant with a twin shaft pugmill mixer, capable of batch or continuous mixing, equipped with synchronized metering devices and feeders to maintain the correct proportions of aggregate, cement, cementitious material, and water. Other pugmill plant requirements are as follows:

313.04.01.01.01.03.01 **Aggregate Storage.** The aggregate and sand must be furnished in 2 or more stockpiles. If previously blended aggregate is furnished, storage may be in a stockpile from which it is fed directly to a conveyor feeding the mixer. If aggregate is furnished in two or more size groups, aggregate separation must be provided at the stockpiles.

313.04.01.01.01.03.02 **Aggregate Bin.** Aggregate bins shall have a feed rate controlled by a variable speed belt, or an operable gate calibrated to accurately deliver any specified quantity of material. If two or more aggregate size stockpile sources are used, the feed rate from each bin shall be readily adjustable to change aggregate proportions, when required. Feed rate controls must maintain the established proportions of aggregate from each stockpile bin when the combined aggregate delivery is increased or decreased.

313.04.01.01.01.03.03 **Plant Scales.** Plant scales for any weigh box or hopper shall be either of beam or springless-dial type, and be sensitive to 0.5 percent of the maximum load required. Beam-type scales shall have a separate beam for each aggregate size, with a single telltale actuated for each beam, and a tare beam for balancing hopper. Belt scales shall be of an approved design. Standard test weights accurate to plus or minus 0.1 percent shall be provided for checking plant scales.

313.04.01.01.01.03.04 **Cement and Cementitious Material Storage.** Separate and independent storage silos shall be used for Portland cement and cementitious materials. Each silo must be clearly identified to avoid confusion during silo loadings. If the *Contractor* chooses to pre-blend the cementitious material, blending equipment acceptable to the *Engineer* shall be used and the *Contractor* shall demonstrate, with a testing plane, the ability to successfully produce a uniform blended material meeting the mix design requirements. Testing of the pre-blended cementitious material shall be done on a daily basis to assure both uniformity and proper quantities.

313.04.01.01.01.03.05 **Cement and Cementitious Material Feed Unit.** Satisfactory means of dispensing Portland cement and cementitious materials, volumetrically or by weight, shall be provided to assure a uniform and accurate quantity of cementitious material enters the mixer.

313.04.01.01.01.03.06 **Water Control Unit.** The required amount of water for the approved mix shall be measured by weight or volume. The unit shall be equipped with an accurate metering device. The water flow shall be controlled by a meter, valve or other approved regulating device to maintain uniform moisture content in the mixture.

313.04.01.01.01.03.07 **Surge Hopper.** For continuous operating pugmills, a surge hopper attached to the end of the final discharge belt shall be provided to temporarily hold the *RCC* discharge to allow the plant to operate continuously. No other stockpiling shall be permitted. For batch mixers, discharge all material in the mixing chamber before recharging.

313.04.01.01.01.04 **Alternative Mixing Equipment.** Other types of batching and mixing equipment and configurations other than twin shaft pugmill mixers may not be used. This includes but is not limited to dry batch plants, central mix tilt drum plants, ready mix truck mixers, volumetric concrete trucks and trailers.

313.04.01.01.01.05 **High-Density Paver.** The paver shall be capable of placing *RCC* to a minimum of 90% of the maximum wet density in accordance with ASTM D1557 or equivalent test method. The paver shall be of suitable weight and stability to spread and finish the *RCC* material, without segregation, to the required thickness, smoothness, surface texture, cross-section, and grade.

313.04.01.01.02 Compactors. Self-propelled steel drum vibratory rollers having a maximum static weight of 10 tons shall be used for primary compaction. For final compaction either a steel drum roller having a minimum static weight of 3 tons, or a pneumatic-tire roller shall be utilized. Walk-behind or similar sized vibratory rollers or mechanical tampers shall be used for compacting areas inaccessible to the large rollers.

313.04.01.01.03 Haul Trucks. Trucks for hauling the *RCC* material from the plant to the paver shall have covers available to protect the material from rain or excessive evaporation. The number of trucks shall be sufficient to ensure adequate and continuous supply of *RCC* material to the paver.

313.04.01.01.04 Water Trucks. At least one water truck, or other similar equipment, shall be on-site and available for use throughout the paving and curing process. Such equipment shall be capable of evenly applying a fine spray of water to the surface of the *RCC* without damaging the final surface.

313.04.01.01.05 Concrete Saws. Furnish concrete saws that are capable of early entry or green sawing new *RCC* for crack control with minimum raveling and to the depth shown on the *Plans*. Equip all saws with blade guards and guides or devices to control alignment and depth. Conventional concrete saws may be used for cold joints preparation.

313.04.01.01.06 Inspection of Equipment. Before start-up, the *Contractor*'s equipment and plant shall be carefully inspected. Should any of the equipment fail to operate properly, no *Work* shall proceed until the deficiencies are corrected.

313.04.01.01.06.01 Access for Inspection and Calibration. The *Engineer* shall have access at all times to any plant, equipment or machinery to be used on this *Project* in order to check calibration, scales, controls or operating adjustments. Where adjustments appear necessary, a competent technician, or instrument repair laboratory is to carry out the necessary adjustment(s).

313.04.01.02 Placing of Materials.

313.04.01.02.01 Pavement Test Section.

313.04.01.02.01.01 Evaluation. The *Contractor* shall construct a 100-foot long test section prior to starting construction. Construct the test section using the proposed mixture design, the materials, and equipment that is listed in the paving construction plan and approved by the *Engineer*. If the pavement placement requires more than one pass of the paver, construct the test section a minimum of two paver widths wide. If the pavement placement requires more than one lift, construct the test section to the required number of lifts. Place the test section in a location approved by the *Engineer*. The *Engineer* shall evaluate the following criteria from the test section:

Adequacy of mixing plant to meet productivity requirements and produce consistent material.

- Maximum density directly behind the paver prior to roller compaction.
- Suitability of the proposed lift thickness.
- Sequence of primary/secondary roller passes (with and without vibration).
- Maximum density following the roller compaction.
- Texture and surface finish acceptability.
- Integrity of both fresh and cold joints (vertical and horizontal).
- Compressive strength of *RCC* based on molded cylinders and extracted cores tested at 7 Days.

313.04.01.02.01.02 Cold Joint Edges. The *Contractor* shall establish the maximum angle for edges to be used in joint faces of cold joints.

313.04.01.02.01.03 Incorporation. If the test area complies with the acceptance testing, it may be incorporated into the *Work*. If the test area does not meet acceptance requirements, the *Contractor* shall remove and reconstruct a new test section with corrected procedures at no additional cost to the *Agency/ Owner*.

313.04.01.02.02 Process.

313.04.01.02.02.01 General. Except for minor variations in moisture content, the same mixture proportions shall be used for the entire project. The water content shall be varied by the *Contractor*, as necessary, to provide a consistency that is most conducive to effective placement

and compaction. If during mixing there is a change in the type or source of cementitious materials, or aggregates, the mixing must be suspended, and a new mix design shall be developed.

313.04.01.02.02.02 Mixture Ingredient Tolerance. The mixing plant must receive the quantities of individual ingredients to within the following tolerances contained in Table 313.04.01.02.02-1.

Table 313.04.01.02.02-1

| Material Variation in % by Weight | |
|-----------------------------------|----------|
| Cementitious Materials | +/- 2.0% |
| Water | +/- 3.0% |
| Aggregates | +/- 4.0% |

313.04.01.02.02.03 Mixing Time. The mixing time shall assure complete and uniform mixing of all ingredients. For central mix facilities, the time of mixing shall be determined from uniformity test results. All materials must be discharged directly into the dump trucks for delivery to the paving operation.

313.04.01.02.02.04 Cleanliness. The mixing chamber and mixer blade surfaces must be kept free of hardened *RCC* or other buildups. Mixer blades shall be checked routinely for wear and replaced if wear is sufficient to cause inadequate mixing.

313.04.01.02.02.05 Plant Calibration. Prior to commencement of *RCC* production, the *Contractor* shall carry out a complete and comprehensive calibration of the plant in accordance with the manufacturer's recommended practice. All scales, containers, and other items necessary to complete the calibration shall be provided by the *Contractor*. After completion of the initial calibration, the plant shall be recalibrated as directed by the *Engineer*.

313.04.01.02.02.06 Daily Reports. The *Contractor* shall supply daily plant records of production and quantities of materials used that day to the *Engineer*.

313.04.01.02.02.07 Transportation. The transportation of the *RCC* pavement material from the plant to the areas to be paved shall be in dump trucks fitted and equipped, when necessary, with retractable protective covers for protection from rain or excessive evaporation. The trucks shall be dumped clean with no buildup or hanging of *RCC* material. The dump trucks shall deposit the *RCC* material directly into the hopper of the paver or into a secondary material distribution system which deposits the material into the paver hopper. Dump truck delivery must be scheduled so that *RCC* material is spread and compacted within the specified time limits. Access routes shall be clearly marked over the area to be constructed. Haul time should not exceed 20 minutes without addition of admixtures which have proven to successfully maintain moisture content levels in *RCC*.

313.04.01.02.03 Placing.

313.04.01.02.03.01 Condition of the Subgrade/Subbase. Prior to *RCC* placement, the surface of the *subgrade/subbase* shall be clean and free of foreign material, ponded water, and frost prior to the placement of the *RCC* pavement mixture. The *subgrade/subbase* must be uniformly moist at the time of *RCC* placement. If sprinkling of water is required to remoisten certain areas, the method of sprinkling shall not be such that it forms mud or pools of free-standing water. Prior to placement of *RCC*, the *subgrade/subbase* shall be checked for proper density and soft of yielding areas and these areas shall be corrected per these *specifications*.

313.04.01.02.03.02 Paver Requirements. *RCC* shall be placed with an approved paver as noted in these *specifications* and shall meet the following requirements.

313.04.01.02.03.02.01 The quantity of *RCC* material in the paver shall not be allowed to approach empty between loads. The material shall be maintained above the auger shaft at all times during paving.

313.04.01.02.03.02.02 The paver shall operate in a manner that will prevent segregation and produce a smooth continuous surface without tearing, pulling or shoving. The spread of the RCC shall be limited to a length that can be compacted and finished within the appropriate time limit under the prevailing air temperature, wind, and climatic conditions.

313.04.01.02.03.02.03 The paver shall proceed in a steady, continuous operation with minimal starts and stops. Paver speed during placement operations shall not exceed the speed necessary to ensure that minimum density requirements are met and surface distress is minimized.

313.04.01.02.03.02.04 The surface of the RCC pavement once it leaves the paver shall be smooth, uniform and continuous without excessive tears, ridges, or aggregate segregation.

313.04.01.02.03.02.05 Lift Thickness. Place RCC in lifts between 4 inches and 9 inches thick. Multiple lifts are not allowed for pavements less than 9 inches thick. For multiple lift placements, compact the bottom layer to the minimum specified wet density before placing the next lift. No lift shall be less than 4 inches.

313.04.01.02.03.02.06 Adjacent Lane Placement. All longitudinal joints must be considered a cold joint and shall be prepared in accordance with "Cold Vertical Joints" section found elsewhere in these *specifications*. Fresh joints will only be allowed under special circumstances at the Engineer's discretion. In that case, the adjacent paving lane shall be placed within 30 minutes and additional precautions may be necessary to avoid excessive moisture loss at the joint such as the use of set retarding admixtures, water misting, and blankets.

313.04.01.02.03.02.07 Multiple Lift Placement. For multiple lift placements, the total pavement thickness shall be as shown on the *Plans*, and the *Contractor* shall submit his method of placement and lift thickness as part of a paving plan subject to approval by the *Engineer*. The surface of the underlying layers shall be kept moist by fog-spray or other approved method until covered with the next lift. In multiple lift construction, the second lift must be placed within 30 minutes of the batch time of the first lift. If more than 30 minutes has elapsed, the interface between the first and second lifts shall be considered a cold joint and shall be prepared in accordance with "Horizontal Cold Lift Joints" section found elsewhere in these *specifications*. At the discretion of the *Engineer*, this time may be increased or decreased depending on the use of set retarding admixtures or the ambient weather conditions of temperature, wind and humidity.

313.04.01.02.03.02.08 Hand Spreading. Broadcasting or fanning the RCC material across areas being compacted shall not be permitted. Additions of material may only be done immediately behind the paver and before any compaction has taken place. Any segregated coarse aggregate shall be removed from the surface before rolling.

313.04.01.02.03.02.09 Segregation. If segregation occurs in the RCC during paving operations, the spreading shall cease until the cause is determined and corrected.

313.04.01.02.03.02.10 RCC placement shall be done in a pattern so that the curing water from the previous placements will not pose runoff problems on the fresh RCC surface or on the subbase layer.

313.04.01.02.04 Compaction.

313.04.01.02.04.01 Timing. Compaction shall begin immediately behind the placement process and shall be completed within 60 minutes of the start of plant mixing. The time may be increased or decreased at the discretion of the *Engineer* depending on use of set retarding admixtures or ambient weather conditions of temperature, wind, and humidity.

313.04.01.02.04.02 Rolling. Apply the sequence and number of passes by vibratory and non-vibratory rolling to obtain the specified density proposed in the paving construction plan and verified on the test section. Do not operate rollers in the vibratory mode while stopped. Use steel drum rollers in static mode and/or rubber-tire rollers for final compaction.

313.04.01.02.04.03 Rolling Longitudinal and Transverse Joints. If a cold joint is planned, the complete lane shall be rolled and cold joint procedures shall be followed per these specifications. If the *Engineer* approves fresh joint construction, the roller shall not operate within 24 inches of the edges of a freshly placed lane until the adjacent lane is placed. Then both edges of the two lanes shall be rolled together within the allowable time.

313.04.01.02.04.04 Longitudinal Joints. Longitudinal joints shall be given additional rolling as necessary to produce the specified density for the full depth of the lift and a tight smooth transition occurs across the joint. Any uneven marks left during the vibrating rolling shall be smoothed out by non-vibrating or rubber-tire rolling. The surface shall be rolled until a relatively smooth, flat surface, reasonably free of tearing and cracking is obtained. For freshly placed *RCC* next to an existing cold joint, roll the complete lane, taking extreme care not to bridge the roller drum between the new unconsolidated fresh material and a previous cold joint edge. Such bridging of roller drum over cold joint edges, especially in vibratory mode, can significantly degrade the cold joint edge.

313.04.01.02.04.05 Speed. The speed of the rollers shall be slow enough at all times to avoid displacement of the *RCC* pavement. Displacement of the surface resulting from reversing or turning action of the roller shall be corrected immediately.

313.04.01.02.04.06 Tight Space Compaction. Compact areas inaccessible to large rollers with small drum rollers, walk-behind vibratory rollers or plate tampers. Cast-in-place, conventional concrete meeting the same strength requirements as specified for *RCC* may be used in these areas as a replacement for *RCC*.

313.04.01.03 Joints.

313.04.01.03.01 Fresh Vertical Joints. Fresh longitudinal joints will only be allowed under special circumstances under the approval of the *Engineer*. A vertical joint shall be considered a fresh joint when an adjacent *RCC* lane is placed within 30 minutes of the batch time of the previous lane. This time may be reduced depending on ambient conditions, as well additional precautions may be necessary to avoid excessive moisture loss at the joint such as the use of set retarding admixtures, water misting, and blankets.

313.04.01.03.01.01.01 Fresh longitudinal joints shall be constructed prior to placement of an adjacent lane by leaving the outer 24 inches of the freshly placed lane uncompacted during rolling. Then both edges of the two lanes shall be rolled together with the allowable time.

313.04.01.03.01.01.02 Adjacent lanes shall be placed such that the new lane abuts tightly against the incomplete edge of the prior lane.

313.04.01.03.01.01.03 The joint formed by both lanes shall be compacted by centering the roller drum over the joint and compacting both edges simultaneously.

313.04.01.03.01.01.04 Extra passes of the roller may be required at the joint to achieve the required density.

313.04.01.03.02 Cold Vertical Joints. Any planned or unplanned construction joints that do not qualify as fresh joints shall be considered cold joints and shall be treated as follows:

313.04.01.03.02.01.01 Longitudinal and Transverse Cold Joints. Formed joints that do not meet the minimum density requirements and all unformed joints shall be cut vertically for the full depth of produced using an edging shoe. The vertical cut shall be at least 6 inches from the exposed edge. Do not perform this operation any sooner than 2 hours after final compaction. Demonstrate to the *Engineer* that saw cutting will not cause significant edge raveling and remove all slurry and excess material from the cutting operation.

If the *Contractor* can demonstrate that a cold vertical joint can be cut meeting the minimum joint density requirements using an "edge shoe," then the use of the edge shoe in lieu of cutting a cold vertical joint is allowed. The edge shoe should be as close to vertical as possible with the maximum allowable positive edge angle being of 10 degrees from vertical.

Cold joints cut after two hours of placement shall be saw-cut $\frac{1}{4}$ to $\frac{1}{3}$ depth of the *RCC* pavement with the rest removed by hand or mechanical equipment. Any modification or substitution of the saw cutting procedure must be demonstrated to and accepted by the *Engineer*. All excess material from the joint cutting shall be removed.

313.04.01.03.02.01.02 Prior to placing fresh *RCC* mixture against a compacted cold vertical joint, the joint shall be thoroughly cleaned of any loose or foreign material. The vertical face shall be wetted and in a moist condition immediately prior to placement of the adjacent lane.

313.04.01.03.02.01.03 Uneven surfaces or slopes greater than as determined for "Cold Joint Edges" shall be cut vertically for the full depth of the *RCC*.

313.04.01.03.02.01.04 The rollers shall pass over the end of the freshly placed *RCC* mixture when a vertical cold joint is to be made. Unless the *RCC* cold joint has been formed by an edging shoe, the edge of the previously placed *RCC* pavement shall be cut back to expose an even vertical surface for the full thickness of the course without disturbance of the *RCC* that is to remain in place. Uneven areas and raveling shall be corrected.

313.04.01.03.02.01.05 The top layer shall be placed so that longitudinal joints in that layer will coincide with joints in the lower layers of the pavement. Transverse joints in the top layer shall coincide with transverse joints in the lower layers of the pavement.

313.04.01.03.02.01 Fresh Horizontal Joints. For multi-layer construction, a horizontal joint shall be considered a fresh joint when a subsequent *RCC* lift is placed within 30 minutes of the batch time of the previous lift. This time may be adjusted at the discretion of the *Engineer* depending on use of retarders or ambient weather conditions, fresh joints do not require special treatment other than cleaning the surface of all loose material and moistening the surface prior to placement of the subsequent lift.

313.04.01.03.02.02 Horizontal Cold Lift Joints. For horizontal cold joints the surface of the lift shall be kept continuously moist and cleaned of all loose material prior to placement of the subsequent lift. The use of cement slurry or mortar grout between lifts is required. The supplementary bonding materials are used, they shall be applied immediately prior to placement of the subsequent lift.

313.04.01.03.02.03 RCC Pavement Joints at Structures. The joints between *RCC* pavement and concrete structures shall be treated as cold vertical joints.

313.04.01.03.02.04 Control Joints. Control joints shall be constructed in the *RCC* pavement to induce cracking at pre-selected locations. Joint locations shall be as shown on the *Plans* or as directed by the *Engineer*. Early entry saws should be utilized as soon as possible behind the rolling operation and set to manufacturer's recommendations. Saw crack control joints to the interval, depth and width specified on the *Plans*. Extend all crack control joints the entire width of paving. When sawing crack control joints, begin as soon as the *RCC* cuts without excessive raveling along the saw cut and finish before conditions induce uncontrolled cracking, regardless of the time or weather.

313.04.01.03.02.05 Isolation Joints. Line the perimeter of fixed structures such as manholes, valves, trench drains, and with strips of fiberboard or other approved isolation joint material, as noted in the plant details, prior to paving.

313.04.01.03.02.06 Expansion Joints. Install expansion joints to the details, dimensions, and locations shown on the *Plans*. If the *Plans* do not include details and conditions warrant expansion joints, propose a plan and install expansion joints in the pavement, with approval of the *Engineer*. Include width, filler, sealing material, location and/or spacing recommendations in the expansion joint plan, considering thermal effects, regional climatic conditions, *RCC* coefficient of thermal expansion, and expected daily temperature ranges at the time of placement.

313.04.01.03.03 Finishing. If the *Agency/Owner* has elected to have a finished surface the *Contractor* shall finish the surface with a mechanical trowel machine to evenly distribute the natural *RCC* material in the mix without the addition of water. Once the troweling process is complete, drag the surface with wet burlap or a broom capable of producing a uniform textured surface in appearance and reasonably free from encrusted matter. If the troweling, brooming, dragging, or other finishing method dislodges or loosens aggregate, cease paving immediately until the problem is resolved to the satisfaction of the *Engineer*.

313.04.01.03.04 Curing.

313.04.01.03.04.01 General. Immediately after final rolling and compaction testing use an approved curing method outlined below.

313.04.01.03.04.02 Water Cure. Water cure shall be applied by water trucks equipped with misting spray nozzles, soaking hoses, sprinkler system or other means that will assure a uniform moist condition to the *RCC*. Application of this moisture must be done in a manner that shall not wash out or damage the surface of the finished *RCC* pavement. The surface of the *RCC* pavement shall be kept continuously moist for three (3) days.

313.04.01.03.04.03 Curing Compound. A white pigmented membrane curing compound conforming to ASTM C 309 or D 977 shall be applied at a rate of 150 SF/gallon no later than one hour after completion of finishing operations on the surface and edges of *RCC*. This application must ensure a uniform void-free membrane across the entire *RCC* pavement. If the application rate is found to be insufficient, the *Contractor*, with approval of the *Engineer*, can increase the application rate to a level which achieves a void-free surface without ponding.

313.04.01.03.04.04 Sheet Materials. Curing paper, plastic and other sheet materials for curing *RCC* shall conform to ASTM C 171. The coverings shall be held securely in place and weighted to maintain a close contact with the *RCC* surface throughout the entire curing period. The edges of adjoining sheets shall be overlapped and held in place with sand bags, planking, pressure adhesive tape, or other method as directed or approved by the *Engineer*. Sheet material shall be provided and kept readily available to cover pavement less than 12 hours old in rainfall occurs.

313.04.02 Acceptance.

313.04.02.01 Thickness. Determine the pavement thickness from cores by average caliper measurements in accordance with ASTM C174. Extract one core for each lot of *RCC* pavement per Table RCC-1. For pavement placement units consisting of less than one lot of *RCC* pavement, include the pavement with the previous or next placement unit.

As an option, use alternative or additional thickness determination methods to satisfy the requirements of Table RCC-1, with the *Engineer's* approval. Such alternate thickness determination procedures can include surveying, GPS devices, and/or LIDAR.

313.04.02.01.01 Mitigation. A pay adjustment will be considered for *RCC* pavement that does not fully meet the specification for thickness and surface texture. These adjustments will be applied to each area of proposed pavement. Limits of area subject to pay factor to be determined by the *Engineer*. *Contractor* shall be responsible for taking additional samples to assist the *Engineer* in determination of limits of deficient area. If a core is found to be deficient in thickness, two additional cores shall be taken at the *Contractor's* expense to determine the extent of the deficiency. Limits of deficient areas are to be determined by the *Agency or Owner*.

Table 313.04.02.01.01-I

| Inches | Payment % |
|-----------------|--------------------|
| 0.00 to 0.24 | 100 |
| 0.25 to 0.49 | 90 |
| 0.50 or greater | Remove and replace |

313.04.03.01 Density.

313.04.03.01.02 In-Place Wet Mat Density Determination. Determine the in-place wet mat density on pavement that is at least 24 inches from any joint in accordance with ASTM C1040 direct transmission mode at 75% of total *RCC* pavement depth for each lot of *RCC* pavement per Table RCC-1. For pavement placement units consisting of less than one lot of *RCC* pavement, include the pavement with the previous or next placement unit.

313.04.03.01.03 In-Place Wet Joint Density Determination. Determine the in-place wet joint density on joints at a distance 12 inches or greater for free edge and 6 inches or greater for a confined edge in accordance with ASTM C1040 direct transmission mode for each lot of *RCC* pavement per Table RCC-1. For pavement placement units consisting of less than one lot of *RCC* pavement, include the pavement with the previous or next placement unit.

313.04.03.01.03.01 Mitigation. For in-place wet mat density and in-place wet joint density, full payment will be made for pavement based on the acceptance criteria in Table RCC-1. Pavement lots that have density that is less than the required density are subject to further evaluation. Take an additional test within a 5 to 8 foot radius (1.5 to 2.5 m), of the original test (within the same placement unit). If this test is below the acceptance criteria in Table RCC-1, additional roller passes shall be made across the full lane width between the last testing location that produced an acceptable reading and the paver. If the additional roller passes do not correct the problem, or causes the density to decrease, the paving operation shall be discontinued until corrections can be made to assure that the specified density can be achieved.

313.04.03.02 Strength.

313.04.03.02.01 Strength Determination. Determine the compressive strength for cylinders prepared in accordance and for each lot of *RCC* pavement per Table RCC-1. For pavement placement units consisting of less than one lot of *RCC* pavement, include the pavement with the previous or next placement unit.

313.04.03.02.01.01 Mitigation. Full payment will be made for cylinders meeting the requirements of the mix design, whose average strength equal to 100% of the specified strength, with no single result below 90 percent.

Pavement lots that have strength that are less than the required strength are subject to further evaluation.

Extract three cores at random locations in the suspect area after the *RCC* pavement is at least 28 days old. Remove, handle and test the compressive strength of the three cores according to ASTM C42.

Determine the average and standard deviation of the compressive strength of the three cores. If the average of the three cores exceeds 85 percent of the minimum specified compressive strength, the *RCC* in the subplot is acceptable and is subject to full payment and acceptance. If the average strength of the three cores is less than 85 percent of the specified compressive strength, the *RCC* is not acceptable and requires removal.

313.04.03.02.01.02 Removal and Replacement. Areas determined to have strength deficiencies that are not resolved through referee testing, as noted above, require removal and replacement. After the referee period or at least seven days, remove the hardened *RCC* material by saw cutting the perimeter of the deficient area full depth. Repair the area using an air-entrained cast-in-place concrete meeting the strength requirements per these *Specifications* or as directed by the *Engineer*. The new concrete shall be doweled into the existing *RCC* layer using dowel bars or as directed by the *Engineer*.

313.04.03.03 Surface.

313.04.03.03.01 Smoothness for RCC Pavements. The finished surface of the RCC pavement, when tested with a 10 foot straight edge, shall not vary from the straight edge by more than 3/8 inch at any one point. Pavements surfaces that have been purposely warped to meet fixtures (manholes, drainage inlets, catch basins), existing curb and gutter, or cross- and side-road connections are exempt from this straightedge requirement. Correct surface irregularities outside of these tolerances as noted below.

313.04.03.03.01.01 Mitigation. When the surface smoothness is outside the specified surface tolerance the *Contractor* shall grind the surface to within the tolerance by use of self-propelled diamond grinders, provided grinding does not create deviation from other tolerances. Milling of the final surface is not acceptable, unless it is for the removal of the pavement. After correction, verify the corrective work by measuring the smoothness as noted in the above section.

313.04.03.03.02 Texture. The final surface texture after rolling and curing shall be smooth and uniform over the entire area of pavement and will reasonably match the surface condition of the test strip. The surface area shall be free of rips, bird baths, areas of loose aggregate, surface pitting, voids or indentation, pockmarks, surface tears greater than 1/4" inch depth and 1/4 inch width, check cracking, segregation or rock pockets, pumped areas, aggregate drag marks, and areas where fines have been washed away during the curing process.

313.04.03.03.02.01 Mitigation. Correct surface texture deficiencies using an approved grinding device, or removal and replacement.

313.05 SCC.

This Subsection is Blank.

314.01 GENERAL.

314.01.01 DESCRIPTION. This Section covers the production, provision, preparation for placement, and placement of *PCCP*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. *PCCP* shall conform to the applicable Subsections of Section 314 – “*PCC*”, unless modified herein.

314.01.02 DESIGN.**314.01.02.01 *PCC*.****314.01.02.01.01 Composition of Mixtures.**

314.01.02.01.01.01 Specified Strength. To ensure that the *PCC* produced will meet or exceed the acceptance criteria for the specified strength; the mix design average strength must be higher than the specified strength. The amount of the overdesign necessary to meet specification requirements depends on the producer's standard deviation of flexural test results and the accuracy which that value can be estimated from historic data for the same or similar materials.

314.02 MATERIALS.**314.02.01 Material Storage.**

314.02.01.01 Lubricants. Lubricant shall be stored at a temperature between 50 °F and 80 °F, and shall be used within 270 *Calendar Days* after date of manufacture.

314.02.02 AGGREGATES. Aggregates shall conform to Subsection 200.06.01 – “Aggregates for *PCCP*.”

314.02.03 CURING MATERIALS. Curing materials shall conform to Subsection 202.03.05.04.03 – “*PCCP*”.

314.02.04 REINFORCING STEEL. Reinforcing steel shall be deformed steel bars conforming to Subsection 206.03.01 – “Bar Steel Reinforcement”, Grade 40.

314.02.05 DOWEL BARS. Dowel bars shall be plain steel bars conforming to ASTM A615, ASTM A616, or A617, and shall be free from burring or other deformation restricting slippage in the concrete. High strength dowel bars shall conform to ASTM A714, Class 2, Type S Grade I, II, or III, Bare Finish, XS. Before delivery to the construction site, each dowel bar shall be epoxy-coated. Coated dowels shall conform to AASHTO M 254.

314.02.06 TIE BARS. Tie bars shall be deformed steel bars conforming to the ASTM A 615, ASTM A616, or ASTM A617, except that rail steel bars, Grade 50 and 60, shall not be used for tie bars that are to be bent or re-straightened during construction. Tie bars designated as Grade 40 in ASTM A615 can be used for construction requiring bent bars.

314.02.07 EPOXY RESIN. Epoxy-resin used to anchor dowels and tie bars in *PCCP* shall conform to ASTM C881, Type I, Grade 3, Class C. Class A or B shall be used when the surface temperature of the hardened *PCCP* is below 60 °F.

314.02.08 JOINT SEALER. Joint filler shall conform to Subsection 202.03.03.03.01 – “Cold Applied Silicone Joint Sealant for *PCC* Pavements”.

314.03 CONSTRUCTION.**314.03.01 CONSTRUCTION EQUIPMENT.**

314.03.01.01 Spreading. *PCC* shall be spread, screeded, shaped and consolidated by one or more self-propelled machines. These machines shall perform in a manner so that the completed pavement will conform to the required cross section with a minimum of handwork.

314.03.01.02 Pump Trucks. The end of the boom on the pump truck shall have a device to prevent *PCC* from falling at the highest point of the boom.

314.03.02 PLACING OF MATERIALS.

314.03.02.01 Forms.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the *PCC*.

314.03.02.02 Joint Devices. All joint devices shall be approved by the *Engineer*. The top of an assembled joint device shall be set at the proper distance below the pavement surface and the elevation shall be confirmed. The devices shall be set to the required position and line and shall be securely held in place by stakes or other means to the maximum permissible tolerances during the placing and finishing of the *PCC*.

314.03.02.02.01 Premolded Joint Filler. Premolded joint filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise directed or approved by the *Engineer*. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the *Engineer*.

Premolded joint material shall be placed and held in a vertical position; if constructed in sections, there shall be no offsets between adjacent units. Premolded joint filler shall be securely fastened via large washer and nail or other approved means, to adjacent hardened *PCCP* panel prior to pouring fresh *PCCP*.

The *Contractor* shall ensure that the installation of joint devices has been accepted by the *Engineer* prior to placing the *PCC*.

314.03.02.03 Dowel Bar Placement. Dowel bars or other load-transfer units of an approved type shall be placed across joints in the manner as shown on the plans. They shall be of the dimensions and spacing as shown on the *Plans* and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. A lubrication bond breaker shall be provided for the epoxy-coated steel dowels except when approved pullout tests indicate it is not necessary. Where butt-type joints with dowels are designated, the exposed end of the dowel shall be oiled.

The *Contractor* shall submit the proposed method of using wire basket supports including shop drawings with proposed method of anchoring the baskets for acceptance by the *Engineer* prior to placement. The proposed method of establishing the assembly locations on the subgrade shall be submitted for acceptance as well.

The sleeves for dowel bars used in isolation joints shall be metal or other type of and approved design to cover 2 to 3 inches of the dowel, with a closed end and with a suitable stop to hold the end of the bar at least 1 inch from the closed end of the sleeve. Sleeves shall be of such design that they will not collapse during construction.

The position and alignment of the dowel bars and assemblies shall be confirmed by the *Engineer*. During the *PCC* placement operation, placement of plastic *PCC* directly on dowel assemblies immediately prior to passage of the paver will maintain dowel position and alignment within maximum permissible tolerances.

Dowel bar assemblies are not allowed in construction joints. The *PCC* shall be struck flush and dowels/tie bars shall be placed into holes drilled into the hardened *PCC*. Holes approximately 1/8 inch to 1/4 inch greater in diameter than the dowel or tie bar shall be drilled with rotary-type core drills that must be held securely in place to drill perpendicularly into the vertical face of the pavement slab. Rotary-type percussion drills may be used provided that spalling of concrete does not occur. Any damage of the *PCC* shall be repaired by the *Contractor* in a method approved by the *Engineer*. Dowels or tie bars shall be bonded in the drilled holes using an epoxy resin material. Installation procedures shall be adequate to ensure that the area around dowels is completely filled with epoxy grout. Drilled holes shall be cleaned with oil-free compressed air. Epoxy shall be injected into the back of the hole and displaced by the insertion of the dowel bar. Bars shall be completely inserted into the hole and shall not be withdrawn and reinserted creating air pockets in the epoxy around the bar. The *Contractor* shall furnish a template for checking the position and alignment of the dowels.

314.03.02.04 PCC.

314.03.02.04.01 Limitations on Mixing and Placing. *PCC* shall not be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated. All *PCC* shall be placed at times that ensure sawing is completed on the same day of placement.

314.03.02.04.02 Finishing. The surface of the pavement shall be finished with a broom, burlap drag or artificial turf finish as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

314.03.02.04.02.01 Brush or Broom Finish. If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 of an inch in depth. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation shall be corrected.

314.03.02.04.02.02 Burlap Drag Finish. If a burlap drag is used to texture the pavement surface, it shall be at least 15 ounces per square yard. To obtain a textured surface, the transverse threads of the burlap shall be removed approximately 1 foot from the trailing edge. A heavy building of grout on the burlap threads produces the desired wide sweeping longitudinal striations of the pavement surface. The corrugations shall be uniform in appearance and approximately 1/16 of an inch in depth.

314.03.02.04.02.03 Artificial Turf Finish. If artificial turf is used to texture the surface, it shall be applied by dragging the surface of the pavement in the direction of concrete placement with an approved full-width drag made with artificial turf. The leading transverse edge of the artificial turf drag will be securely fastened to a lightweight pole on a traveling bridge. At least 2 feet of the artificial turf shall be in contact with the concrete surface during dragging operations. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated by the Contractor to provide a satisfactory texture. The corrugations shall be uniform in appearance and approximately 1/16 of an inch in depth.

314.03.02.04.02.04 Tining. If tining is used to texture the surface, it shall be performed in accordance with the applicable requirements of Section 409.03.10 "Finishing" of the *Silver Book*.

314.03.02.04.03 Protection of Fresh Surface. The finished surfaces of the freshly placed *PCC* shall be kept damp by applying a water-fog or mist with approved spraying equipment until the pavement is covered by the curing medium. If necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.15 PSF per hour as determined in accordance with Figure 2.1.5 in ACI 305R, Hot Weather Concreting, which takes into consideration relative humidity, wind velocity, and air temperature.

When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the *Contractor* shall immediately take such additional measures as necessary to protect the pavement surface. Such measures shall consist of wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

314.03.02.04.04 Curing. Curing shall be accomplished immediately after the final finishing operation. The *PCC* shall not be left exposed for more than 30 minutes during the curing period. The use of fly ash or set retarding admixtures can delay the occurrence of bleed water. Curing should be applied after bleed water is gone from the surface. Curing materials shall be applied in accordance with Table 314.03.02.04.04-I.

314.03.02.04.04-I Curing Requirements

| Evaporation Rate (lbs/ft ² /hr) ⁽¹⁾ | Curing Requirement |
|---|--|
| less than 0.2 | Single coat membrane. |
| 0.2 - 0.4 | Two coat membrane. |
| 0.4 - 0.6 | Continuous water fogging until cotton mats are applied and maintained wet. |
| greater than 0.6 | Paving operations shall be terminated or not be initiated if conditions are anticipated. |

1. Figure 2.1.5 from ACI 305R, "Hot Weather Concreting", shall be used in determining the Evaporation Rate regardless of ambient temperature.

314.03.02.05 Joints.

314.03.02.05.01 Sawing. Joint sawing shall be accomplished as soon as the pavement can support the sawing equipment to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs. Sawing shall be carried on until completion at the required spacing, consecutively in sequence of the PCC placement. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Sawing shall produce a slot at least .01 feet wide, but not to exceed .02 feet wide and to the depth shown on the plans.

314.03.02.05.02 Construction Joints.

314.03.02.05.02.01 Longitudinal. Longitudinal construction joints shall be slip-formed or formed against side forms as shown on the joint layout plans.

314.03.02.05.02.02 Transverse. Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

314.03.02.06 Joint Sealing. Joints shall be sealed as soon after completion of sawing and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be above 40° F at the time of installation of the preformed joint seal.

Immediately before sealing, the joints shall be thoroughly cleaned of all laitance, curing compound, and other foreign material. Cleaning shall be accomplished by sandblasting, wire brushing, or high pressure water blast. Upon completion of cleaning, the joints shall be blown out with compressed air. The joint faces shall be surface dry when the seal is applied.

Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be accepted by the *Engineer* before sealing is allowed. A qualified installer representing the preformed sealant company shall be present during the initial stages of sealing until such time that the *Engineer* is satisfied that the installation is being performed according to the manufacturer's directions.

Preformed joint sealer shall be placed using equipment capable of installing the sealer in the upright position, without cutting, nicking, distorting, or otherwise damaging the seal. Hand placing of preformed joint sealer will not be allowed. Lubricant shall be applied to the concrete or the preformed seal, or both, and the seal shall be installed in a substantially compressed condition and at the depth below the surface of the pavement as shown in the plans.

The method of installation shall be such that the joint sealer will not be stretched more than 5 percent of the minimum theoretical length, or compressed more than 2 percent. The method of installation shall be checked for stretching or compression, using transverse joint sealer. The check shall consist of installing sealer in five joints of at least 25 feet in length, removing the sealer immediately after installation, and checking the length.

This check may be modified by premarking or precutting the sealer to length prior to installation if this is compatible with the equipment being used. If the measured length of any of these five sealers indicated that the sealer is stretched or compressed beyond these limits, the installation shall be modified to correct the situation.

Once satisfactory sealing operations have started, one joint length per every hundred shall be removed and checked. If the limits are exceeded, the joint sealers on either side shall be removed until the condition disappears. The affected joints shall be resealed in a satisfactory manner at no cost to the owner, and the method of installation shall be checked again for satisfactory procedure. The seal shall be installed in the longest practicable lengths in longitudinal joints and shall be cut at the joint intersections for continuous installation of the seal in the transverse joints. After placing, all sealant shall be poured with neoprene cement at intersections of joint materials to produce a waterproof joint intersection.

If the joint as sawed is oversized, the joint shall be resawn to a uniform width and a wider joint seal installed at no cost to the Owner. The width of the sawcut joint shall be adjusted for each increment of 10° F deviation from 60° F as per the manufacturer's recommendation. The joint and corresponding joint material widths required shall be in accordance with Table 314.03.02.06-I

Table 314.03.02.06-I. Joint Material Width Requirements

| Joint Width (Inches) | Joint Material Width (Inches) @ 60 °F |
|----------------------|--|
| 0.35 to 0.47 | 9/16 |
| 0.48 to 0.59 | 13/16 |
| 0.60 to 0.75 | 1 |
| 0.76 to 0.97 | 1-1/4 |
| <0.97 | 1-5/8 |

Silicone sealants shall be installed in accordance with the manufacturer's recommendation.

314.03.02.07 Repair, Removal and Replacement.

314.03.02.07.01 General. New pavement slabs that are broken or contain cracks shall be removed and replaced or repaired, as specified hereinafter at no cost to the Owner. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The *Engineer* will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be 4 inches diameter, shall be drilled by the *Contractor* and shall be filled by the *Contractor* with a well consolidated PCC bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. All epoxy resin used in this work shall conform to ASTM C881, Type V.

314.03.02.07.02 Shrinkage Cracks. Shrinkage cracks, which do not exceed 4 inches in depth, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved. Care shall be taken to assure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the *Engineer*. Shrinkage cracks, which exceed 4 inches in depth, shall be treated as full depth cracks in accordance with Subsections 314.03.10.16.05 – “Full Depth Cracks Present, Original Joint Not Opened” and 314.03.10.16.06 – ‘Full Depth Cracks Present, Original Joint Also Cracked’.

314.03.02.07.03 Slabs with Cracks through Interior Areas. Interior area is defined as that area more than 6 inches from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than 4 inches in depth, that extend into the interior area.

314.03.02.07.04 Cracks Close To and Parallel To Joints. All cracks essentially parallel to original joints, extending full depth of the slab, and lying wholly within 6 inches either side of the joint shall be treated as specified hereinafter. Any crack extending more than 6 in from the joint shall be treated as specified in Subsection 314.03.10.16.03 - "Slabs With Cracks Through Interior Area."

314.03.02.07.05 Full Depth Cracks Present, Original Joint Not Opened. When the original uncracked joint has not opened, the crack shall be sawed and sealed, and the original joint filled with epoxy resin as specified below. The crack shall be sawed with equipment specially designed to follow random cracks. The reservoir for joint sealant in the crack shall be formed by sawing to a depth of 3/4 in, plus or minus 1/16 in, and to a width of 1/4 in, plus or minus 1/8 in. Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent such raveling or spalling. The joint sealant shall be a liquid sealant as specified. Installation of joint seal shall be as specified for sealing joints or as directed. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler type material has been used to form a weakened plane in the transverse joint, it shall be completely sawed out and the saw cut pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remainder of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

314.03.02.07.06 Full Depth Cracks Present, Original Joint Also Cracked. At a joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced for the full lane width and length.

314.03.02.07.07 Removal and Replacement of Full Slabs. Where it is necessary to remove full slabs, unless there are keys or dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If keys, dowels, or tie bars are present along any edges, these edges shall be sawed full depth 24 inches from the edge if only keys are present, or just beyond the end of the dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 1 inch of the depth of the dowel or key.

The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along keyed or doweled edges shall be carefully broken up and removed using light, hand-held jackhammers, 30 lb. or less, or other approved similar equipment.

Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. The joint face below keys or dowels shall be suitably trimmed so that there is not abrupt offset in any direction greater than 1/2 inch and no gradual offset greater than 1 inch when tested in a horizontal direction with a 12 ft. straightedge.

No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4 inch deep occurs at any point along any edge, the area shall be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary.

If underbreak over 4 inches deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels, tie bars, or keys on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All 4 edges of the new slab shall thus contain dowels or original keys or original tie bars.

Placement of PCC shall be as specified for original construction. Prior to placement of new PCC, the underlying material (unless it is stabilized) shall be re-compact and shaped. The surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing

compound from contacting dowels or tie bars. The resulting joints around the new slab shall be prepared and sealed as specified for original construction.

314.03.02.08 Repairing Spalls Along Joints. Where directed, spalls along joints of new slabs, and along parallel cracks used as replacement joints, shall be repaired by first making a vertical saw cut at least 1 inch outside the spalled area and to a depth of at least 2 inches. Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least 1/2 inch of visually sound concrete. The cavity thus formed shall be thoroughly cleaned with high-pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat of epoxy resin, Type III, Grade I, shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Pooling of epoxy resin shall be avoided. The cavity, depending on volume, shall be filled with low slump PCC or with a polymeric concrete patch or elastomeric concrete matching the color of the PCC when cured (as manufactured by D.S. Brown). Concrete shall be used for larger spalls, generally those more than 1/2 cu. ft. in size and polymeric or elastomeric shall be used for the smaller ones. Any spall less than 0.1 cu. ft. shall be repaired only with polymeric or elastomeric material. Portland cement concrete mixtures shall be proportioned as directed and shall be mixed, placed, consolidated, and cured as directed. Polymeric and elastomeric materials shall be mixed and placed as recommended by the manufacturer, and as approved by the engineer. These materials shall match the color of PCC when cured. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or patching material. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab shall be removed and replaced as previously specified.

314.03.02.09 Opening to Traffic. Based upon minimum opening strength requirements and other specified requirements herein, the *Engineer* shall determine when the traffic or other vehicles will be allowed on the PCC pavement. The *Engineer* shall sample each subplot from the plastic PCC delivered to the job site. Sampling locations shall be determined by the *Engineer* in accordance with random sampling procedures contained in ASTM D3665. For each subplot one beam and one cylinder shall be tested at a time determined by the *Contractor* for the means of verifying a flexural strength of 550 PSI, as determined by Test Method ASTM C78. No pavement will be opened to mixed traffic until the average of the lot has attained 550 PSI with no single subplot specimen less than 500 PSI.

Prior to opening to traffic, the pavement shall be cleaned by flushing with water until all dirt and dust are removed from the pavement surface. It shall be the *Engineer's* sole discretion if the pavement surface is clean enough to be opened up to traffic.

314.04 ACCEPTANCE. This Subsection intentionally left blank.

315.01 GENERAL.

315.01.01 DESCRIPTION. This Section covers the production, provision, preparation for placement, and placement of *PCC* structures.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. Conventional *PCC* shall conform to the applicable Subsections of Section 311 – “*PCC*”. All other structures shall conform to Section 502 – “Concrete Structures” and Section 503 – “Prestressed Concrete and Precast Concrete” of the *Silver Book* or other applicable references.

316.01 GENERAL.

316.01.01 DESCRIPTION. This Section covers the design, provision, excavation, preparation for placement, placement and backfilling of monolithic precast RC box intended for use in drainage applications and other conveyance systems.

316.01.01.01 Terms.

Acceptable Crack. A crack width less than 0.1 inch and located in a non-corrosive environment (pH >5.5).

Monolithic. A structure cast in a one-piece form and transported as a completed structure.

Slabbing. The separation of PCC from the reinforcing steel.

Spalling. The peeling, popping-out and flaking off of a PCC surface.

316.01.01.02 Design. This Section does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the resulting pipe and pipe system. Design requirements shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. If details are not provided by the *Agency*, the *Engineer* shall adhere to the standard installations in accordance with the applicable Article in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The *Current* edition shall be used.

316.01.01.02.01 Box Design Verification. Box design verification shall be performed when there is a change to material suppliers, materials, mix design, equipment or manufacturing operation, but no less than once every 12 months for each size box. Monolithic boxes shall conform to ASTM C1433 or C1577 (as applicable), Section 5.

Design verification records shall be maintained by the manufacturer and made available upon request.

316.01.01.03 Strength Class. The strength class required for a project is dependent on the bedding and backfill material, the depth of cover and the loading conditions. The bedding and backfill requirements used by the *Engineer* to determine the class of pipe required should be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

The *Engineer* may refer to the standard installations, as defined in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications, which provide flexibility in selecting the installation that best meets the projects unique combination of site conditions, available backfill materials and desired construction and inspection materials. Once the type of installation is selected the correct strength class of RC pipe can be determined.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The *Current* edition shall be used.

316.01.01.03.01 PCC.

316.01.01.03.01.01 Composition of Mixtures. The Mix Design shall comply with ASTM C1433 or ASTM C1577. The compressive strength at 28 Days, slump, target air content, aggregate gradation and type of cementitious material shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

316.01.01.04 Safety. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”, except as modified herein.

316.01.01.04.01 Trenches. Unless otherwise directed or approved by the *Engineer*, *Trenches* shall not be excavated until immediately before installation of pipe and other appurtenances.

316.02 MATERIALS. The materials used shall be determined and/or accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to performing subsequent *Construction Activities*.

316.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

316.02.02 CARE OF MATERIALS. The box and/or box components shall be supported so as not to create a concentrated point loading situation.

316.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or installations except as provided in Subsection 100.31.02 – “Use of Other Materials”.

316.02.04 AGGREGATES. Aggregates shall conform to Section 200 – “Aggregates”.

316.02.05 CEMENTITIOUS MATERIALS. Cementitious materials shall conform to Subsection 202.02 – “Cementitious Materials”.

316.02.06 ADMIXTURES. Admixtures shall conform to Subsection 202.03.01 – “Admixtures”.

316.02.07 FIBERS. Fibers shall conform to Subsection 202.03.02 – “Fibers”.

316.02.08 CURING MATERIALS. Curing materials shall conform to Subsection 202.03.05 – “Curing Materials”.

316.02.09 WATER. Water shall conform to Section 205 – “Water”.

316.02.10 REINFORCING STEEL. Reinforcing steel shall conform to Section 206 – “Reinforcing Steel”.

316.03 CONSTRUCTION.

316.03.01 SUBMITTALS.

316.03.01.01 Certificate of Compliance. The *Contractor* shall provide a *Certificate of Compliance* for each material in accordance with Subsection 100.31.01 – “*Certificate of Compliance*”, except as modified herein.

316.03.01.01.01 Required Information.

- A. A statement that the individual responsible for the affirmation has the legal authority to bind the supplier or manufacturer and/or fabricator;
- B. Quantity of pipe shipped; and
- C. The size, class and quantity of pipe shipped.

A certificate shall be sent with each shipment. The *Contractor* shall ensure that the *Certificates of Compliance* have been reviewed and accepted by the *Engineer* prior to unloading the associated material at the *Site of Work*.

316.03.01.02 PCC. The *Contractor* shall submit, in writing, the *PCC* mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the *PCC*.

316.03.01.03 Quality Control Program. Manufacturer shall maintain a quality control program which is certified annually. At the time of this publication *ACPA Q-Cast* and *NPCA* are the most widely recognized national certification programs. A comparable internal certification program may be submitted to the *Agency* for review and approval.

316.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

316.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

316.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

316.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

316.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers; Methods and Equipment”

316.03.06.01 Batch Plant and Delivery Fleet. Unless otherwise directed or approved by the *Engineer* plants used for the ready-mix production of PCC shall be of sufficient capacity and coordinated to adequately handle the proposed construction. The plant, including the delivery fleet, shall hold a current *NRMCA* certification.

Information regarding certification, including a complete list of the related tests, and an electronic directory of *NRMCA* certified plants are available at www.nrmca.org.

The plant shall include satisfactory equipment or use other methods which will meet local conditions, city, county, state, and federal laws pertinent to air pollution.

316.03.07 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements. Any proposed construction loads that were not specifically identified in the design process shall be reviewed and approved by the *Engineer*.

316.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”

316.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303 - “Excavating”, except as modified herein.

316.03.09.01 Cover Limits. In no instance shall the cover limits of the box be exceeded.

316.03.09.02 Trench Width. For pipe, the minimum and maximum width of *Trench* permitted shall be as shown on the *Plans* or *Standard Details* or specified in the *Special Provisions* and/or *Special Technical Specifications*, and shall be of such a width to allow placement proper construction of joints and compaction of bedding and backfill. Unless otherwise directed or approved by the *Engineer*, trenches shall be excavated to a width that will provide adequate working space for mechanical compaction equipment, but not less than required by Article in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The Current edition shall be used.

Trench walls shall not be undercut.

If the maximum *Trench* width is exceeded, the *Contractor* shall provide additional bedding, another type of bedding, or a higher strength of pipe, as directed by the *Engineer*, at no additional cost to the *Agency/Owner*.

316.03.09.02.01 Narrow Trenches. Narrow trenches may be allowed by the *Engineer* provided the clearance between the pipe and *Trench* wall is adequate to allow compaction of the backfill.

316.03.09.03 Trench Foundation. The *Foundation* shall be accurately graded to provide uniform bearing and support for each section of the pipe at every point along its entire length, except for portions of the pipe where it is necessary to excavate for bells and for proper sealing of the pipe joints.

When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavating, the *Contractor* shall excavate and expose the existing improvement before trenching for or laying any pipe or conduit on the project. Any adjustments in line or grade which may be necessary to accomplish the intent of the *Plans* will then be made.

316.03.09.03.01 Oversize Material or Bedrock. Unless otherwise directed or approved by the *Engineer*, rocks larger than 4 inches in any dimension or *Bedrock*, exposed by excavating, shall be removed to a minimum depth of 6 inches below the *OD* of the pipe. The *Contractor* shall replace the removed materials as directed or approved by the *Engineer*.

If information regarding oversize materials or *Bedrock* was not available and no provisions for removal and replacement were included in the *Contract Documents*, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

316.03.09.03.02 Unsuitable Material. The *Contractor* shall remove any material unsuitable for pipe support to the depth directed by the *Engineer*. The *Contractor* shall replace the removed materials as directed or approved by the *Engineer*.

If information regarding unsuitable materials was not available and no provisions for removal and replacement were included in the *Contract Documents*, the *Contractor* may request additional compensation. The *Contractor* shall submit any request for an increase to the *Contract Amount* in accordance with Subsection 100.35.01 – “*Change Order*”.

316.03.10 PLACING OF MATERIALS.

316.03.10.01 Backfill. Backfill above the top of the box shall conform to Subsection 200.03.06 – “Class E Backfill” with a relative compaction of at least 90 percent of the maximum dry density, within 2 percent of optimum moisture content, determined in accordance with *ASTM D1557* or slurry backfill when specified in the project plans or specifications.

316.03.10.01.01 Mechanically Compacted Backfill. Mechanically compacted backfill shall be layered in 12" maximum lifts. Avoid usage of impact tampers directly above the box until the full loose layer backfill depth above the box is obtained.

316.03.10.01.02 Slurry Backfill. If slurry backfill is specified the slurry backfill shall conform to Subsection 337.08.01 – “Slurry Backfill”, Type A (Excavatable). The slurry backfill shall be placed around the box from the foundation bedding to the springline.

316.03.10.02 Box Installation. Installation shall be per *ASTM C1675* unless noted otherwise in this specification or in the project plans and specifications.

Ensure that no rocks greater than 3 inches or other rigid or jagged material is present in the bedding material where the box may be laid directly on the material.

Prior to placing backfill material, all lifting holes in concrete culverts shall be completely filled with grout.

316.03.10.03 Connections. All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or concrete junction structure, shall be made by either grouting the lateral in to a fabricated reinforced opening, connecting the lateral with an approved Cast in Place field collar, or in a manufactured wye or tee. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater strength as the box.

Connections should be detailed in the project plan sheets or sent as part of the submittal package for approval of the engineer prior to fabrication.

316.03.10.04 Joints. Joints for precast *RC* box shall meet the requirements of *ASTM C990*.

Precast *RC* box shall be supplied with a *T&G* joint.

T&G joints may be sealed using cement mortar or mastic material in the joint gap.

The precast *RC* box *T&G* joint shall be constructed by following method:

316.03.10.04.01 T&G Joints

316.03.10.04.01.01 Mortared Joints. Use only an approved mortar (or non shrink grout).

Compose mortar of 1 part Portland cement and 2 parts mortar aggregate by volume. Add only enough water to permit placing and packing of the soft workable mortar. The water-cement ratio shall not exceed 0.53. After the ends of the sections of box are cleaned and wetted, place mortar firmly into the lower half of the groove end of the previously laid section. Firmly place mortar on the top half of the tongue end of the section to be jointed. Snugly insert the tongue end into the groove end of the section previously laid. Use enough mortar to completely fill the joint.

316.03.10.05 Grout.

316.03.10.05.01 Composition of Materials. Grout shall consist of one part by volume of Portland cement and three parts of clean sand and shall contain only sufficient moisture to permit packing

Brush or point the interior joint. Trowel or brush smooth the inside joints and remove excess mortar from the interior box joint. Fill the outside joint recesses with mortar. Firmly fill the external space between the ends of the jointed box from the outside with laying mortar.

Backfill of the box trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before backfilling, do not backfill until 16 hours after jointing the box sections. When the box is not backfilled while the mortar is plastic, cure the mortar using a method approved by the *Engineer*. Do not allow free water to come in contact with the boxline until the mortar in the joints has set at least 24 hours.

316.03.10.05.01.01 Mastic Joints. Wrap mastic joint sealant around the tongue and snugly insert tongue end into the groove end of the section previously laid. Alternately, Contractor may place mastic firmly into the lower half of the groove end of the previously laid section and firmly place mastic on the top half of the tongue end of the section to be jointed. Snugly insert the tongue end into the groove end of the section previously laid.

316.03.10.05.01.02 Joint Gaps. The *Contractor* should make every effort to pull the box completely home. Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps should not exceed the gap tolerance listed below.

The recommended joint gap is one that does not exceed 1/2 of the *T&G* joint length. If this gap is exceeded, the contractor shall submit, for approval by the *Engineer*, methods to properly seal the joint.

316.03.10.05.01.03 Joint Material. In lieu of mastic material conforming to Section 203, the following extruded cellular rubber gaskets may be used for soil tight applications:

316.04 ACCEPTANCE.

316.04.01 Damaged Work.

316.04.01.01 Repair. Cracks in boxes (both longitudinal and circumferential) that are less than 0.10 inch in width in a non-corrosive environment ($pH > 5.5$) are generally considered non-structural flaws and need not be repaired.

Cracks that are equal to or exceed 0.10 inch in width shall require an evaluation by a *Professional Engineer*.

Damaged ends, chips or cracks which do not pass through the wall can be patched using an approved concrete patching material.

317.01 GENERAL.

317.01.01 DESCRIPTION. Segmented RC Box covered by this Subsection is intended for use in drainage applications and other conveyance systems. The boxes shall conform to the ASTM C1786 or as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

317.01.01.01 Terms.

Acceptable Crack. A crack width less than 0.1 inch and located in a non-corrosive environment (pH >5.5).

Segmented. A structure comprised of two or more individually cast components which are assembled at the *Site of Work* to form a completed structure.

Slabbing. The separation of *PCC* from the reinforcing steel.

Spalling. The peeling, popping-out and flaking off of a *PCC* surface.

317.01.02 Design. This Section does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the resulting pipe and pipe system. Design requirements shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. If details are not provided by the *Agency*, the *Engineer* shall adhere to the standard installations in accordance with the applicable Article in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The *Current* edition shall be used.

317.01.02.01.01 Box Design Verification. Box design verification shall be performed when there is a change to material suppliers, materials, mix design, equipment or manufacturing operation, but no less than once every 12 months for each size box. Monolithic boxes shall conform to ASTM C1786.

Design verification records shall be maintained by the manufacturer and made available upon request.

317.01.02.01 Strength Class. The strength class required for a project is dependent on the bedding and backfill material, the depth of cover and the loading conditions. The bedding and backfill requirements used by the *Engineer* to determine the class of pipe required should be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

The *Engineer* may refer to the standard installations, as defined in Section 12⁽¹⁾ – “Buried Structures and Tunnel Linings” of the AASHTO LRFD Bridge Design Specifications, which provide flexibility in selecting the installation that best meets the projects unique combination of site conditions, available backfill materials and desired construction and inspection materials. Once the type of installation is selected the correct strength class of *RC* pipe can be determined.

1. Section as designated in the 7th Edition published in 2014. Section designations may change with the publication of subsequent editions. The *Current* edition shall be used.

317.01.02.01.02 PCC.

317.01.02.01.02.01 Composition of Mixtures. The Mix Design shall comply with ASTM C 1786. The compressive strength at 28 Days, slump, target air content, aggregate gradation and type of cementitious material shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

317.01.02.02 Safety. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”, except as modified herein.

317.01.02.02.01 Trenches. Unless otherwise directed or approved by the *Engineer*, *Trenches* shall not be excavated until immediately before installation of pipe and other appurtenances.

317.02 MATERIALS. The materials used shall be determined and/or accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to performing subsequent *Construction Activities*.

317.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

317.02.02 CARE OF MATERIALS. The box and/or box components shall be supported so as not to create a concentrated point loading situation.

317.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or installations except as provided in Subsection 100.31.02 – “Use of Other Materials”.

317.02.04 AGGREGATES. Aggregates shall conform to Section 200 – “Aggregates”.

311.02.05 CEMENTITIOUS MATERIALS. Cementitious materials shall conform to Subsection 202.02 – “Cementitious Materials”.

317.02.06 ADMIXTURES. Admixtures shall conform to Subsection 202.03.01 – “Admixtures”.

317.02.07 FIBERS. Fibers shall conform to Subsection 202.03.02 – Fibers”.

317.02.08 CURING MATERIALS. Curing materials shall conform to Subsection 202.03.05 – “Curing Materials”.

317.02.09 WATER. Water shall conform to Section 205 – “Water”.

317.02.10 REINFORCING STEEL. Reinforcing steel shall conform to Section 206 – “Reinforcing Steel”.

317.03 CONSTRUCTION.

317.03.01 SUBMITTALS.

317.03.01.01 Certificate of Compliance. The *Contractor* shall provide a *Certificate of Compliance* for each material in accordance with Subsection 100.31.01 – “*Certificate of Compliance*”, except as modified herein.

317.03.01.02 Required Information.

- A. A statement that the individual responsible for the affirmation has the legal authority to bind the supplier or manufacturer and/or fabricator;
- B. Quantity of pipe shipped; and
- C. The size, class and quantity of pipe shipped.

A certificate shall be sent with each shipment. The *Contractor* shall ensure that the *Certificates of Compliance* have been reviewed and accepted by the *Engineer* prior to unloading the associated material at the *Site of Work*.

317.03.01.03 PCC. The *Contractor* shall submit, in writing, the *PCC* mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the *PCC*.

317.03.01.04 Quality Control Program. Manufacturer shall maintain a quality control program which is certified annually. At the time of this publication *ACPA Q-Cast* and *NPCA* are the most widely recognized national certification programs. A comparable internal certification program may be submitted to the *Agency* for review and approval.

317.03.01.04.01 Salvage of Existing Systems. Boxes, in general, cannot be reused or salvaged. Items such as vault frames and manhole covers may be salvaged and reused at the discretion of the *Engineer*.

317.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

317.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

317.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

317.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

317.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers; Methods and Equipment”

317.03.06.01 Batch Plant and Delivery Fleet. Unless otherwise directed or approved by the *Engineer* plants used for the ready-mix production of *PCC* shall be of sufficient capacity and coordinated to adequately handle the proposed construction. The plant, including the delivery fleet, shall hold a current *NRMCA* certification.

Information regarding certification, including a complete list of the related tests, and an electronic directory of *NRMCA* certified plants are available at www.nrmca.org.

The plant shall include satisfactory equipment or use other methods which will meet local conditions, city, county, state, and federal laws pertinent to air pollution.

317.03.07 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements. Any proposed construction loads that were not specifically identified in the design process shall be reviewed and approved by the *Engineer*.

317.03.08 SUBGRADE PREPARATION. *Subgrade* preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”

317.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303 - “Excavating”, except as modified herein.

317.03.09.01.01 Embankment Conditions.

317.03.09.01.02 Cover Limits. The box cover height should be determined during the design phase. In no instance shall the cover limits of the box be exceeded.

317.03.09.01.03 Trench Width. The minimum trench width shall be wide enough (between the box and trench wall) to permit the proper construction of joints and compaction of backfill around the box, but shall be at least equal to the trench width required under *AASHTO* Section 27 for Concrete Culverts.

If special circumstances exist, narrower trench widths may be used as approved by *Engineer*.

317.03.09.01 Placing of Materials.

317.03.09.01.04 Foundation and Bedding. The *RC Box* strength class for a project is dependent on the bedding and backfill material and compaction. The bedding and backfill requirements used by the engineer to determine the strength of box required should be called out on the project plans and specifications or the plans and specifications may refer to the local agency standard plan sheets that governed the design.

317.03.09.02 Backfill. Backfill above the top of the box shall conform to Subsection 200.03.06 – “Class E Backfill” with a relative compaction of at least 90 percent of the maximum dry density, within 2 percent of optimum moisture content, determined in accordance with ASTM D1557 or slurry backfill when specified in the project plans or specifications.

317.03.09.02.01 Mechanically Compacted Backfill. Mechanically compacted backfill shall be layered in 12" maximum lifts. Avoid usage of impact tampers directly above the box until the full loose layer backfill depth above the box is obtained.

317.03.09.02.02 Slurry Backfill. If slurry backfill is specified the slurry backfill shall conform to Subsection 337.08.01 – “Slurry Backfill”, Type A (Excavatable). The slurry backfill shall be placed around the box from the foundation bedding to the springline.

317.03.09.02.03 Connections. All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or concrete junction structure, shall be made by either grouting the lateral in to a fabricated reinforced opening, connecting the lateral with an approved Cast in Place field collar, or in a manufactured wye or tee. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater strength as the box.

Connections should be detailed in the project plan sheets or sent as part of the submittal package for approval of the engineer prior to fabrication.

317.03.09.02.04 Joints.

317.03.09.02.04.01 T&G Joints

317.03.09.02.04.01.01 Mortared Joints. Use only an approved mortar (or non-shrink grout). Compose mortar of 1 part Portland cement and 2 parts mortar aggregate by volume. Add only enough water to permit placing and packing of the soft workable mortar. The water-cement ratio shall not exceed 0.53. After the ends of the sections of box are cleaned and wetted, place mortar firmly into the lower half of the groove end of the previously laid section. Firmly place mortar on the top half of the tongue end of the section to be jointed. Snugly insert the tongue end into the groove end of the section previously laid. Use enough mortar to completely fill the joint.

317.03.09.03 Grout.

317.03.09.03.01 Composition of Materials. Grout shall consist of one part by volume of Portland cement and three parts of clean sand and shall contain only sufficient moisture to permit packing

Brush or point the interior joint. Trowel or brush smooth the inside joints and remove excess mortar from the interior box joint. Fill the outside joint recesses with mortar. Firmly fill the external space between the ends of the jointed box from the outside with laying mortar.

Backfill of the box trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before backfilling, do not backfill until 16 hours after jointing the box sections. When the box is not backfilled while the mortar is plastic, cure the mortar using a method approved by the engineer. Do not allow free water to come in contact with the boxline until the mortar in the joints has set at least 24 hours.

317.03.09.03.01.01.01 Mastic Joints. Wrap mastic joint sealant around the tongue and snugly insert tongue end into the groove end of the section previously laid. Alternately, Contractor may place mastic firmly into the lower half of the groove end of the previously laid section and firmly place mastic on the top half of the tongue end of the section to be jointed. Snugly insert the tongue end into the groove end of the section previously laid.

317.03.09.03.01.01.02 Joint Gaps. The contractor should make every effort to pull the box completely home. Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps should not exceed the gap tolerance listed below. .

The recommended joint gap is one that does not exceed 1/2 of the T&G joint length. If this gap is exceeded, the contractor shall submit, for approval by the Engineer, methods to properly seal the joint.

317.03.09.03.01.01.03 Joint Material. In lieu of mastic material conforming to Section 203, the following extruded cellular rubber gaskets may be used for soil tight applications:

317.03.09.03.01.01.03.01 Extruded Cellular Rubber Gaskets.

- A. Gaskets shall be manufactured from extruded closed cellular rubber, and meeting the physical requirements of ASTM D1056, Class 2C1. Each gasket shall be a single continuous part, conforming to the joint size and shape. The outer surface shall be completely covered with a smooth, impermeable natural skin of the same material.
- B. Gasket cross-sectional diameters and installation practices, to include maximum and minimum joint gaps, shall be in accordance with the manufacturer's recommendations. Submit a copy of the manufacturer's installation instructions.
- C. Do not use this type of gasket when the pipe is installed by jacking or boring methods.

317.04 ACCEPTANCE.

317.04.10.01 Damaged Work.

317.04.10.01.01 Repair. Cracks in boxes (both longitudinal and circumferential) that are less than 0.10 inch in width in a non-corrosive environment ($\text{pH}>5.5$) are generally considered non-structural flaws and need not be repaired.

Cracks that are equal to or exceed 0.10 inch in width shall require an evaluation by a *Professional Engineer*.

Damaged ends, chips or cracks which do not pass through the wall can be patched using an approved concrete patching material.

318.01 GENERAL.

318.01.01 DESCRIPTION. This Section covers the preparation and treatment of an existing surface with bituminous material and sand blotter if shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

318.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

318.01.01.02 Terms.

Prime Coat. Prime coat shall be defined as an application of low viscosity asphalt or asphalt emulsion to an aggregate base in preparation for an initial layer of asphalt.

Tack Coat. Tack coat shall be defined as a light coat of asphalt emulsion applied to an existing pavement or other surface to create a bond with the new pavement.

318.01.02 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”.

318.02 MATERIALS. The materials used shall be determined and/or accepted by the *Engineer*. The *Contractor* shall ensure that the certificate has been reviewed and accepted by the *Engineer* prior to transport.

318.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

318.02.02 CARE OF MATERIALS.

318.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage”.

318.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or methods except as provided in Subsection 100.31.02.

318.02.04 ASPHALT. Asphalt shall conform to Subsection 201.03 - “Cutback Asphalts” or 201.04 – “Emulsified Asphalts” except as modified herein.

318.02.04.01 Dilution. The emulsion shall be diluted by water. The asphalt to water ratio shall be. Water shall be added by weight of emulsion to create a 50/50, 60/40, or 70/30 asphalt to water ratio. The distillation rate shall be specified by the *Contract documents*, on the *Plans*, or by the *Engineer* in writing.

318.02.05 SAND BLOTTER. Sand blotter shall meet the requirements of Subsection 200.02.07 – “Sand Seal Aggregate or Sand Blotter.”

318.02.06 WATER. Water shall conform to Section 205 – “Water”.

318.03 CONSTRUCTION.**318.03.01 SUBMITTALS.**

318.03.01.01 Certificate of Compliance. The *Contractor* shall provide a certificate of compliance for each aggregate source in accordance with Subsection 100.31.01 – “Certificate of Compliance”, except as modified herein.

318.03.01.02 Additional Information. Unless waived by the *Engineer*, the certificate shall also include the following information:

- A. Results of all tests required by the specifications;
- B. Accredited Laboratory name and website address of accreditation program; and
- C. Personnel name(s) and website address of qualification program.

318.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

318.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.18 – “Location of Work”.

318.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

318.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

318.03.05.01 Preparation of Surface. The existing surface shall be patched as shown on the *Plans* and cleaned and be free of irregularities to provide a reasonably smooth and uniform surface to receive the treatment. The edges of existing pavements, which are to be adjacent to new pavement, shall be cleaned to permit the adhesion of bituminous materials.

318.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”, except as modified herein.

318.03.06.01 Distributors. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to 14 feet at readily determined and controlled rates from 0.05 to 2 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gages, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable literally and vertically.

318.03.07 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

318.03.08 PLACING OF MATERIALS.

318.03.08.01 Application of Bituminous Materials. No more prime or tack shall be applied than can be covered in the same shift. The prime and tack coat shall be applied in such a manner as to offer the least inconvenience to adjacent traffic.

318.03.08.01.01 Prime Coat. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. When traffic is maintained, not more than 1/2 of the width of the section shall be treated in one application. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Excess bituminous material shall be “squeegeed” from the surface. Excess prime shall not exist at the time of paving. Skipped areas of deficiencies shall be corrected.

When traffic is maintained, one-way traffic shall be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portion and the remaining width of the section shall be primed.

318.03.08.01.01.01 Application Rate. Unless otherwise directed or approved by the *Engineer* or shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* the bituminous material shall be uniformly applied at the rate specified in Table 318.03.08.01.01-I.

TABLE 318.03.08.01.01.01-I

| Application Rate (Gallons per square yard) | |
|--|--|
| | |
| 0.15 to 0.25 | |
| | |

318.03.08.01.01.02 Application Temperatures. The temperature of the bituminous material shall conform to the applicable requirements of Tables 318.03.08.01.01.02-I and 318.03.08.01.01.02-II.

TABLE 318.03.08.01.01.02-I

| Grade and Type <i>MC and SC</i> | Distributor Spraying Temperature °F | | Pugmill Mixing Temperature ⁽¹⁾ °F | |
|------------------------------------|--|---------|---|---------|
| | Minimum | Maximum | Minimum | Maximum |
| 70 | 120 | 180 | 95 | 140 |
| 250 | 165 | 220 | 135 | 175 |
| 800 | 200 | 255 | 165 | 205 |
| 3000 | 235 | 290 | 200 | 240 |

1. The maximum spraying temperature may be used if the aggregate is not heated.

TABLE 318.03.08.01.01.02-II

| Grade of Asphalt Emulsion | Distributor Spraying Temperature °F | | Pugmill Mixing Temperature ⁽¹⁾ °F of Emulsion and Aggregates | |
|---------------------------------|--|---------|--|---------|
| | Minimum | Maximum | Minimum | Maximum |
| RS-1, CRS-1 | 75 | 130 | Not used for Mixing | |
| RS-1, CRS-1 | 110 | 160 | Not used for Mixing | |
| SS-1, CSS-1 | 75 | 130 | 50 | 130 |
| SS-1h, CSS-1h | 75 | 130 | 50 | 130 |
| CMS-2S | 100 | 160 | 60 | 140 |

1. The maximum spraying temperature may be used if the aggregate is not heated.

318.03.08.01.02 Tack Coat. The emulsion shall be diluted by water. Water shall be added in the quantity of 50 percent of the emulsion by weight. To accomplish this mixing, the distributor shall be partly filled with water, and the correct proportion of emulsified asphalt shall then be added, and the remaining water to be added shall be sprayed in the tank under pressure and then thoroughly circulated within the distributor.

318.03.08.01.02.01 Application Rate. Unless otherwise directed or approved by the *Engineer* or shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* the bituminous material shall be uniformly applied at the rate specified in Table 318.03.08.01.02.01-I.

TABLE 318.03.08.01.02.01-I

| Application Rate (Gallons per square yard) | |
|--|--|
| | |
| 0.08 to 0.13 | |
| | |

318.03.08.01.02.02 Application Temperatures. When asphaltic emulsion is used, the temperature at the time of application shall conform to the applicable requirements in Table 318.03.08.01.01.02-II.

The tack coat shall break before subsequent paving operations.

318.03.08.02 Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate within 3 to 6 days and the roadway must be used by traffic, blotter material shall be spread and removed if excessive in the amounts required to absorb any excess bituminous material. When necessary for traffic, blotter material may be spread prior to 3 days penetrating time.

318.03.09 WEATHER LIMITATIONS.

318.03.09.01 Surface Moisture. Prime or tack coat shall not be placed on a grade which is frozen or which has a moisture content which would be detrimental to the compaction or quality of the prime or tack coat.

318.03.09.02 Temperature. Prime or tack coat shall not be placed unless the both the ambient and surface temperatures conform to Table 318.03.09.02-I.

Table 318.03.09.02-I

| | Ambient Temperature ° F | Aggregate Temperature ⁽¹⁾ ° F |
|------------|----------------------------|---|
| Prime Coat | 50 Minimum | - |
| Tack Coat | 40 Minimum | 40 Minimum |

1. Shall be measured on surface that is to be paved.

318.03.10 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

318.03.11 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

318.04 ACCEPTANCE. Placement of prime and/or tack coat shall be complete and accepted by the *Engineer* prior to placement of HMA.

319.01 DESCRIPTION. This work specification covers the construction of one or more courses of roadmix bituminous pavement on a prepared base or road surface in accordance with this Subsection and typical cross section shown on the Plans or established by the Engineer.

The mineral aggregate and bituminous material may be mixed in place in the prepared roadbed, or mixed off the roadbed by either roadmix or plantmix methods.

319.02 COMPOSITION OF MIXTURES. A mix design shall be performed and submitted to the Engineer in accordance with Subsections 337.01 "Mix Design" and 337.04 – "Bituminous Plantmix" to determine the composition of the mixture. The type and gradation of aggregate and type and grade of bituminous material will be specified in the Contract in the Special Technical Specifications. No roadmix bituminous mixture shall be placed without approval by the Engineer of a mix design.

319.03 CONSTRUCTION EQUIPMENT.

319.03.01 MOTOR GRADERS. Motor graders for spreading, shaping, and finishing mixture shall be of the self-powered type with blades not less than 12 feet long and wheel bases of not less than 17 feet.

319.03.02 DISTRIBUTORS. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to 14 feet at readily determined and controlled rates from 0.05 to 2 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gages, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable literally and vertically.

319.03.03 MIXING PLANTS. Traveling or stationary mixing plants or other equipment of proven performance may be used by the Contractor in lieu of the Specified equipment, if approved. Traveling mixing plants shall have positive controls for applying asphalt.

319.03.04 ROLLERS. Rollers used shall conform to the requirements of Subsection 320.03.04 – "Rollers."

319.03.05 WEATHER LIMITATIONS. The mixing, spreading, and compacting of roadmix bituminous pavement shall be carried on only when the surface on which the materials to be placed is dry and when the atmospheric temperature is above 50 degrees Fahrenheit, and has not been below 40 degrees Fahrenheit during the preceding 24 hours.

319.03.06 PREPARATION OF EXISTING SURFACE. Before spreading materials for roadmixing, the surface of the base or road surface on which the roadmix is to be placed shall be conditioned as specified in Section 320 – "Bituminous Plantmix."

After a prime coat is applied, it shall be left undisturbed not less than 24 hours. The Contractor shall maintain the primed surface until the roadmix material has been placed. This maintenance shall include the spreading of sand or other material, if necessary, to prevent adherence of the prime coat to the tires of vehicles using the primed surface and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become damaged shall be repaired before the roadmix material is placed.

319.03.07 PLACING AGGREGATES. Mineral aggregate shall be deposited upon the prepared subgrade, or mixing area, by the use of spreader boxes, or from the vehicles equipped, or supplemented with suitable spreading devices.

The mineral aggregate shall contain sufficient material to construct the roadmix surfacing as planned, including sufficient material for surfacing special features off the traveled way. The aggregate shall not be mixed with earth or other deleterious matter.

If the surface moisture of the aggregate is more than 2 percent of the dry weight of the aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be turned by blades or disc harrows or otherwise aerated until the moisture content is reduced to 2 percent or less. The aggregate shall be spread smoothly and uniformly over half the road or other convenient width of the surface ready for the application of bituminous material, except that when a traveling mixing plant is used the aggregate shall be formed into a uniform cross section.

In lieu of aerating and drying the aggregate, the Contractor may use an approved additive. The additive shall permit suitable coating of the wet aggregate and shall prevent the bituminous coating from stripping in the presence of water.

319.03.08 APPLICATION OF BITUMINOUS MATERIAL. The bituminous material shall be uniformly distributed in successive applications, in such amounts and at such intervals as directed. The temperature of the bituminous material shall conform to the applicable requirements of Section 315 – "Prime Coat." The mixing equipment shall follow immediately behind the distributor after each application of bituminous material. No more bituminous material shall be applied per day than can be mixed with the aggregate on the same day it is applied.

319.03.09 MIXING. The materials may be mixed upon the roadbed, or upon some other approved area of the roadbed by roadmixing methods, or the material may be mixed at a central mixing plant by plantmix methods as specified below, whichever the Contractor elects.

- a. **Roadmixing Methods.** Prior to applying the bituminous material, the prepared aggregate shall be spread smoothly and uniformly over 1/2 the mixing area or some other convenient width. The first application of bituminous material shall then be applied and partially mixed with the aggregate. The remaining applications of bituminous material with a partial mixing after each application shall follow in like manner. After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the mixing surface and then thoroughly mixed and combined by the mixing units specified by blading the mix from side to side of the mixing surface, or by manipulation producing equivalent results, until all particles are coated with bituminous material and the whole mass has uniform color and the mixture is free from spots containing an excess or deficiency of bituminous material, balls, or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When so directed by the Engineer, the mixing process shall be confined to part of the width or area of the roadbed so as to allow a convenient passage for traffic.

Prior to spreading and compacting, should the mixture show an excess or deficiency of bituminous material, or an uneven distribution thereof, the condition shall be corrected by adding mineral aggregate or bituminous material, as the case may be, and then remixing to produce a satisfactory mixture. If necessary, all compressed masses of mixed materials shall be broken up.

When the mineral aggregate consists of the existing material on the roadbed and an allowance for additional mineral aggregate has not been provided for on the Plans, additional mineral aggregate may be obtained by scarifying material from the roadbed as directed by the Engineer or, in lieu thereof, the Contractor may import suitable material. No additional compensation will be allowed for conforming to the above requirements, except that additional materials imported and added to that in place will be paid for at the unit price bid.

The amount of material mixed in any 1 day shall not be more than can be spread and compacted on the following day, provided, however, that when directed by the Engineer, mixed material may remain in the windrow for a longer period.

In lieu of mixing the material as above specified, a roadmixing machine or any equipment other than that required above may be employed which will produce the completed mixture equal to that which would be produced by the means above specified. The Agency reserves the right to order the use of any equipment discontinued which, in the opinion of the Engineer, fails to produce a satisfactory mixture.

The roadmixing machine shall be of the pugmill or auger type which picks up the loose material from the mixing area, or it may be of the type which cuts a true plane in material at a specified depth, leaving no loose material in either case. Either type shall introduce the bituminous material through a metering device at the time of mixing. The machine shall be equipped to provide for a positive control of the amount of bituminous material introduced into the mix, which can be readily adjusted to the changes required.

The rate of movement of the roadmixing machine, the amount of the material mixed, and the amount of mixing shall be so regulated that a mix satisfactory to the Engineer will result. The materials shall be mixed until a uniform mixture of unchanging appearance is obtained and all particles of aggregate are thoroughly coated with bituminous materials. Before mixing, the loose materials 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.

Materials mixed off the roadbed shall be uniform in character and equal in all respects to that which would be produced by mixing on the roadbed as above specified.

- b. **Plantmixing Method.** Should the Contractor elect to mix the materials at a central mixing plant by the plantmix method, the mineral aggregate shall be dried, proportioned, and mixed with the bituminous material in accordance with the applicable requirements of Section 320 – "Bituminous Plantmix" – of these Specifications with the following modifications: When the moisture content of the mineral aggregate does not exceed 2 percent by weight of the dry aggregate and laboratory tests indicate that such increased moisture content will not produce an unstable mixture, mixing of the materials without passing the aggregate through a dryer will be permitted.

Unless otherwise specified in the Special Provisions, separation of the mineral aggregate into required sizes and storing in separate bins will not be required.

319.03.10 SPREADING, COMPACTING, AND FINISHING. Before the finished mixture is spread for compaction, a triangular cut shall be made with a motor grader at each edge of the base course to provide for a thickened edge of bituminous mixture. The cut shall be approximately 2 inches deep at the outer edge and slope to zero 2 feet in toward the center. In making a cut, the excavated material shall be thrown to the edge of the roadbed in a small windrow against which the mixture shall then be spread.

After roadmixing operations have been completed and the mixture has been approved by the Engineer, the mixture shall be uniformly spread over the area to be surfaced to the proper width and to such depth as will compact to the required thickness. The mixture shall be spread by means of a motor grader meeting the requirements of Subsection 319.03.01 – “Motor Graders.”

Segregation of coarse or fine particles shall be avoided and the mixture shall be free from lumps or pockets of coarse and fine material after spreading.

After the mixture has been spread as above specified, approximately the top 1/2 of the material shall be removed by motor graders and placed into a windrow on one side. The windrow shall be so placed that earth or other extraneous materials will not become intermixed with the windrowed material. The exposed area not occupied by the windrow shall then be thoroughly rolled. Rolling shall be continuous throughout the spreading operations. The windrowed material shall then be respread over the entire surface by alternating the windrow from one side of the roadbed to the other and to the center, and gradually decreasing the amount of material moved until the entire surface has uniform texture and is smooth and true to cross section and grade and is uniformly compacted. During blading and rolling, all lumps and loose stones shall be moved to the outside of the surface area and disposed of.

All rolling, except the final finish rolling, shall be done with pneumatic-tired rollers. The finish rolling shall be done with steel-tired tandem or three wheeled rollers commencing at the lower edge, progressing toward the highest portion. Under no circumstances shall the highest portion be rolled first.

319.03.11 SURFACE TOLERANCES. The surface will be tested by the Engineer using a 12 foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed 0.03 foot. All humps or depressions exceeding the Specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

319.04 MEASUREMENT OF QUANTITIES. The quantity of roadmix bituminous surface aggregate to be measured for payment will be the based on the Contract unit, as indicated in the Bid Proposal, conforming to all the requirements for the completed work.

When the mixture is mixed at a central mixing plant by the plantmix method, and the quantity is measured in tons, the number of tons will be determined by weighing the completed mixture of aggregate and bituminous material, which conforms to all the requirements for the completed work, and deducting from this weight the weight of the bituminous material.

When mixing and compacting is to be paid for as a Contract item on a lineal foot basis, the quantity will be determined from measurements taken along the centerline of the roadway to be the nearest 1 foot length. No extra allowance will be made for mixing widened sections and shoulder dikes, unless otherwise provided in the Special Provisions

The quantity of bituminous mixture, the placing of which is to be paid for as a Contract item on an area basis in addition to the Contract prices paid for the bituminous mixture, will be determined from measurements of the quantity compacted in-place, which conforms to all the requirements for the completed work, measured based on the Contract unit, as indicated in the Bid Proposal.

319.05 BASIS OF PAYMENT. The quantity of materials measured will be paid for at the Contract unit price bid per Contract item.

The Contract unit price bid per Contract item shall be full compensation for all work involved in constructing roadmix bituminous surface, as shown on the Plans or established by the Engineer, including, but not limited to, furnishing all the material; scarifying; mixing; loading; hauling; placing; and compacting.

Mineral aggregate consisting of material-in-place on the roadbed will not be measured and paid for.

Full compensation for furnishing and applying bituminous material or asphalt emulsion as provided for in Subsection 319.03.06 – “Preparation of Existing Surface” – shall be considered as included in the Contract unit price bid for the principal items involved and no further compensation will be paid.

320.01 GENERAL.

320.01.01 DESCRIPTION. This Section covers the production, provision, preparation for placement, and placement of *HMA*.

The *State* policy, enacted in 2012, is to encourage and promote the use of recycled aggregate, recycled bituminous pavement and recycled rubber from tires in the construction, reconstruction, improvement, maintenance and repair of public roads in the *State*.

HMA containing recycled materials, conforming to the requirements specified herein, may be substituted at the *Contractor*'s option for any lift of conventional *HMA*. The *Agency* and/or *Engineer* shall ensure the use of recycled material is not restricted. At the time of publication of the latest revision of these specifications, *RAP* is the most common recycled material used locally; therefore, specifications have been developed for its use. The use of other materials would require additional specifications.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

320.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

320.01.01.01.02 Terms.

Design. Design shall be defined as preparing mix design(s) for *HMA*.

Lot. Lot shall be defined as 500 tons of bituminous mixture or portion thereof exceeding 250 tons for each day's placement, with each day's placement consisting of at least one lot.

Production. Production shall be defined as furnishing, proportioning, combining and mixing all materials in accordance with approved *HMA* mix design(s).

Hot Plant. Hot plant shall be defined as a facility which produces *HMA*.

Batch Plant. Batch Plant shall be defined as a facility in which the mix is produced in batches. The feeders feed aggregate to a rotary dryer where the moisture is removed. The aggregate is then transported to a set of screens where it is divided into component sizes and stored in “hot-bins”. These aggregates are then proportioned into a weigh bin by the plant's blending computer, then introduced into a pugmill and “dry-mixed”. The asphalt is introduced and the mixture is then “wet-mixed”. At the end of this cycle the pug gate opens and the finished hot-mix is either discharged directly into a waiting truck or it is dropped into a moveable chute, which leads to a slat conveyor and then a holding silo.

Drum Plant. Drum plant shall be defined as a continuous mix facility. In the feeders the aggregates are proportioned into the correct blend to meet job requirements. This material is then conveyed to the dryer/mixer where the first two thirds of the unit is dedicated to moisture removal. In the last third of the unit the asphalt is injected and the resultant material is thoroughly mixed. At the end of the process the finished hot-mix is discharged into a slat conveyor for transport to a storage silo.

Placement. Placement shall be defined as transferring, spreading, compacting and grading to a specified line and grade of the *HMA*.

320.01.02 DESIGN. This Subsection does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the resulting composite roadway section. The *Engineer* shall show specific design requirements on the *Plans* or specify these requirements in the *Special Provisions* and/or *Special Technical Specifications*.

320.01.02.01 HMA.

320.01.02.01.01 Composition of Mixtures. A mix design shall be prepared in accordance with Subsection 337.01 - “Mix Design”. The blows per side, target air voids, aggregate gradation and type and grade of asphalt shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

320.01.02.01.01.01 HMA. For *HMA* containing 15 percent or less of *RAP* by dry weight of aggregate, the mix design shall be performed in accordance with Subsection 337.04 – “*HMA*”.

320.01.02.01.01.02 HMA with Greater Than 15 Percent RAP. For *HMA* containing greater than 15 percent of *RAP* by dry weight of aggregate, the mix design shall be performed in accordance with Subsection 337.05 – “*HMA* with Greater Than 15 Percent *RAP*.”

320.01.03 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”.

320.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to transport.

320.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “*Inspection and Testing*” and the applicable Subsections of Section 336 – “*Inspection and Testing*”.

320.02.02 CARE OF MATERIALS.

320.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “*Material Storage*.” except as modified herein.

320.02.02.01.01 Aggregates. Sufficient storage space shall be provided for the aggregate required. The storage yard shall be maintained neatly and orderly and separate aggregate stockpiles shall be readily accessible for sampling.

320.02.02.01.01.01 RAP. The *RAP* stockpiling area shall be graded and compacted so a firm, smooth, well drained area can be maintained at all times.

320.02.02.02 Processing and Stockpiling RAP for Incorporation in HMA. *RAP* incorporated into *HMA* shall be processed and stockpiled in such a manner to produce a uniform *RAP* product. Layer placing or alternate approved methods shall be used to prevent coning or segregation of component sizes. The stockpile shall be maintained in a loose and uncompacted state. To prevent premature consolidation, *RAP* shall not be stored in confined metal bins or hoppers unless slated for immediate processing.

Immediately prior to feeding the *RAP* into the mixing plant, the material shall first pass through an apparatus which eliminates oversize material.

320.02.02.02.01 Process Control Plan. A written Process Control Plan shall be required from any construction material producer processing *RAP* to be incorporated in any percentage as a blend material during the production of *HMA*. This written plan shall be provided to the *Engineer* upon request. The *Agency* and/or *Engineer* shall have the option to inspect *RAP* processing facilities and/or request representative samples of processed *RAP* for properties verification.

The process control plan shall include a brief narrative for each location or facility where *RAP* processing occurs that describes procedures implemented during initial handling of unprocessed *RAP* materials. In an effort to optimize consistency of *RAP* to be incorporated in *HMA*, measures shall be described to minimize inclusion of undesirable materials such as lightweight aggregate, organics, dirt, concrete, and trash into the finished *RAP* product.

320.02.02.02.02 Process Control Testing. Process control testing shall be performed in conformance with Subsection 336.03.04.06 – “*HMA* Containing *RAP*”. A summary of the results of all process control test data shall be included with the Process Control Plan.

320.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or methods except as provided in Subsection 100.31.02 – “*Use of Other Materials*”, except as modified herein.

320.02.03.01 RAP. If the original mix design *RAP* stockpile is supplemented during the one year approval period of the mix design, testing of the supplemented *RAP* shall be conducted in accordance with Subsection 320.02.02.02 – “*Process Control Testing*”.

320.02.04 AGGREGATES. Aggregates shall conform to Section 200 – “Aggregates”, except as modified herein.

320.02.04.01 RAP for Type 2 and Type 3C HMA. RAP for Type 2 and Type 3C HMA shall be sized so that 100 percent of that product passes a 3/4” sieve when tested in accordance with Subsection 336.03.04.06 – “RAP”.

320.02.04.02 RAP for Type 3 HMA. RAP for Type 3 HMA shall be sized so that 100 percent of that product passes a 1/2” sieve when tested in accordance with Subsection 336.03.04.06 – “RAP”. It shall be the materials producers’ option to determine whether individual RAP products shall be further fractionated.

320.02.04.03 Miscellaneous Areas. Unless otherwise directed or approved by the *Engineer*, aggregate for HMA used in miscellaneous areas shall conform to Subsection 202.02.03 – “Plantmix and Roadmix Aggregate”, Type 3.

320.02.05 ASPHALTS AND ADDITIVES. Asphalts and additives shall conform to Section 201 – “Asphalts and Additives”.

320.03 CONSTRUCTION.

320.03.01 SUBMITTALS.

320.03.01.01 Certificate of Compliance. The *Contractor* shall provide a certificate of compliance for each material in accordance with Subsection 100.31.01 – “Certificate of Compliance”, except as modified herein:

320.03.01.01.01 Asphalts and Additives. The date of each test performed shall be no more than 30 *Calendar Days* prior to the date of shipment to the hot plant.

320.03.01.02 HMA. The *Contractor* shall submit, in writing, the HMA mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the HMA.

320.03.01.03 Quality Control Program. Unless otherwise directed or approved by the *Engineer*, a written Quality Control Program shall be required for the HMA production process. This written plan shall be provided to the *Engineer* upon request. The *Agency* and/or *Engineer* shall have the option to inspect production facilities and/or request representative samples of mixture components or produced HMA for properties verification.

The overall plan shall address the individual elements which affect the quality of the HMA including, but not limited to, mix design; aggregate gradation; quality of materials; stockpile management; proportioning; mixing; transporting; and placing and compaction.

320.03.01.04 Haul Route. Unless waived by the *Engineer*, the *Contractor* shall submit to the *Engineer* a document designating the route to be used for transporting of materials. The *Contractor* shall ensure that the document has been reviewed and accepted by the *Engineer* prior to proceeding with the related *Construction Activity*.

320.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

320.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

320.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

320.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

320.03.05.01 Preparation of Existing Surface. When the surface of the existing bituminous pavement or old base is irregular, it shall be brought to uniform grade and cross section established. Tack coat shall be applied in accordance with Section 318 – “Prime and Tack Coat”.

When shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, all longitudinal and transverse joints and all cracks shall be sealed by the application of the specified joint sealing compound before spreading the *HMA* on an existing bituminous pavement or *PCC* surface. All excess bituminous material shall be removed from joints and cracks prior to spreading the *HMA*.

Contact surface of existing curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of asphalt emulsion prior to the *HMA* being placed against them in accordance with Section 318 – “Tack and Prime Coat.”

325.03.05.02 Temporary Resurfacing. The *Contractor* shall maintain all temporary resurfacing in a safe, rideable condition.

320.03.06 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”, except as modified herein.

320.03.06.01 Hot Plant. Plants used for the preparation of *HMA* shall be of sufficient capacity and coordinated to adequately handle the proposed construction. Equipment shall be capable of heating to mixing temperatures in accordance with the manufacturer’s recommendations.

The plant shall be equipped with a suitable thermometric instrument placed at the discharge chute of the drier to automatically register or indicate the temperature of the heated aggregates.

The plant shall include satisfactory precipitation devices or use other methods which will meet local conditions, city, county, state, and federal laws pertinent to air pollution.

The maximum temperature of the *HMA* when leaving the plant shall be 350°*F*. The permissible moisture content of the *HMA* shall not exceed 1.0 percent as determined by AASHTO T 329. Should the aggregate contain excessive moisture when heated within temperature limits, the *Contractor* shall take satisfactory corrective action before resuming *HMA* operations.

320.03.06.01.01 Asphalt. Asphalt shall be measured or gauged and introduced into the mixer in the amount(s) specified by the job mix formula. The asphalt material shall be heated in a manner that will avoid local overheating and provide a continuous supply of asphalt to the mixer at a uniform temperature at all times.

An armored thermometer of adequate range in temperature reading shall be fixed in the asphalt feed line near the discharge valve.

320.03.06.01.01.01 Storage. Tanks for the storage of asphalt shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for asphalt shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring the asphalt in the storage tanks.

320.03.06.01.02 Aggregates.

320.03.06.01.02.01 Heating and Drying. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process.

320.03.06.01.02.01.01 RAP. The plant shall be modified such that the combination of *RAP* and virgin aggregate can be heated to a temperature needed for a resultant mix temperature. The *RAP* shall be introduced into the plant in such a manner as to ensure uniform proportioning and to protect the material from direct contact with the burner flame.

320.03.06.01.02.02 Proportioning.

320.03.06.01.02.02.01 Batch Plant. Aggregates proportioned immediately after the heating and drying process shall be screened into a minimum of two fractions in the case where minus 1/2 Inch aggregate is used, and into a minimum of three fractions when larger sized aggregate is used. The screened material shall be conveyed to separate compartments ready for proportioning and mixing with asphalt material.

The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregates required to meet the *JMF*.

320.03.06.01.02.02.02 Drum Plant. Aggregates proportioned prior to the heating and drying process shall be separated into at least three bins. Each portion of the material shall be stored separately. When moving the aggregate from storage to compartment bins, any method may be used which will not cause segregation, degradation, or combinations of aggregate which fail to meet the specified gradation requirements.

320.03.06.01.02.03 Lime Treatment.

320.03.06.01.02.03.01 Marination Method. Lime marinated aggregates shall be prepared in accordance with the Marination Method described in Subsection 401.03.08 – “Preparation of Aggregates”, of the *Silver Book*.

320.03.06.01.02.03.02 Dry Lime. The moisture content of the aggregate shall be a minimum of 4 percent prior to introduction of dry lime at the plant. The dry lime shall be delivered to the combined aggregates from the silo to a calibrated metering device which is interlocked with the aggregate control (electrically driven feeder actuated from the same circuit). When the aggregates and the lime have been combined, the entire mass shall be mixed until a uniform coating has been achieved.

320.03.06.01.02.03.02.01 Batch Plant. In batch plants, dry lime introduced at the plant shall be added to the aggregate prior to drying.

320.03.06.01.02.03.02.02 Drum Plant. In continuous mix and/or drum dryer plants, dry lime introduced at the plant shall be added to the aggregate after the aggregate is proportioned.

320.03.06.01.02.04 Mineral Filler. Mineral filler shall be drawn from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition. The mineral filler for delivery to the mixer shall be from a vane-type metering device which is interlocked (electric driven feeders shall be actuated from the same circuit) to the flow of each aggregate feeder. The drive shaft on the mineral filler vane feeder shall be equipped with a revolution counter reading to 1/10 of a revolution, and a means for varying the rate.

320.03.06.01.02.05 Job Control Grading Band. During construction, test properties of the *HMA* furnished shall conform to Table 320.03.06.02.02.05-I.

TABLE 320.03.06.01.02.05.01-I

| Test Property | Job Control Grading Band |
|--|---|
| Aggregate passing the No. 4 sieve and larger (%) | <i>JMF</i> Target Value ± 7 |
| Aggregate passing the No. 8 to 100 sieves (%) | <i>JMF</i> Target Value ± 4 |
| Aggregate passing the No. 200 sieve (%) | <i>JMF</i> Target Value $\pm 2^{(1)}$ |
| Asphalt (%) | <i>JMF</i> Target Value $\pm 0.5^{(2)}$ |
| Laboratory Air Voids (%) | <i>JMF</i> Target Value ± 1.5 |

1. Not to exceed 8%.
2. By total weight of the mix

320.03.06.01.03 Additives. Additives shall be measured or gauged and introduced into the mixer in the amount(s) specified by the *JMF*. Additives, when used, shall be controlled and handled in accordance with the manufacturer's recommendations.

320.03.06.02 Transport. Trucks used for hauling *HMA* shall have tight, clean, smooth metal beds which have been thinly coated with an asphalt release agent to prevent the *HMA* from adhering to the beds. Do not use diesel or kerosene. Tarps shall be used if the haul distance or hauling time results in cooling of the *HMA* to below temperature specified for placement at the work site.

320.03.06.03 Placement. Pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary and capable of spreading and finishing layers of *HMA* in lane widths applicable to the specified typical section and thicknesses shown on the *Plans*. Pavers used for shoulders and similar construction shall be capable of spreading and finishing layers of *HMA* in widths shown on the *Plans*.

Pavers shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the *HMA* uniformly in front of the screed.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the *HMA*.

Hydraulic strike-off screed extensions shall only be used for tapered sections and odd shaped areas. The *HMA* pavement for all uniform roadway sections shall be placed, spread, and compacted only by that portion of the paver equipped with a vibratory screed which is equipped with screed heaters.

Unless otherwise directed or approved by the *Engineer*, the paver shall be equipped with a leveling device which facilitates smooth transition between grade changes.

320.03.06.04 Finishing. The *Contractor* shall provide a minimum of two steel wheel rollers and one pneumatic roller, unless otherwise approved by the *Engineer*. All rollers shall have an operational reversing mechanism so that the roller is capable of changing directions smoothly.

Rollers shall be equipped with a system that prevents *HMA* from sticking to the wheels. A release agent may be used provided it does not damage the *HMA* or impede the bonding of layers.

320.03.06.04.01 Breakdown Rollers. Breakdown rollers shall be a two axle tandem weighing not less than 10 tons and capable of rolling with or without vibration.

320.03.06.04.02 Pneumatic Rollers. Pneumatic-tired rollers shall be equipped with pneumatic tires of equal size and diameter mounted on two axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading, so that the total operating weight of the roller is not less than 10 tons.

The tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by one tread of the following tires. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than 5 psi. The inflation pressure shall be in accordance with the tire manufacturer's recommendation. Minimum tire size shall be 7.50 by 15 Inches, four ply.

320.03.06.04.03 Finish Rollers. The finish roller shall be a two axle tandem steel wheel roller weighing not less than 8 tons.

320.03.07 CONSTRUCTION LOADS. The *Contractor*'s operations shall not produce a surcharge which would impact stability of adjacent improvements.

320.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”.

320.03.09 EXCAVATING. Excavating shall be performed in accordance with Section 303 - “Excavating”.

320.03.10 PLACING OF MATERIALS. The *Contractor*'s operations shall not create dust hazard or other nuisance. The *Contractor* shall immediately remove and dispose of any nuisance material and/or spillage within the *Site of Work* and/or any routes used for transport of materials.

320.03.10.01 Spreading and Compacting. The *Contractor* shall ensure that the surface has been accepted by the *Engineer* prior to placing the *HMA*.

320.03.10.01.01 Tack Coat. Unless otherwise directed or approved by the *Engineer* tack coat shall be applied to the surface of *HMA* courses that are not constructed in the same shift. Tack coat shall be applied in accordance with Section 321 – “Prime and Tack Coat”.

The *HMA* shall be spread and struck off to grade, and elevation established. Pavers shall be used to distribute the *HMA* either over the entire width or over such partial width as may be feasible.

Only in areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the *HMA* may be spread by other means to obtain the specified lines, grades and cross sections. Use a pneumatic tamper, plate compactor, or equivalent, to achieve thorough compaction.

320.03.10.01.02 Lift Thickness. In no case shall the compacted thickness of a single lift be less than 3 times the nominal maximum particle size of the mix being placed, defined as one sieve size larger than the first sieve to retain more than 10%, unless otherwise approved by the *Engineer*. In no case shall the compacted thickness of a single lift exceed 4 inches.

The paver(s) shall move at a uniform rate with a minimum amount of stopping. Placing of the *HMA* shall be as continuous as possible.

Unless otherwise directed or approved by the *Engineer*, the minimum temperature entering the paver shall be 250 °F.

320.03.10.01.03 Windrow Placement. At the *Contractor*’s option, *HMA* base or surface material may be placed in a windrow in front of the paver. When used, the windrow shall be properly sized to insure the delivery of the correct amount of material to the paver at all times. The *HMA* shall be transferred from the windrow to the paver in such a manner that the materials in the paver will be uniform. The base, upon which the windrow was formed, shall not be disturbed during pickup of the *HMA*. There shall be no excess paving material remaining on this base between the pickup device and the paver.

320.03.10.02 Rolling. The *Contractor* shall use a rolling pattern which ensures satisfactory compaction. Unless otherwise directed or approved by the *Engineer*, initial rolling shall commence at the lower edge and shall progress toward the highest portion of the roadbed.

The breakdown roller shall immediately follow the paver and shall completely cover the *HMA* mat. The pneumatic roller shall follow the breakdown roller and shall completely cover the *HMA* mat. The pneumatic rolling shall be performed at a suitable temperature to ensure that *HMA* does not stick to the pneumatic tires. The finish roller shall follow the pneumatic roller and shall completely cover the *HMA* mat.

All rolling shall be performed in such a manner that cracking, shoving, or displacement will be avoided. The roller shall be kept in continuous motion while rolling so that all parts of the pavement shall receive equal compression. The motion of the roller shall be slow enough at all times to avoid displacement and cracking of the pavement. Any displacement occurring as result of reversing the direction of the roller, or from any other cause, shall be corrected immediately.

Unless otherwise directed or approved by the *Engineer*, rollers shall not pass over the unprotected edges of a freshly laid *HMA*.

Unless otherwise directed or approved by the *Engineer*, the finish rolling shall be completed while the temperature of the *HMA* is at or above 140°F.

320.03.10.03 Joints.

320.03.10.03.01 Longitudinal. Longitudinal joints shall be constructed only on the shoulders or edge of travel lanes. Longitudinal joints in *HMA* pavement shall be located to coordinate with the striping plan. Longitudinal joints shall be spaced in such a manner that joints in succeeding layers will overlap the joint of the preceding layer by at least 6 inches horizontally.

When the temperature of the adjacent mat is less than 130°F, a tack coat shall be applied in accordance with Section 318 – “Tack and Prime Coat” to the contact surface of longitudinal joints prior to placement of additional HMA against the previously rolled material.

320.03.10.03.02 Transverse. Transverse joints exposed to traffic shall be finished with a 25 horizontal to 1 vertical transition to the existing surface. The transition joint material shall be removed prior to placement of additional HMA by exposing the full depth of the mat and removing the excess material.

When the temperature of the adjacent mat is less than 130°F, a tack coat shall be applied in accordance with Section 318 – “Tack and Prime Coat” to the contact surface of transverse joints prior to placement of additional HMA against the previously rolled material.

320.03.10.04 Miscellaneous Areas. Miscellaneous areas include road approaches and connections, median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way

The HMA placed in miscellaneous areas may be spread in one layer. The material shall be compacted to the required lines, grades, and cross section.

Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required cross section.

320.03.11 WEATHER LIMITATIONS.

320.03.11.01 Surface Moisture. HMA base layer or surface layer shall not be placed on a grade which is frozen or which has a moisture content which would be detrimental to the compaction or quality of the HMA.

320.03.11.02 Temperature. Dense grade HMA base layer or surface layer shall not be placed unless the both the ambient and surface temperatures conform to Table 320.03.11.02-I.

Table 320.03.11.02-I

| Compacted Thickness | Ambient Temperature °F | Surface Temperature ⁽¹⁾ °F |
|-----------------------|------------------------|---------------------------------------|
| Greater than 2 Inches | 40 Minimum | 40 Minimum |
| 2 Inches or Less | 45 Minimum | 45 Minimum |

1. Shall be measured on surface that is to be paved.

320.03.11.02.01 Open Grade. Unless otherwise directed or approved by the *Engineer*, open grade plantmix surface shall be placed only when the ambient and surface temperature is above 60° F.

320.03.12 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

320.03.13 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

320.04 ACCEPTANCE. HMA pavement shall be accepted based on the following criteria:

- Surface tolerance;
- In place relative compaction; and
- Thickness.

320.04.01 SURFACE TOLERANCE. The surface of the compacted HMA pavement shall be smooth and free from irregularities due to placement operation, ruts, humps, depressions. Any ridges, indentations, or other objectionable marks left in the surface of the HMA by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the mat surface shall be discontinued and other acceptable equipment shall be furnished by the *Contractor*.

Unless otherwise directed or approved by the *Engineer*, when a straightedge 12 feet long is laid on the surface of the compacted mat and parallel with the centerline of the roadway, the surface shall not vary more than 1/8 Inch from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 1/4 Inch are present when tested with a straightedge 12 feet long laid in a direction transverse to the centerline and extending from edge to edge of a 12 foot traffic lane. The finished grade of the pavement surface shall vary no more than 5/8 Inch from design finished grade in both profile and cross section.

320.04.01.01 Mitigation. Compacted *HMA* pavement surfaces which do not conform to Subsection 320.04.01 – “Surface Tolerance” shall be mitigated by grinding with an application of a surface seal. The seal shall be recommended by the *Engineer* and accepted by the Public Works Department of the maintaining *Agency* prior to application by the *Contractor* at no additional cost to the *Agency/Owner*.

320.04.02 RELATIVE COMPACTION. Relative compaction of the compacted layer shall be based on the *Theoretical Maximum (Rice) Specific Gravity* and determined in accordance with Subsection 336.18 – “*HMA*”. Each lot of compacted *HMA* shall have a *Rice Relative Compaction* between 97% and 92% for mixes with a target air void content of 4% and 98% and 93% for mixes with a target air void content of 3%.

320.04.02.01 Mitigation. Compacted *HMA* pavement which do not conform to Subsection 320.04.02 – “Relative Compaction” shall be evaluated for acceptance and mitigation by the *Engineer* in accordance with Tables 320.04.02.01-I for mixes with a target air void content of 4% or Table 320.04.02.01-II for mixes with a target air void content of 3%.

Table 320.04.02.01-I – 4% TARGET AIR VOID CONTENT

Introduction: This process is provided to assist in assessing compacted pavement for conformance with Subsection 336.18.02.02.05 – “Relative Compaction” and, if recommended for acceptance, providing recommendations for any mitigation measures needed to achieve the design service life of the pavement. The process requires sound engineering analysis and judgment. The *Engineer/Engineer of Record* shall evaluate all relative parameters, including mix properties; location within the pavement section and roadway cross section; environmental considerations; and future maintenance, and provide the recommendation regarding acceptance and any needed mitigation measures. The recommendation shall be stamped and signed by a *Professional Engineer* and provided to the Public Works Department of the maintaining Agency for determination of the acceptability of the recommendation. The *Engineer/Engineer of Record* shall include documentation from the Public Works Department of the maintaining Agency that any mitigation measures have been accepted with the letter of verification regarding the adequacy of the improvements. The *Contractor* shall comply with any mitigation measures at no additional cost to the *Agency/Owner*.

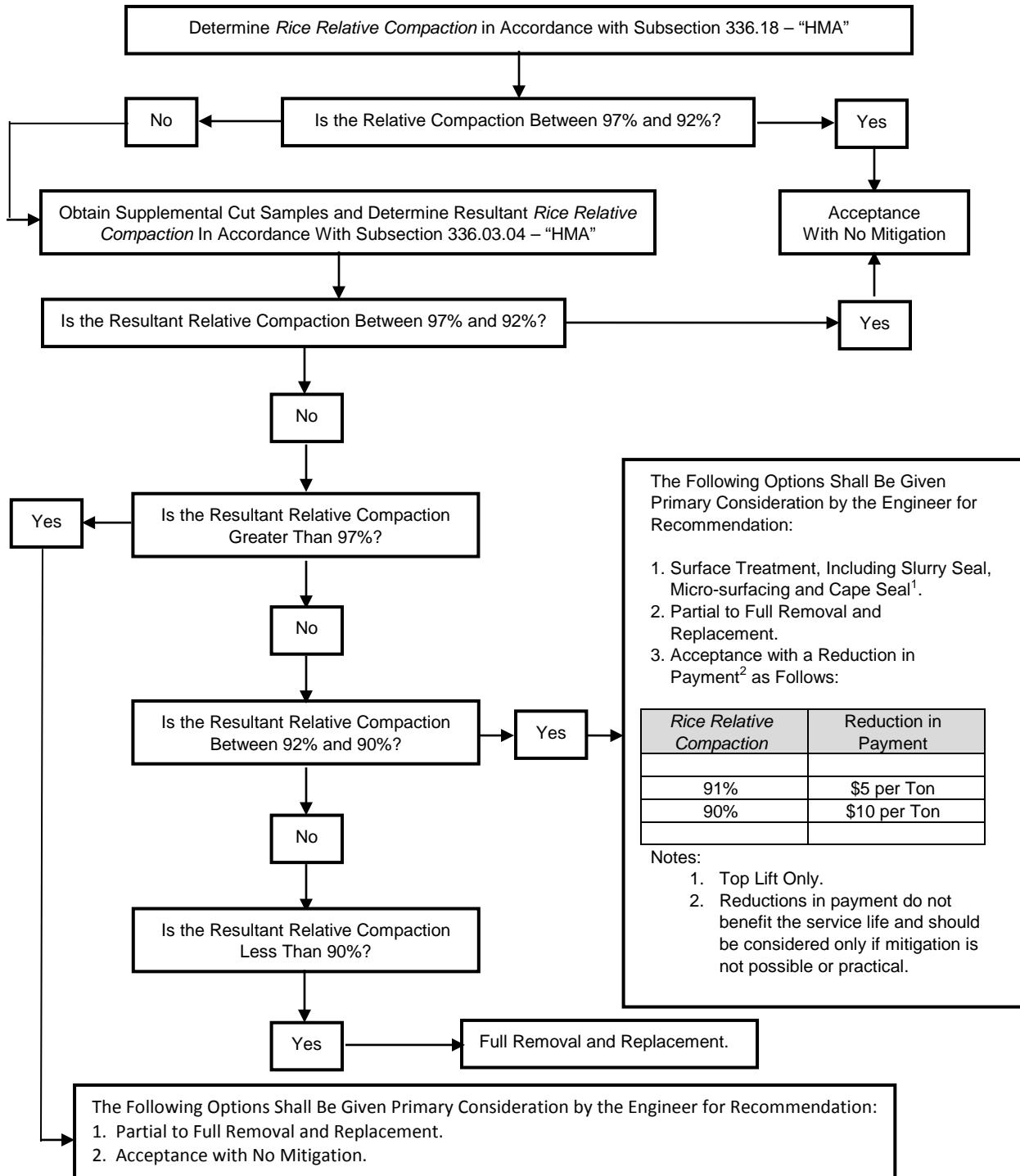
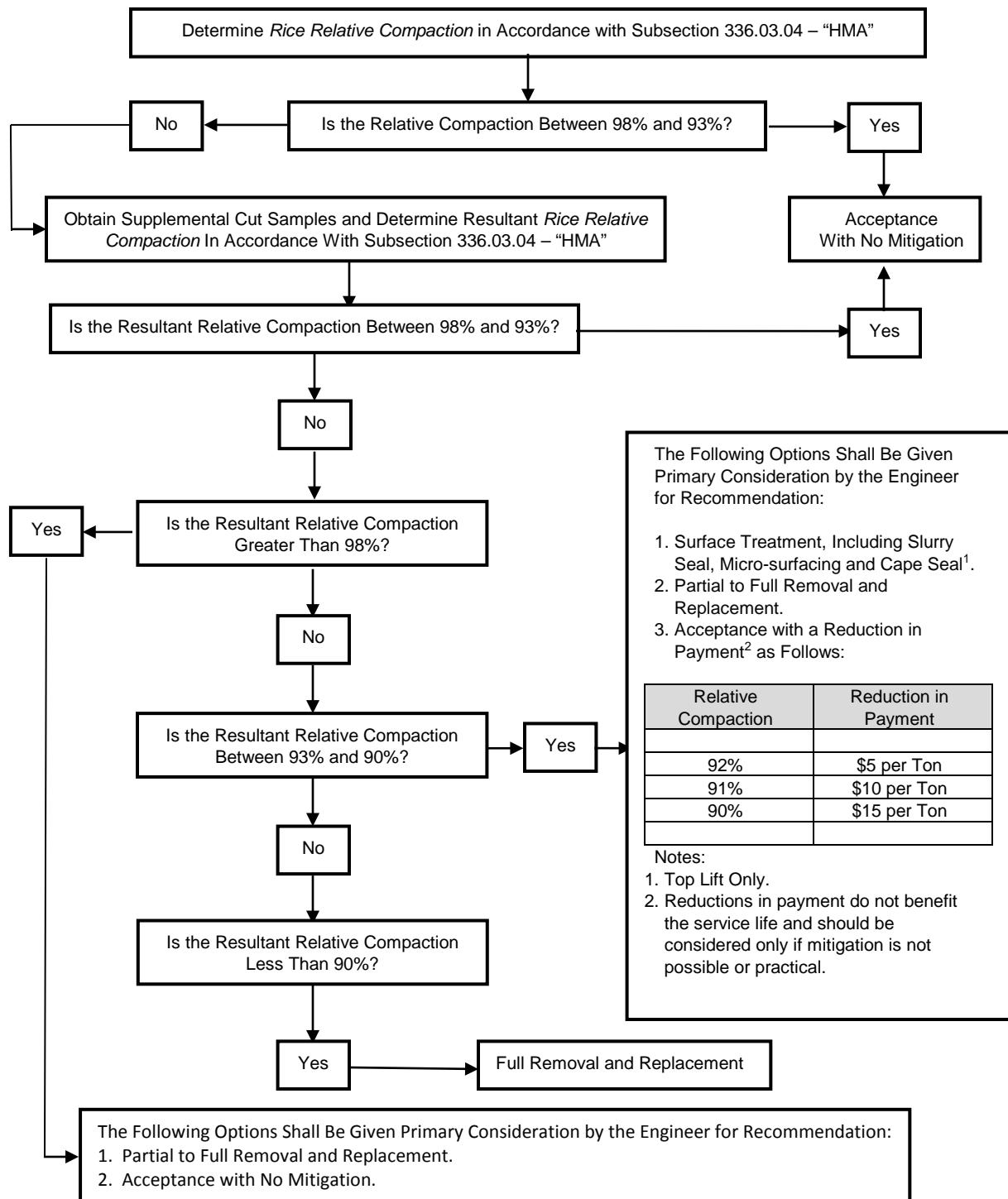


Table 320.04.02.01-II – 3% TARGET AIR VOID CONTENT

Introduction: This process is provided to assist in assessing compacted pavement for conformance with Subsection 336.04.02 – “Relative Compaction” and, if recommended for acceptance, providing recommendations for any mitigation measures needed to achieve the design service life of the pavement. The process requires sound engineering analysis and judgment. The *Engineer/Engineer of Record* shall evaluate all relative parameters, including mix properties; location within the pavement section and roadway cross section; environmental considerations; and future maintenance, and provide the recommendation regarding acceptance and any needed mitigation measures. The recommendation shall be stamped and signed by a *Professional Engineer* and provided to the Public Works Department of the maintaining Agency for determination of the acceptability of the recommendation. The *Engineer/Engineer of Record* shall include documentation from the Public Works Department of the maintaining Agency that any mitigation measures have been accepted with the letter of verification regarding the adequacy of the improvements. The *Contractor* shall comply with any mitigation measures at no cost to the *Agency/Owner*.

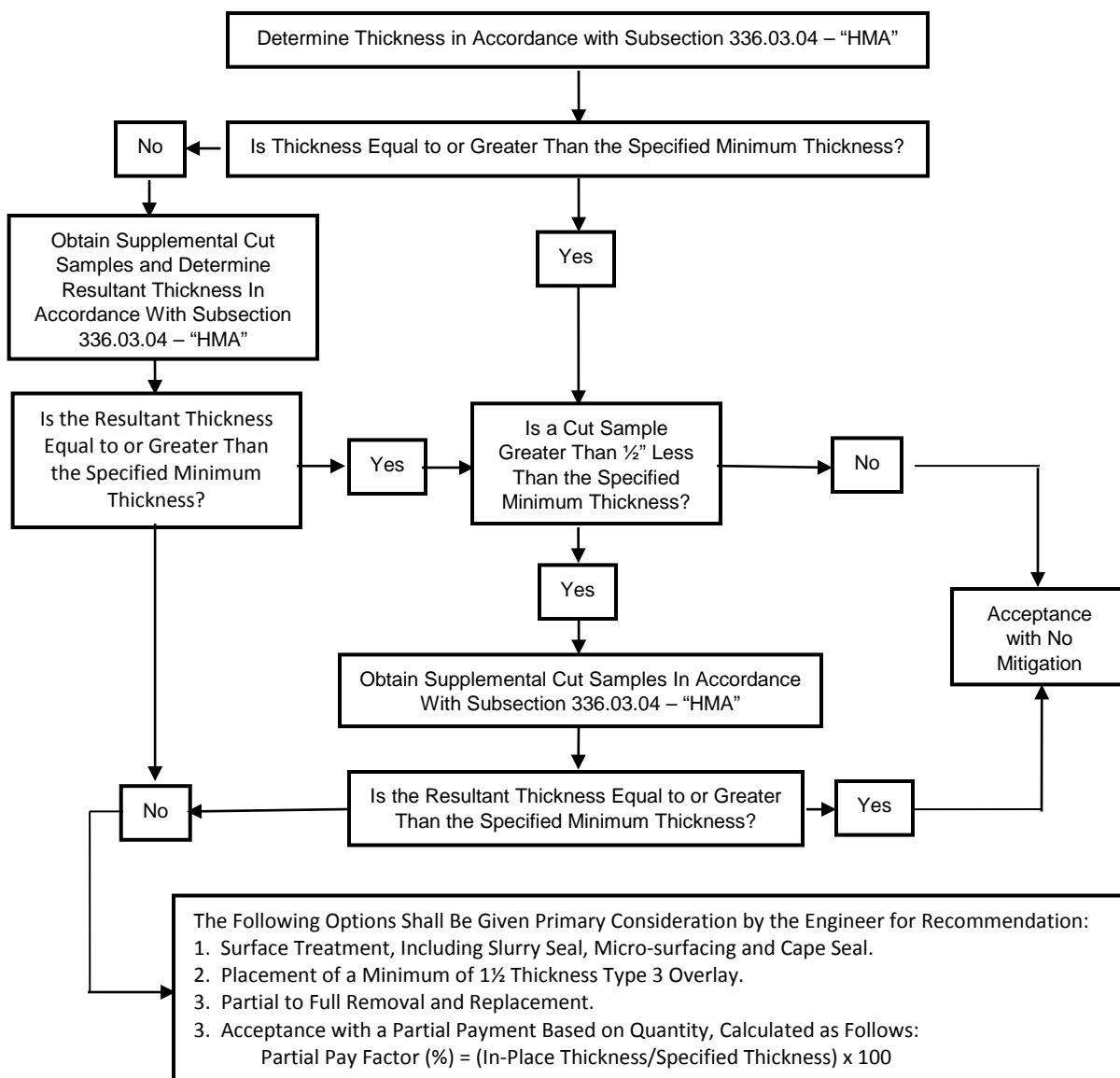


320.04.03 THICKNESS. Cut samples taken in accordance with Section 336.03.04 - "HMA" shall be used to determine conformance with thickness specifications. The average thickness of cut samples shall be at least equal to the specified minimum thickness of the HMA pavement per each lot sampled with no single core greater than $\frac{1}{2}$ " less than the specified minimum thickness.

320.04.03.01 MITIGATION. Compacted HMA pavement which does not conform to Subsection 320.04.03 – "Thickness" - shall be evaluated by the *Engineer* in accordance with Table 320.04.03-I.

Table 320.04.03.01-I

Introduction: This process is provided to assist in assessing compacted pavement for conformance with Subsection 336.04.03 – "Thickness" and, if recommended for acceptance, providing recommendations for any mitigation measures needed to achieve the design service life of the pavement. The process requires sound engineering analysis and judgment. The *Engineer/Engineer of Record* shall evaluate all relative parameters, including location within the pavement section and roadway cross section; environmental considerations; and future maintenance, and provide the recommendation regarding acceptance and any needed mitigation measures. The recommendation shall be stamped and signed by a *Professional Engineer* and provided to the Public Works Department of the maintaining Agency for determination of the acceptability of the recommendation. The *Engineer/Engineer of Record* shall include documentation from the Public Works Department of the maintaining Agency that any mitigation measures have been accepted with the letter of verification regarding the adequacy of the improvements. The *Contractor* shall comply with any mitigation measures at no additional cost to the Agency/Owner.



324.01 DESCRIPTION. This work shall consist of the preparation of surfaces to be painted, pavement to be striped or marked, and the application, protection, and drying of the required number of coats of paint of the kinds and at the points specified or ordered by the Engineer.

324.02 MATERIALS. All materials shall be in accordance with Section 214 – “Paint,” – of these Specifications and shall meet or exceed the minimum standards hereinafter set forth:

324.02.01 Raw Materials. American Society for Testing Materials (ASTM) and Federal Specifications.

324.02.02 Prepared Paints. Federal Specifications are specified to designate the type of material and standard of quality. Manufacturer's standard, first grade materials meeting or exceeding these requirements may be used if approved by the Engineer. Materials not bearing manufacturer's identification as a standard, first grade product of his regular line will not be considered.

324.02.03 Proprietary Materials. Proprietary materials when specified hereinafter by the manufacturer's trade name designate the standard of quality or type of material required. When the quality or type of material required is not specified, the Contractor shall apply for directions as to selection of materials and receive approval thereof from the Engineer before proceeding; only the best quality of such materials shall be used, as determined by the Engineer.

324.02.04 Materials List. Materials lists shall be submitted to the Engineer for approval and none shall be used until such approval has been obtained. All materials proposed for use shall be delivered to the site in original containers, seals unbroken, stored where directed, and none may be used until approved by the Engineer. Materials that are not approved must be immediately removed from the job site.

324.02.05 Number of Coats. Unless otherwise required in the Contract Documents, the number and kinds of coats of paint shall be as set forth in Section 214 – “Paint.”

324.03 CONSTRUCTION

324.03.01 Weather Limitations. 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 applications are such that the atmospheric temperature is at or below 40 degrees Fahrenheit or when freshly painted surfaces may become damaged by rain, wind, dust, or condensation, or when it can be anticipated that the atmospheric temperatures will drop below 40 degrees Fahrenheit during the drying period. If fresh paint is damaged by the elements, it shall be replaced by the Contractor at his expense.

Subject to the approval of the Engineer in writing, 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 the limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosure shall be considered as included in the prices paid for the various contract items of work and no additional payment will be made therefor.

324.03.02 Workmanship. All work shall be done by painters and finishers of established status and reputation for executing their work by the very best methods for each kind or type. Painting shall not be done except when the surface is dry and when weather conditions are satisfactory as set forth above.

Strict adherence to these Specifications and the recommendations of the manufacturer whose materials are used shall be followed in the application. The Contractor shall use such skills, equipment, materials, and give his thorough attention to details as will provide thoroughly workmanlike and satisfactory results throughout.

Work which shows carelessness, lack of skill and execution, or which is defective due to any other cause shall be removed and refinished or repainted as directed without additional cost to the Owner. On all surfaces which are inaccessible for brushing, the paint shall be applied 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 that the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush.

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 to keep the pigments in suspension.

Paint specified or formulated shall be ready for application and thinning will be allowed only on direction of the Engineer.

The Contractor shall protect all parts of the structure being painted against disfigurement by splatters, splashes, and smudges of paint or paint materials. When paint is being applied on structures carrying public traffic, the Contractor shall be responsible for any damage caused by his operations to passing vehicles or persons and may be required to use canvas shields or other protective means to guard against such damage.

Paint stains which result in an unsightly appearance shall be removed by the Contractor at his own expense.

324.03.03 Surface Preparation of Steel Surfaces. The following methods of surface preparation apply to steel surfaces. Unless otherwise specified, the sandblasting method shall be used.

- a. **Sandblasting.** All visible oil, grease, dirt, mill scale, rust, old paint, and other foreign material shall be removed from steel surfaces by an approved blast cleaning apparatus. Blast cleaning shall be sufficient to meet the requirements of Steel Structures Painting Council, SSPC Specifications SP-10, Photo Vis: C Sa 2 1/2 Near-White.

Abrasives used for such blast cleaning shall be either clean dry sand, mineral grit, steel shot, or steel grit, at the option of the Contractor, and shall be a grading suitable to produce satisfactory results. The use of abrasives other than those specified herein will not be permitted unless approved in writing by the Engineer.

When sandblasting is being performed on structures open to traffic, the Contractor shall provide suitable protective devices to prevent damage to traffic.

When sandblasting is being performed near machinery, all journals, bearings, motors, and moving parts shall be sealed against entry of sand dust before sandblasting begins.

Unless otherwise authorized by the Engineer, sandblasted surfaces shall be primed or treated the same day sandblasting is done. If cleaned surfaces rust before painting is accomplished, they shall be recleaned by the Contractor.

- b. **Washes.** Rust-inhibitor chemical washes shall be applied to freshly sandblasted steel surfaces prior to the application of the first undercoat of paint, except whenever the first undercoat of paint is applied to the cleaned surfaces within a 4 hour period after cleaning, washes will not be required. Washes shall be applied in not more than 4 hour intervals. If in the opinion of the Engineer, atmospheric conditions are such that corrosion products form on freshly sandblasted surfaces in less than 4 hours, treatment may be required at more frequent intervals.

Rust-inhibitor chemical washes may be applied by brush or spray, and they shall be applied in a careful manner to insure that all surfaces are covered.

During the application of the rust-inhibitor chemical wash, no sandblasting will be permitted to the areas being treated.

No paint shall be applied until after the treated surfaces have thoroughly dried.

The first undercoat of paint shall be applied to the treated surfaces the same day that cleaning and washing have been done.

- c. **Steam Cleaning.** All dirt, grease, loose chalky paint, or other foreign material which has accumulated on the previously painted surfaces shall be removed with an approved steam cleaning apparatus which shall precede all other phases of cleaning.

It is not intended that sound paint be removed by this process. Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than 24 hours after cleaning.

A detergent soap consisting of 45 percent sodium metasilicate, 43 percent sodium sesquisilicate, 10 percent sodium tetraphosphate, and 2 percent Naccanol shall be added to the feed water of the steam generator at the approximate rate of 1 pound of detergent per 200 pounds of water.

Any residue which may accumulate on cleaned surfaces shall be removed by flushing with fresh water, but washing down the cleaned surfaces will not otherwise be required.

- d. **Hand Cleaning.** All dirt, loose rust, and mill scale, dead paint, or paint which is not firmly bonded to the metal surfaces shall be removed by wire brushes, either hand or powered, hand scraping tools or sandpaper.

Pneumatic chipping hammers will not be allowed unless authorized in writing by the Engineer. Hand cleaning shall be sufficient to remove all loose material which would prevent the bond of succeeding coats of paint.

Hand cleaning will be permitted as an alternative to sandblasting on all steel except bridge girders. Bridge girders shall be cleaned by method (a) – “Sandblasting” – supplemented by minor amounts of hand cleaning as determined by the Engineer.

324.03.04 PAINTING STEEL SURFACES

- a. Paint. The paint to be applied to the steel surfaces shall conform to the requirements of Section 214 – “Paint,” – of these specifications. A minimum of three coats of paint shall be required. The prime coat shall consist of a minimum dry film thickness of 2 mils. The intermediate coat shall consist of a minimum dry film thickness of 1 and 1.5 mils. The intermediate coat of paint shall be of such shade as to contrast with both the prime and finish coats. The finish coat shall consist of a minimum dry film thickness of 1 and 1.5 mils. The total thickness of all coats shall not be less than 5 mils.

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.

Prior to erection, all new structural steel shall be cleaned and painted with the prime coat of paint.

- b. Field Cleaning. Unless otherwise specified in the Contract Documents, after erection and riveting or welding, all surfaces of unpainted structural steel which will be exposed to air, shall be sandblasted in accordance with the requirements of Subsection 324.03.03 – “Surface Preparation of Steel Surfaces.”

Any damage resulting from the Contractor's operations to **sound** paint on areas not designated for treatment shall be repaired to the satisfaction of the Engineer.

- c. Painting. Painting of structural steel prior to erection will be limited to surface preparation and one undercoat of paint. Any deficiencies in the first coat of paint shall be corrected to the satisfaction of the Engineer, prior to the application of succeeding coats of paint.

Surfaces exposed to the atmosphere which would be inaccessible for painting after erection shall be painted the full number of coats prior to erection.

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 paint coats. In spot painting, any old paint which lifts after application of the first spot coat shall be removed by scraping and the area repainted before application of the next coat.

The application of the finish coat will not be permitted until the required total film thickness of the undercoats of paint as described in Subsection 324.03.04 (a) – “Paint” – (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 undercoat of paint.

Metal surface to be embedded in concrete need not be painted.

- d. Machine Finished Surfaces. 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.
- e. Frames and Grates. Prior to installation, all surfaces of frames and grates exposed to the atmosphere shall be painted with two coats of paint. Unless otherwise specified in the Contract Documents, the exposed surfaces shall be painted after installation with one finish coat as specified for structural steel.

324.03.05 Painting Timber

All new timber requiring painting shall be painted with three coats of paint. The paint used for various coats will be as specified in these Specifications or in the Contract Documents.

- a. Preparation of Surfaces. All cracked or peeled paint, loose chalky paint, dirt, and other foreign matter shall be removed by wire brushing, scraping, or other approved means immediately prior to painting. Unpainted timber shall be thoroughly dry before paint is applied.

- b. Painting. When permitted in writing by the Engineer, the first coat of paint may be applied prior to erection.

After the first 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, 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.

324.04 PAVEMENT STRIPING AND MARKINGS. The Contractor shall apply all traffic striping, marking, and all other directional information on the surfaces of highways, streets, detour roads, parking lots, median strips, and curbing only when required by the Contract Documents.

Should the Contractor elect to alter the existing traffic stripes and markings, or to divert the flow of traffic on construction projects for his own convenience and there are no specific pavement markings or lane delineations shown on the Plans or in the Special Provisions, he shall, with the approval of the Engineer, provide the necessary temporary striping in accordance with the M.U.T.C.D. at no expense to the Contracting Agency.

When not otherwise shown on the Plans, detour transitional traffic line striping shall have a minimum taper of 20:1 for temporary striping and 30:1 for permanent striping. Temporary traffic lanes shall be at least 10 feet wide and no lane shall encroach within 5 feet of an open excavation or within 2 feet of a longitudinal curb.

All traffic stripes (except black stripes) shall be beaded on the final finish coat in accordance with Subsections 214.03.03 – “Traffic Beads” – and 324.08 – “Reflective Material.”

The Contractor shall furnish all equipment, materials, labor, and supervision necessary for painting traffic lanes, directional arrows, guide lines, curbs, parking lanes, crosswalks, and other designated markings in accordance with the Plans, or for approved temporary detours essential for safe control of traffic through and around the construction site. The Contractor shall remove by wet sandblasting (or by other approved methods) all existing or temporary traffic markings and lines that may confuse the public. When temporary detour striping or markings are no longer required, they shall be removed prior to painting the new traffic stripes or markings.

324.04.01 Weather Limitations. All paint shall be applied within the temperature range specified by the Engineer or as recommended by the paint manufacturer. Paint shall be applied only when the pavement surface is dry and clean, when the air temperature is above 40 degrees Fahrenheit, and when the weather is not windy, foggy, or humid.

324.04.02 Equipment. All equipment required to perform the work shall be approved in advance by the Engineer and shall include such apparatus as brushes, brooms, compressors, air blowers to properly clean the pavement surface, a mechanical marking machine, a suitable device for heating the paint to the specified temperatures, a bead dispensing device, and auxiliary hand spray paint equipment, paint rollers, or other equipment as may be necessary to satisfactorily complete the work.

The striping machine shall be an approved spray-type marking machine suitable for applying traffic paint at the temperatures specified in Subsection 324.04.01 for the particular paint or as recommended by the paint manufacturer. It shall have sufficient paint capacity for each color with adequate air pressure to perform the work satisfactorily without excessive stopping. The machine shall produce a uniform thickness and cross section at the required coverage and shall produce markings with clean-cut edges without running or spattering. It must be capable of being guided within the straightness tolerances set forth in these Specifications. The machine shall have suitable adjustments for painting the line width specified and, when required, shall be equipped with an automatic cycling device to produce intermittent (skip) lines. A standard Skip-line pattern is normally a 24 foot cycle of which 9 feet are painted and 15 feet are unpainted. However, the machine shall be equipped to produce a variable skip pattern, including simultaneous paint of a broken line on one side and a solid line on the other side of a multiple stripe. An acceptable tolerance in the skip pattern is plus or minus 6 inches.

The striping machine shall be capable of three gun applications consisting of one black and two yellow spray guns operating simultaneously or individually. The equipment shall also be capable of operating two white guns simultaneously.

The striping machine shall have a wheel base of sufficient length to produce a straight line to meet the straightness tolerance specified. The machine must also be capable of producing curved lines without abrupt breaks, in accordance with approved layouts.

Provisions shall be made for a dispenser capable of applying glass beads at the required rates.

Equipment for applying molten thermoplastic material shall readily extrude the material between 400-425 degrees Fahrenheit to produce a continuous line 1/8 inch to 3/16 inch thick, of uniform cross section, and having clear sharp dimensions.

Thermoplastic material may also be applied by an approved machine that flame sprays the material onto clean road surfaces. This machine shall be capable of applying a coat 10 mils thick which will dry to “no pick up” in accordance with ASTM D 711. The equipment shall produce a smooth continuous line having clear sharp dimensions.

Word markings, letters, numerals, and symbols shall be applied using suitable spray equipment together with stencils and templates.

The Contractor shall provide a wet sandblasting machine with sufficient sand, water, and air capacity to completely remove all existing or temporary traffic striping or markings that may be confusing to the public. This machine shall meet all requirements of the air pollution control district having jurisdiction. All sand used in wet sandblasting shall be removed from the pavement without delay as the sandblasting operation progresses. Removal of striping by high velocity water jet may be permitted when approved by the Engineer.

324.04.03 Geometry, Stripes, and Traffic Lanes. Permanent and temporary striping and marking shall be in accordance with the M.U.T.C.D. manual and the Nevada Control manual.

324.05 SURFACE PREPARATION. Existing markings and striping, either permanent or temporary, which are to be abandoned or obliterated shall be removed by wet sandblasting or other approved methods. Dry sandblasting may be used in selected areas only with the permission of the Engineer and with approval of the air pollution control authority having jurisdiction over the area in which the work will be performed. Alternate methods of paint removal require prior approval of the Engineer. Obliteration of traffic striping with black paint or light emulsion oil shall be done only with the prior approval of the Engineer.

Before applying paint, the existing pavement surface shall be cleaned by washing, sweeping, blowing, or vacuuming as necessary to remove moisture, dirt, grease, oils, acids, laitance, or other foreign matter which would reduce the bond between the paint and the pavement. Areas which cannot be satisfactorily cleaned shall be scrubbed with a water solution of tri-sodium phosphate (10 percent Na₂ PO₄ by weight) or other approved cleaning solution. After cleaning, the surface shall be rinsed with water and dried before painting.

324.06 CONTROL POINTS. When necessary, the Engineer will furnish the necessary control points for all required pavement striping and markings. The Contractor shall establish all traffic striping between these points by stringline or other method to provide striping that will vary not more than 1/2 inch in 50 feet from the specified alignment.

When no previously applied figures, markings, or traffic striping are available to serve as a guide, suitable layouts shall be spotted in advance of the permanent paint application. Traffic lines may be spotted by using a rope as a guide for marking spots every 5 feet, by using a marking wheel mounted on a vehicle, or by any other means satisfactory to the Engineer.

The Contractor shall stripe or otherwise delineate the traffic lanes per the M.U.T.C.D. manual in the new roadway or portion of roadway, or detour before opening it to traffic if it is required by the Contract Documents.

The Contractor shall provide an experienced technician to supervise the location, alignment, layout, dimensions, and application of the paint.

324.07 APPLICATION. Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved Plans or as provided in the Special Provisions. Where temporary traffic striping and marking is required, it shall not be applied until the layouts, alignments, sequencing, and condition of the existing surface have been approved.

Paint shall be mixed in accordance with the manufacturer's instructions. It shall be mixed thoroughly and applied to the surface at the proper temperature, at its original consistency without the addition of any paint thinner. If the paint is applied in two coats, the first coat shall be thoroughly dry before the second coat is applied. Before applying thermoplastic paint on concrete surfaces, there shall be a prime coat consisting of either a two component epoxy or a 15 percent solution of buna N rubber in methyl-ethyl ketone applied 1/2 hour before application of the thermoplastic paint.

Traffic striping shall be applied in one application.

If the paint is applied in two coats, beads will be required only in the second coat. The first coat shall be thoroughly dry before the second coat is applied. On open-graded surfaces, the second coat shall follow no sooner than 14 calendar days after initial application.

Ten days shall elapse between the application of a bituminous seal coat and the permanent traffic marking. The paint shall not bleed, curl, or discolor when applied to bituminous surfaces. If bleeding or discoloring occurs, the unsatisfactory areas shall be given an additional coat of paint.

Straight strips deviating more than 1/2 inch in 50 feet shall be obliterated by sandblasting and the markings corrected. The width of markings shall be as designated, within a tolerance of 4 percent. When existing striping and markings are to be repainted, they shall be repainted so as to completely cover the old markings within 1/4 inch. Stripe repainting shall be retraced with a longitudinal tolerance of 6 inches plus or minus at the end of each stripe.

Abrupt breaks in striping alignment will not be allowed. The striping shall be a continuous operation except where crossovers are required to complete painted medians.

All painting shall be performed by competent and experienced equipment operators and painters using proper equipment, tools, stencils, templates, and shields in a workmanlike manner.

Difficulties normally experienced in cool weather shall be minimized by heating the traffic paint to provide for a uniform flow of material.

Reflective material shall be applied to traffic stripes and markings, in accordance with Subsection 324.08 – “Reflective Material” – and 214.03.03 – “Traffic Beads.”

Temporary striping and marking shall be renewed when the stripes and markings have lost 50 percent of their original visual effectiveness.

All paint materials shall be tested before application to verify that they meet the Specification requirements. The Engineer shall be notified upon delivery of the paint to permit inspection and sampling. When required by the Engineer, the Contractor shall furnish a notarized certificate signed by either an authorized employee of the manufacturer or test laboratory or both stating that the paint conforms to the specified requirements. This certificate shall not be interpreted as final approval of paint.

324.08 REFLECTIVE MATERIAL. Reflective material shall consist of glass beads in conformance with Subsection 214.03.03 – “Traffic Beads” – of these Specifications. Reflective material shall be added to the surface of the final coat of paint prior to setting so that beads will have proper adhesion. Special care shall be taken with rapid dry paint and thermoplastic materials.

Reflective material (glass beads) shall be applied at a rate of 6 to 8 pounds of beads per gallon of paint. Glass beads shall be applied to pavement markings, curbs, and crosswalks by use of a dispensing device developed for this purpose or other methods approved by the Engineer.

The Engineer may authorize the use of paint containing premixed glass beads. The type, gradation, quantity, and quality of the premixed glass beads shall be approved prior to the manufacture of the paint. In addition to the specified premixed beads, 2 to 3 pounds of beads per gallon of paint shall be mechanically applied when the paint is applied.

If thermoplastic paint is required, glass beads may be added directly to the combined pigment, filler, and resin. Prior to setting, all thermoplastic paint surfaces shall receive an additional application of at least 1 pound of glass beads per gallon of paint.

324.09 TEMPORARY PAVEMENT STRIPING TAPE

324.09.01 Description. This work shall consist of furnishing, locating, placing, maintaining, and removing continuous temporary pavement striping tape and temporary pavement striping tape (pilot line).

324.09.02 Materials. Temporary striping tape shall be yellow or white of any combination thereof as directed by the Engineer and shall conform to the following requirements:

“Temporary Striping Tape,” “Temporary Striping Tape (Pilot Line),” and “Temporary Arrows” may be either Type 1 or Type 2 tape. The Contractor will have the option as to which type is used.

Type 1 tape is more readily removable from the surface and is recommended for use on surfaces which are not designated to be covered or removed and on temporary areas where traffic patterns are to be altered.

Type 2 tape is much more difficult to remove from the surface and is recommended for use on surfaces which are to be covered or removed, in which case removal of the tape will not usually be required.

Should the Contractor elect to use either Type 1 or Type 2, it shall be his responsibility for its removal when required and removal shall be to the satisfaction of the Engineer.

Type 1 tape shall conform to the following requirements:

Composition. The removable preformed pavement marking film shall consist of a white or yellow mixture of high quality of polymeric materials, pigments, and glass beads, with a reflective layer of beads bonded to the top surface. A nonmetallic medium coated with a pressure sensitive adhesive shall be incorporated to facilitate removal. The white and yellow materials shall have the following initial average reflectance values at 0.2 degree and 0.5 degree observation angles and 86 degrees entrance angle, as measured in accordance with the testing procedures of Federal Test Method Standard 370:

| | White | | Yellow | |
|--------------------|-------|------|--------|------|
| Observation Angle | 0.2° | 0.5° | 0.2° | 0.5° |
| Specific Luminance | 1770 | 1270 | 1310 | 810 |

Removability. The marking film shall be completely removed from asphalt and Portland Cement Concrete either manually or with a roll-up device, at temperatures above 40 degrees Fahrenheit (4 degrees C.) without use of heat, solvents, grinding, or sand blasting.

Type 2 tape shall conform to the following requirements:

Composition. The metallic backed striping tape shall consist of a white or yellow reflective film on a conformable metallic backing, precoated with a pressure sensitive adhesive.

324.09.03 Construction. Temporary Striping Tape (Pilot Line) shall be 4 inch by 12 inch sections and shall be placed on traffic lane lines at 40 foot intervals, with the longer side parallel to traffic. Lane lines and 40 foot intervals shall be located by the Contractor as approved by the Engineer. Prior to the end of a working day, a temporary pilot line shall be placed on each new lift of bituminous surfacing over which public traffic is directed. The exception to the foregoing is that the State shall be responsible for placing pilot line on the final open graded surface using State furnished labor, materials, and equipment.

Continuous temporary striping tape shall be furnished, located, applied, maintained, and removed by the Contractor at locations indicated on the Plans or determined by the Engineer.

The surface to which the tape (pilot line or continuous) is applied shall be dry, free of oils, grease, dust, and dirt. The tape shall be tamped down immediately after application in order to obtain a proper bond, and shall be removed from final pavement surface and where necessary to reroute public traffic as directed by the Engineer.

It should be considered normal and expected that portions of the temporary striping tape shall have to be replaced during the life of the contract. The locations and extent of these replacements shall be determined by the Engineer.

324.10 PROTECTION OF WORK. The Contractor shall use proper and sufficient directional signs, warning devices, barricades, pedestals, lights, traffic cones, flagmen, or other devices to protect the work, workmen, and the public.

All markings and striping shall be protected from injury and damage of any kind while the paint is drying. All adjacent surfaces shall be protected from disfiguration by splatter, splashes, spillage, and ripping of paint or other material.

324.11 SCHEDULING OF WORK. In areas of high traffic volume, the Contractor shall schedule his work to paint traffic lines and markings in off-peak traffic hours or on weekends.

324.12 UNACCEPTABLE WORK. Any work or material not conforming to the Plans or Specifications shall be unacceptable and shall be redone, removed, replaced, or made satisfactory to the Engineer at the sole expense of the Contractor.

324.13 MEASUREMENT OF QUANTITIES AND BASIS OF PAYMENT

324.13.01 Painting. No direct measurement of quantities or payment shall be made for painting, cleaning structural steel, or preparing surfaces for painting unless indicated in the Contract Documents or directed by the Engineer. Compensation for this work shall be considered as included in the contract unit prices bid for the particular item requiring painting, unless indicated otherwise.

324.13.02 Traffic Striping and Marking. The quantity of traffic striping and marking shall be measured by one or more of the following methods: lineal footage, the area in square feet, or one lump sum item complete in place.

The lump sum or unit prices established shall include full compensation for furnishing all labor, materials, tools, and equipment, and for doing all work involved in, or appurtenant to, the painting of all traffic striping or markings as shown on the Plans, indicated in the Special Provisions, or as directed by the Engineer.

All costs for temporary pavement painting for the convenience of the Contractor, including costs for sandblasting of existing lines and markings, shall be at his sole expense.

325.01 GENERAL.

325.01.01 DESCRIPTION. This Section covers furnishing, installing and/or removing new or modified traffic signals, interconnect, *ITS* devices, flashing beacon systems, lighting systems, sign illumination systems, and traffic count stations, including temporary or partial installations for future systems, or combinations thereof, and the related materials as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

This Section is for construction specifications only and is not intended to be a “qualified products list” nor intended to encourage or discourage the use of any product.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

325.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

325.01.01.01.01 Definitions. The intent and meaning of terms, words, and phrases used in this Section shall be interpreted first in accordance with Section 1A.13 – “Definitions of Words and Phrases in This Manual” of the *MUTCD* and Chapter 1 – “Introduction” of the *FHWA Traffic Detection Handbook*.

325.01.02 DESIGN. This Subsection does not address the complete design and operation requirements that must be taken into account by the *Engineer* in order to ensure proper application of the individual products and achieve the expected performance of the resulting system.

In addition to the *Code* and local jurisdictional requirements, the design shall be in accordance with the requirements of applicable codes including the *IESNA*, *IMSA*, *MUTCD*, *NEMA*, and *UL*; and this Subsection.

325.01.02.01 Battery Backup Systems. The battery backup system shall supply a minimum uninterrupted continuous power supply (ups) service for a minimum of 2 hours of normal signal operation.

325.01.02.02 Conduit. Unless otherwise directed or approved by the *Engineer*, when not shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, conduit shall be at least 3 inches in diameter (*ID*), except when intercepting or extending existing conduit, in which case the conduit shall match the existing diameter.

325.01.02.03 Controller Cabinets. Unless otherwise directed or approved by the *Engineer*, cabinets shall be located to provide an all-weather access and a safe working area. In unpaved areas, a raised *PCC* pad of the size shown on the *Plans* shall be placed in front of each controller cabinet foundation. At a minimum, the pad shall be square and match the width of the foundation. The cabinet should be placed in a location that minimizes the potential for exposure to water sources.

325.01.02.04 Flashing Beacons. Each beacon shall consist of a single section traffic signal head in accordance with *MUTCD*, with lens color (yellow or red) shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

325.01.02.05 Foundations. Foundations for posts, signal poles, pedestals and controller bases shall be *PCC* placed in accordance with Section 311 – “Concrete Structures and Masonry Construction”.

The footprint for controller bases shall be larger than the cabinet footprint.

325.01.02.06 Grout.

325.01.02.06.01 Composition of Materials. Grout shall consist of one part by volume of Portland cement and three parts of clean sand and shall contain only sufficient moisture to permit packing.

325.01.02.07 Luminaires. Luminaire design shall be in accordance with *IESNA*, *FHWA Roadway Lighting Handbook* and *AASHTO Roadway Lighting Design Guide*. The design shall include an illuminance plan utilizing a *LLF* of 1.0.

325.01.02.08 Pedestrian Detection. Where shown on the *Plans*, pedestrian push buttons shall comply with *MUTCD* or approved by the *Engineer*.

325.01.02.09 PCC.

325.01.02.09.01 Composition of Mixtures. Unless otherwise provided in the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, a mix design shall be performed in accordance with Subsections 337.01.01 "Mix Design" and 337.10 – "PCC Structures, Slope Paving, Flatwork and Curbs" to determine the composition of the mixture. Mixture properties shall conform to Table 337.10.01.01-I.

325.01.02.10 Temporary Systems. Unless shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, the lengths of wood poles for temporary systems shall be 25 feet for service poles and 35 feet for other poles. Wood poles shall be placed in the ground to a depth of at least 10 percent of the pole length plus 2 feet.

325.01.02.11 Traffic Detection. The *Engineer* is directed to the FHWA Traffic Detection Handbook for traffic detection design.

325.01.02.12 Traffic Signal Cable. Unless otherwise directed or approved by the *Engineer*, any signal pole with a mast arm shall be fed, at a minimum, by a single 25 conductor, No. 14 cable. Pedestrian push button post shall be fed, at a minimum, by a single 3 conductor, No. 14 cable for each push button installed. Any pole without a mast arm shall be fed, at a minimum, by a single 15 conductor, No. 14 cable.

325.01.02.13 Traffic Signal Pre-empting System. The pre-empt system is intended to identify the presence of designated priority vehicles, and shall enable such vehicles to remotely cause the traffic signal controller to advance to and/or hold a desired traffic signal display by using existing controller functions. The preempt detector shall detect the activator for a minimum distance of 1800' from the traffic signal

Unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, no distinction is necessary between the various vehicles that are equipped with pre-empt activation devices.

320.01.03 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – "Safety".

325.02 MATERIALS. The materials used shall be approved and/or determined by the *Engineer*.

325.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection of the materials in accordance with Subsections 100.30 – "Inspection and Testing" and the applicable subsections of Section 336 – "Inspection and Testing".

325.02.02 CARE OF MATERIALS. All materials shall be manufactured, fabricated, handled, loaded, shipped, unloaded, and stored in such a manner as to be undamaged and in sound condition. Damaged materials shall not be used nor will be accepted by the maintaining *Agency*.

325.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03.

325.02.03 USE OF OTHER MATERIALS. The *Contractor* shall not use other materials and/or methods except as provided in Subsection 100.31.02.

325.02.04 AGGREGATES. Aggregates shall conform to Section 200 – "Aggregates".

325.02.04.01 Bedding for Pull Boxes. Aggregates for bedding of pull boxes shall conform to Subsection 200.03 – "Aggregates for Bedding and Backfill", Class B or C.

325.02.05 CONDUIT. Conduit to be installed underground shall be rigid nonmetallic type conforming to the requirements of the UL Standard for Rigid Nonmetallic Conduit (Publication UL 651). Unless otherwise directed or approved by the *Engineer*, exposed conduit and fittings shall be rigid metallic material manufactured of mild steel conforming to UL Publication UL 6 for Rigid Metallic Conduit. Exposed conduit shall be unpainted, unless painted to match the color of the structure to which it is attached.

325.02.06 CONDUCTORS. Copper wire for conductors shall conform to ASTM B3 and ASTM B8. Conductors shall consist of stranded copper of the gauge shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

IMSA rated color-coated cables shall be utilized. All conductors shall have clear, distinctive and permanent markings on the outer surface throughout the entire length showing the manufacturer's name or trademark, insulation type-letter designation, conductor size, and voltage rating. All individual field wires shall be labelled to indicate their point of connection or as directed by the maintaining *Agency*.

325.02.07 CONTROLLERS. Controllers shall be supplied as specified by the maintaining *Agency*.

325.02.08 TRAFFIC SIGNAL PRE-EMPTION CABLE. Traffic signal pre-emption cable shall be specified by the detector manufacturer.

325.02.09 LUMINAIRES. All parts of the luminaire shall be fabricated from corrosion-resistant materials.

325.02.09.01 Housing. Luminaire housing/chassis coating shall meet ASTM B117 Salt Fog environment for 1000 hours minimum without blistering or peeling. The coating shall demonstrate gloss retention of greater than or equal to 90% for 1000 hours exposure QUV test per ASTM G53 UVB313, 4 hour UV-B 60°C/4 hour Condensation 50°C.

Unless otherwise directed or approved by the *Engineer*, the exterior shall be factory painted and finished with a material that is resistant to rust, solvents, oils, acids, and alkalis.

325.02.10 PULL BOXES. Pull boxes shall be standard pull boxes as shown on the *Standard Plans*. Unless waived by the *Engineer*, all metal lids for pull boxes shall be grounded and traffic rated.

325.02.10.01 Cover Markings. All covers shall be marked with the initials of the owning *Agency* and for their primary use, as follows:

325.02.10.01.01 Traffic Signal. On a pull box which contains traffic signal conductors with or without street lighting conductors.

325.02.10.01.02 Street Lighting. On a pull box which contains street lighting conductors only. "HIGH VOLTAGE" shall be inscribed below where street lighting voltage is above 600 volts.

325.02.10.01.03 Irrigation Control. On a pull box where irrigation control conduit enters the pull box.

325.02.10.01.04 Count Station. On a pull box where traffic count station conduit enters the pull box.

325.02.10.01.05 Ramp Meter. On a pull box where ramp metering conduit enters the pull box.

325.02.10.01.06 ITS. On a pull box when *ITS* components enter the box.

Marking shall be clearly defined and uniform in depth and may be placed parallel to either the long or short sides of the cover.

Marking letters shall be between 1 and 3 inches high.

Marking shall be applied to each steel or cast iron cover prior to galvanizing, if required, by one of the following methods:

Method "A": Cast iron strips, at least 1/4 inch thick, with the letters raised a minimum of 1/16 inch. Strips shall be fastened to covers with 1/4 inch flathead stainless steel machine bolts and nuts. Bolts shall be peened after tightening.

Method "B": Sheet steel strips, at least 22 gauge with the letters raised a minimum of 1/16 inch above the surrounding surface of the strips. Strips shall be fastened to covers by spot welding, tack welding, or brazing, or with 1/4 inch roundhead stainless steel machine bolts and nuts. Bolts shall be peened after tightening.

Method "C": Bead welding the letters on the covers. The letters shall be raised at least 3/32 inch.

325.02.11 SIGNAL HEADS. Unless otherwise directed or approved by the *Engineer*, the exterior shall be factory painted and finished with a material that is resistant to rust, solvents, oils, acids, and alkalis.

325.02.11.01 Housing. Unless otherwise directed or approved by the *Engineer*, or shown on the *Plans*, or specified in the *Special Provisions* and/or *Special Technical Specifications*, housing shall be made of cast

aluminum or 3003 H14 sheet aluminum alloy with finish on both sides, and shall be 1/8 inch thick minimum at the points of support.

The housing for pedestrian signals shall be dustproof, weatherproof, and corrosion resistant and shall provide easy access to, and replacement of, all components.

The housing shall be suitable for either post-top or bracket mounting.

325.02.11.02 Visor. The visor shall be of material similar to the housing. The signal visor shall be tunnel type. The top of the visor shall extend a minimum length of 6 inches at the top and 5 inches at the bottom when measured from the surface of the lens. The front shall be normal to the top.

325.02.11.03 Fasteners. All the machine screws, studs, and washers shall be either plated brass, stainless steel, or other corrosion resistant material.

325.02.12 TEMPORARY SYSTEMS. Unless shown on the Plans or specified in the Special Provisions and/or Special Technical Specifications, wood poles for temporary installation shall be ASA Class 5, or larger, Douglas Fir or Southern Yellow Pine. Wood poles shall be treated after fabrication as provided in Section 208 – “Timber and Preservation Treatment.”

Wood poles shall not have more than 180 degrees twist in grain over the full length.

325.02.13 SIGNAL POLES. All ferrous metal parts of signal poles shall be galvanized.

Signal poles with luminaire arms only shall be fabricated of not less than No. 10 U.S. Standard gauge steel. When a weldable grade steel is used, the gauge shall not be less than No. 11 U.S. Standard Gauge steel.

325.02.13.01 Bolts. Bolts shall conform to ASTM F1554. The material grade shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. Bolts shall be galvanized in accordance with the requirements of ASTM F2329.

325.02.13.02 Nuts and Washers. Nuts shall conform to ASTM A563. Nuts shall be galvanized in accordance with the requirements of ASTM F2329.

325.03 CONSTRUCTION.

325.03.01 SUBMITTALS.

325.03.01.01 Certificate of Compliance. The *Contractor* shall provide a certificate of compliance for each material in accordance with Subsection 100.31.01 – “*Certificate of Compliance*”. The *Contractor* shall ensure that the certificates of compliance have been reviewed and accepted by the *Engineer* prior to unloading the associated material on-site.

325.03.01.02 Component List and Drawings. Unless otherwise permitted in writing by the *Engineer*, the *Contractor* shall, within 14 *Calendar Days* following execution of the *Contract*, submit to the *Engineer* for approval, a list of components and materials proposed for installation. Written comments regarding the submittal shall be provided to the *Contractor* within 21 *Calendar Days* of the submittal. The *Contractor* shall ensure that the list has been reviewed and accepted by the *Engineer* prior to ordering materials.

The list shall include name of the manufacturer, size, and identifying number of each item. The list shall be supplemented by other data as directed by the *Engineer*. All submittals shall be neatly tabbed and labeled in a notebook or binder for the *Engineer* review. The submission of detailed electrical drawings and diagrams may be waived by the *Engineer* provided construction is as detailed on the *Plans*.

325.03.01.02.01 Cabinets. The *Contractor* shall furnish scale drawings of cabinets showing location and spacing of shelves, terminal blocks and equipment, including dimensioning.

All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation manuals shall be submitted at the time the controllers are delivered for testing or, if ordered by the *Engineer*, prior to purchase. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

325.03.01.03 Warranties, Guarantees, and Instruction Sheets. Manufacturers' warranties and guarantees furnished for materials used in the work, and instruction sheets and parts lists supplied with

materials shall be delivered to the maintaining Agency prior to acceptance of the project. The effective date of the beginning of the warranty period is the date of final project acceptance.

325.03.01.04 PCC. The *Contractor* shall submit, in writing, the *PCC* mix design at least 30 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 14 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the *PCC*.

325.03.02 INSPECTION AND TESTING. The *Contractor* shall accommodate inspection and testing in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable subsections of Section 336 – “Inspection and Testing”.

325.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”, except as modified herein.

325.03.03.01 Location. The exact locations of system components, including signals, beacons, poles, lighting fixtures, signs, controls, services, and appurtenances, will be established by the *Engineer* in the field.

325.03.04 SCHEDULING OF WORK. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

325.03.05 EXISTING IMPROVEMENTS AND SYSTEMS.

325.03.05.01 Existing Improvements. Removal of existing improvements shall be performed in accordance with 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

325.03.05.02 Existing Systems. The *Contractor* shall notify the Agency, including traffic enforcement and signal maintenance, and the *Engineer*, prior to performing any work on existing systems.

When existing equipment is to be reinstalled, the *Contractor* shall furnish and install all necessary materials and equipment, including signal mounting brackets, anchor bolts, nuts, washers, and *PCC* as required to complete the installation. The *Contractor* shall notify the *Engineer* prior to removal of any existing equipment, which, in the *Contractor*’s opinion, is not suitable for reinstallation. The *Engineer* will make a determination of the condition of the equipment.

325.03.05.02.01 Cleaning of Existing Equipment. Unless waived by the *Engineer*, existing equipment which is to be reinstalled shall be cleaned prior to reinstallation. All incandescent or fluorescent traffic signal, flashing beacon, and lighting fixtures, including sign lighting, to be reinstalled shall be relamped.

325.03.05.02.02 Removal of Existing Systems. Unless otherwise directed or approved by the *Engineer*, when not shown otherwise on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, existing system components not reused shall be removed from the public right of way and legally disposed of by the *Contractor*, except if not interfering with other construction. Materials not interfering with other construction may, with the written approval of the *Engineer*, be abandoned in place.

325.03.05.02.02.01 Conduit. When conduit is to be abandoned in place, the method of abandonment shall be approved by the *Engineer*.

325.03.05.02.02.02 Foundations. When a foundation is to be abandoned in place, the top of foundation, anchor bolts, and conduits shall be removed to a depth of at least 0.5 foot below the surface of subgrade.

Areas impacted by the removal of the existing system components shall be filled with material equivalent to the surrounding material and compacted as directed by the *Engineer*.

325.03.05.02.03 Protection and Maintenance of Existing Systems and Temporary Systems. Unless otherwise directed or approved by the Agency, the *Contractor* shall protect and maintain existing electrical systems (traffic signal, ramp metering, highway and street lighting, flashing beacon, underground facilities, and sign illumination) in effective operation for the benefit of the traveling public

during the progress of the work, except when shutdown or temporary installation is permitted to allow for alterations or final removal of the systems. Shutdown or temporary installations shall be as specified in the *Special Provisions* and/or *Special Technical Specifications*. Unless otherwise directed or approved by the *Agency*, lighting system shutdowns shall not interfere with the regular lighting schedule.

325.03.05.02.04 Modification of Existing Systems. Where existing systems are to be modified, the existing materials shall be incorporated in the revised system, salvaged or abandoned as shown the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Where existing rigid metal underground conduit systems are to be modified or extended, a non-metallic conduit shall be installed.

Unless otherwise directed or approved by the *Engineer*, existing underground conduit to be incorporated into a new system shall be cleaned with compressed air or approved equivalent. The compressed air shall be blown from the Traffic Signal Cabinet to the first pull box to avoid filling the Cabinet with debris. Any debris in the cabinet shall be removed by the *Contractor* at no cost to the *Agency*.

325.03.05.02.05 Salvage of Existing Systems. The *Contractor* shall exercise care in removing and salvaging electrical equipment so that it will remain in its original form and existing condition. Attention is directed to the Provisions in Section 301 – “Protection and Restoration.” The *Contractor* shall replace, at no cost to the *Owner*, any of the above-mentioned electrical equipment, which, as determined by the *Engineer*, has been damaged or destroyed by lack of care.

325.03.05.02.05.01 Salvage for Reuse.

325.03.05.02.05.01.01 Poles. When directed by the *Engineer*, existing signal poles to be relocated or reused in place shall be replaced if there is existing damage. The *Contractor* shall furnish new anchor bolts and nuts required for relocating existing signal poles. These items are considered incidental to the work.

Drilled holes left in the shafts shall be filled as directed or approved by the *Engineer*.

325.03.05.02.05.01.02 Electrical Equipment. When salvaged electrical equipment is to be reinstalled, the *Contractor* shall furnish and install all new materials and equipment needed to complete the installation.

325.03.05.02.06 Surplus Equipment. As shown on the *Plans* or directed by the *Engineer*, existing electrical equipment removed and not reused, including controller units, cabinets, signal heads, luminaires, poles mast arms, ballasts, transformers, service equipment, pull boxes, and detector contact units shall be salvaged for reuse by the maintaining *Agency*.

The *Contractor* shall deliver surplus equipment to the maintaining *Agency*. The *Contractor* shall make an inventory list of the surplus equipment and have the maintaining *Agency* sign-off on the delivered equipment. Copies of the signed inventory list will be distributed to all parties involved in the project.

325.03.05.03 Temporary Systems. Temporary systems shall be in place prior to modification or removal of the existing system. Temporary systems shall be kept in effective operation until no longer required for the traveling public.

A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction.

Wood poles shall be placed in the ground to a depth of at least 10 percent of the pole length plus 2 feet. Pole alignment shall be no more than 4 inches in 20 feet out of plumb.

After each wood pole is set in the ground, the space around the pole shall be backfilled with selected earth or sand, free of rocks and other deleterious material, placed in layers approximately one foot thick. Each layer shall be moistened and thoroughly compacted.

All other pole types shall be securely mounted.

Mast arms for luminaires shall be mounted to provide a mounting height of 30 feet. A minimum vertical clearance of 17 feet shall be maintained from the bottom of all overhead equipment to the travel surface.

325.03.06 CONSTRUCTION EQUIPMENT. The Contractor shall provide all equipment, tools, and machinery in accordance with Subsection 100.34 – “Character of Workers; Methods and Equipment”.

325.03.07 CONSTRUCTION LOADS. The Contractor’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

325.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”.

325.03.09 EXCAVATING. Excavation shall be performed in accordance with Section 303 – “Excavating”. The Contractor shall dispose unsuitable material, surplus material and/or materials not designated for reuse in accordance with Subsection 100.31.04 – “Material Disposal”.

325.03.10 PLACING OF MATERIALS.

325.03.10.01 Backfill. Backfill shall be performed in accordance with Section 304 – “Fill and Backfill”.

325.03.10.02 Conductors. All conductors shall be run in conduit except for overhead and temporary installations, and where conductors are run inside poles.

325.03.10.03 Conduit. The location of ends of all conduits in structures, or terminating at curbs, shall be marked by a “Y” at least 3 inches high cut into the face of curb, gutter, or wall, directly above the conduit and above grade line.

Conduit runs shown on the *Plans* may be changed to avoid underground obstructions with written approval by the *Engineer*.

Conduit cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges.

Reducing couplings will not be permitted. Slip joints or running threads will not be permitted for coupling conduit. Nonmetallic conduit fittings for connecting nonmetallic conduit to rigid metal conduit shall be threaded on the metal conduit side.

Conduit bends, except factory bends, shall have a radius of not less than 6 times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using the longest radius practicable.

Conduit stubs from safety lighting bases shall extend at least 6 inches from face of foundation and at least 24 inches below top of foundation.

325.03.10.03.01 Metal Conduit Ends. All metal type conduit ends shall be threaded and shall be capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with conduit grounding bushings.

Exposed non-galvanized threads on metal conduit resulting from field cuts shall have a cold galvanizing compound treatment applied.

325.03.10.03.02 Nonmetallic Conduit Ends. Nonmetallic type conduit ends shall have an appropriate size bell end installed prior to installation of wire or cable. Nonmetallic type conduit ends shall be capped until wiring is started.

Nonmetallic type conduit connections shall be of the solvent weld type.

325.03.10.03.03 Pull Boxes. Where pull boxes are placed in conduit runs, the conduit shall be fitted with threaded bushings and bonded in accordance with the *Code*.

Conduit entering through the bottom of a pull box shall terminate 1 to 2 inches above the bottom and shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run.

Conduit entering through the side of nonmetallic pull boxes shall terminate not more than 2 inches inside the box wall and not less than 6 inches above the bottom, and shall be sloped toward the top of

the box to facilitate pulling of conductors. The space between the side of the pull box and the conduit shall be grouted to prevent movement of the conduit.

325.03.10.03.04 Rigid Metallic Conduit Used Underground. Where rigid metallic conduit is used underground, it shall be either tarred and wrapped or shall be spirally wrapped with a corrosion protection polyvinyl chloride or polyethylene pressure sensitive tape, applied with a suitable primer. The wrap shall have a nominal thickness of 20 mils, consisting of either one layer of 20 mil tape or two separate layers of 10 mil tape. A single wrap of 10 mil tape with a half lap will not be acceptable.

325.03.10.03.05 Non Metallic Conduit Used Underground. Locate wire shall be placed above or inside nonmetallic conduit prior to backfilling.

325.03.10.03.06 Conduit For Use in Future Structures. Conduit for future use in structures shall be threaded and capped. Conduit leading to soffit, wall, or other lights or fixtures below the grade of the pull box shall be sealed by means of a sealing fitting and sealing compound, except that sealing fitting and sealing compound will not be required where conduit terminates in a structure pull box.

325.03.10.03.07 Conduits For Future Conductors. Detectable Mule Tape shall be installed in all conduits which are to receive future conductors. At least 5 feet of slack shall be coiled up at each termination.

325.03.10.03.08 Expansion Fittings. Expansion fittings shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a copper bonding jumper having the amperage required by the *Code*.

Each expansion-deflection fitting for rigid metallic conduit shall consist of a molded neoprene sleeve with a bonding jumper passing through a separate waterproof compartment and two silicon bronze couplings. Fittings shall permit a minimum of 3/4 inch expansion and contraction and a 3/4 inch deflection without deformation.

325.03.10.04 Foundations. Foundations shall be placed on a firm, non-yielding grade and monolithic where practicable. For posts, signal poles, and pedestals not on structures, the top 2 inches of the *PCC* foundation shall be placed after the post, signal pole, or pedestal is in proper position.

Anchor bolts, anchor bars or studs shall be provided with 2 nuts and 2 washers each. Anchors shall be placed in proper position and to proper height, and shall be held in place by means of an appropriate template until the *PCC* sets.

Conduit ends shall be placed in proper position and to proper height as shown on the *Plans*, and shall be held in place by means of a template until the *PCC* sets.

325.03.10.04.01 Forms. The exposed portions of the foundation shall be formed to present a neat appearance.

Forms shall be true to line and grade. Forms shall be rigid and securely braced in place. Both forms and ground which will be in contact with the *PCC* shall be thoroughly moistened before placing *PCC*.

Forms shall be removed when the *PCC* has thoroughly set.

325.03.10.04.02 Finish. Tops of foundations for posts and signal poles, except special foundations, shall be finished to curb or sidewalk grade or as directed by the *Engineer*. Ordinary surface finish, as specified in Subsection 311.14.01 – “Ordinary Surface Finish” – shall be applied to exposed surfaces of *PCC*.

Unless otherwise directed by the *Engineer*, posts, poles, signal poles, and pedestals, except *PCC* pedestals cast in place, shall not be erected until the foundation has attained 90 % of the design strength, and shall be plumbed or raked, as directed by the *Engineer*.

Plumbing of poles shall be accomplished by adjusting nuts before grouting or before the foundation is finished to final grade. Shims or other similar devices for plumbing or raking of posts, signal poles, or pedestals will not be permitted.

After each post, signal pole, or pedestal on structures is in proper position, grout shall be placed under the base plate. The exposed portions shall be formed to present a neat appearance. Grout shall contain only sufficient moisture to permit packing.

Where obstructions prevent the construction of a planned foundation the *Contractor* shall construct an effective foundation satisfactory to the *Engineer*.

325.03.10.05 Signal Poles, Mast Arms, Steel Pedestals, and Posts. Field welding shall be performed by a certified welder at the locations shown on the plans or as directed by the *Engineer*.

Signal poles, posts, and other ferrous materials shall be galvanized as provided in Section 213 – “Galvanizing.” All exposed edges resulting from modification of ferrous components shall be protected by cold galvanization in accordance with *MIL DOD-P-21035A*.

Handholes in the base of signal poles shall conform to the details shown on the *Plans*.

Signal poles shall be straight, with a permissive variation not to exceed 1 inch measured at the midpoint of a 28.5, 30, or 35 foot signal pole and not to exceed 3/4 inch measured at the midpoint of an 18, 20, or 25 foot signal pole.

All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to 1/8 inch radius, unless otherwise shown on the *Plans*. Shafts shall be provided with slip-fitter shaft caps.

Factory openings on poles shall be covered by an approved method or as shown on the *Standard Plans*.

325.03.10.06 Pull Boxes. When approved by the *Engineer*, the *Contractor* may, at no additional cost to the *Owner*, install additional pull boxes to facilitate the work.

There shall be a minimum of 6 inches between the top of the conduit (bell end) and the bottom of the pull box lid including any brackets underneath the lid used to support the lid.

Unless otherwise directed or approved by the *Engineer*, the tops of pull boxes shall be flush with the surrounding grade or top of adjacent curb. Where practical, pull boxes shown in the vicinity of curbs shall be placed adjacent to the back of curb, and pull boxes adjacent to a signal pole shall be placed along the side of foundations as shown on the *Plans*.

325.03.10.07 Wiring. In addition to the *Code* and local jurisdictional requirements, the wiring shall be in accordance with the requirements of applicable codes and this Subsection.

325.03.10.07.01 Installation. Unless otherwise specified and/or directed or approved by the *Engineer*, splices are not allowed. Splices shall not be allowed in the handhole located at the base of the signal pole.

325.03.10.07.01.01 Conductors. Conductors shall be pulled into the conduit by hand and the use of winches or other power actuated pulling equipment shall not be permitted.

Unless otherwise directed or approved by the *Engineer*, when new conductors are to be added to existing conductors in a conduit, all conductors shall be removed; the conduit shall be cleaned and both old and new conductors shall be pulled into the conduit as a unit.

Temporary conductors less than 10 feet above grade shall be enclosed in conduit.

At least 1 foot of slack shall be left for each conductor at each signal or lighting standard, or combined standard, and at least 3 feet of slack at each pull box.

Ends of spare conductors shall be taped and neatly trained.

Wiring within controller cabinets shall be neatly arranged and laced, or enclosed in plastic tubing. All signal light conductors, except branch neutrals, shall be run continuously without splices from a terminal block located in a cabinet, compartment, or signal head, to a similarly located terminal block.

All stranded conductors smaller than No. 14 AWG shall be terminated in crimp style terminal lugs.

Connection to each terminal of a pedestrian push button shall be by a single conductor.

325.03.10.07.01.01.01 Connectors and Terminals. Conductors shall be joined by the use of connectors or other methods permitted by the *Engineer*.

Where permitted, splices, with or without connectors shall be soldered, except that soldering of pressure connectors and terminals may be omitted provided the connectors and terminals are applied with the proper type tool as recommended by the manufacturer of the connector or terminal being applied.

325.03.10.07.01.01.02 Pedestrian Push Buttons. The neutral for pedestrian push button circuits shall be separate from the signal light circuit neutral.

325.03.10.08 Bonding and Grounding. Bonding and grounding shall be in accordance with the *Code* and the *Standard Plans*.

325.03.10.09 Controller Cabinets. All controller cabinets shall conform to *NEMA* and the *Standard Plans* and *Standard Specifications* and requirements set forth by the maintaining *Agency*. Unless otherwise directed or approved by the *Engineer*, cabinets shall be installed in accordance with the manufacturer's recommendations.

Cabinets shall be securely fastened to the *PCC* foundation.

Cabinets shall be sealed against the environment with the exception of the air filter and fan cutout.

Cabinets shall be plumb and the door shall open and close without catching on the rim of the opening that the door covers. Shims shall not be allowed when leveling the cabinet. Unless otherwise directed or approved by the *Engineer*, doors shall open and close to their full extent with no modifications.

The interior of the cabinet, which includes the conduits, must be cleaned of all debris that accumulates during modification and installation.

Unless otherwise directed or approved by the *Engineer*, the exterior shall be factory painted and finished with a material that is resistant to rust, solvents, oils, acids and alkalis.

Unless otherwise directed or approved by the *Engineer*, no auxiliary panels or conduit shall be attached to the exterior of the cabinet.

325.03.10.10 Service. Electrical service installation and materials shall conform to the requirements of the serving utility.

325.03.10.11 Pedestrian Detection. The installation shall be tamper-proof.

325.03.10.12 Signal Head Assembly. The vehicle traffic signal head shall be level and secure.

325.03.10.12.01 Pedestrian Traffic Signal Head Assembly. Pedestrian signals shall comply with *MUTCD*.

Each signal shall be provided with an "egg crate type" visor designed to eliminate sun phantom.

Gaskets shall be provided as required to make the unit rain-tight and dust-tight.

A terminal block shall be mounted in the unit for field wiring.

325.03.10.13 Luminaires. The unit shall be mounted to the existing mast arm that supports the safety lighting with no special constructed mounts or wire splicing methods.

The luminaire shall be securely attached to the pipe tenon. Use of a straight tubular section of pipe tenon, either 1-1/4" or 2", in accordance with Table 2 of *ANSI/C136.3* and Section 7 of *ANSI/C136.13* is permitted.

Leveling is permitted through no less than $\pm 3^\circ$ from the axis of attachment.

To prevent the entrance of wildlife, openings shall be limited around the pipe tenon mounting area to no more than $\frac{1}{4}$ inch greater than the range of tenon sizes and leveling adjustment. The use of supplemental closures is permitted.

325.03.10.14 Loops. Where shown on the *Plans*, loops shall be installed and a termination pull box shall be provided.

Loops shall be centered in lanes. Distance between side of loop and a lead-in saw cut from adjacent detectors shall be 12" minimum. Distance between lead-in saw cuts shall be 6" minimum.

A saw shall be used for cutting loops into pavement. The bottom of saw slot shall be smooth with no sharp edges. Slots shall be washed until clean, blown out and thoroughly dried before installing loop conductors.

Loop circuit pairs shall be identified and tagged in the termination pull box, including the loop number, start (S) and finish (F) of conductor. Lead-in cables shall be identified and tagged with sensor number and phase.

No more than 2 twisted pairs shall be installed in one sawed slot.

Allow additional length of conductor for the run to the termination pull box. At least 5 feet of slack shall be coiled up at each termination.

The additional length of each conductor for each loop shall be twisted together into a pair (6 turns per 3' length minimum) before being placed in the slot and conduit that leads to the termination pull box.

The *Contractor* shall test each loop circuit for continuity, circuit resistance, and insulation resistance at the pull box before filling slots. The *Contractor* shall also test each loop circuit for continuity, circuit resistance and insulation resistance at the controller cabinet location.

Slots shall be filled as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Loop conductors shall be spliced to lead-in cable. All splices shall be soldered using rosin-core solder. Lead-in cable shall not be spliced between the termination pull box and the controller cabinet terminals. Where loop conductors are not to be spliced to a lead-in cable, the ends of the conductors shall be taped and waterproofed with electrical insulating coating.

End of lead-in cable and Type 2 loop wire shall be waterproofed prior to installing in conduit to prevent moisture from entering the cable.

325.03.11 WEATHER LIMITATIONS. Work shall not be performed when weather conditions are detrimental to the quality of the finished product.

325.03.12 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

325.03.13 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”, except as modified herein.

325.04 ACCEPTANCE. All work shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* shall be complete and in satisfactory operating condition at the time of acceptance of the project.

326.01 DESCRIPTION. This work shall consist of furnishing, fabricating, casting, machining, preparing, transporting, erecting, or placing any or all reinforcing steel, structural steel, rivet and eye bar steel, steel forging, casting, and any other metal of the type, shape, dimensions, and quality required by the Plans or these Specifications.

326.02 REINFORCING STEEL

326.02.01 Material Grades. Materials shall conform to Section 206 – “Reinforcing” – and 207- “Structural Steel” – of these Specifications.

All bar steel reinforcement may be either Grade 40 or Grade 60 unless otherwise specified on the Plans.

Spiral reinforcement may be either Bar Steel Reinforcement or Steel Wire of the equivalent size of the bar steel.

One extra bar of each diameter shall be furnished per contract for each 100 tons or fraction(s) thereof. This bar shall be from the longest bar of each size so that it can be used to replace any bar of that diameter which is selected to be used as a field sample. The field sample must be of sufficient length to provide for two, 2 foot samples of each diameter. The extra bars shall be indicated on the fabricator's details.

326.02.02 Materials List. Before placing reinforcing steel, two copies of a list of all reinforcing steel shall be furnished to the Engineer at the site of his use in administering the Contract. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the Plans and as specified.

326.02.03 Protection of Material. Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance. However, when steel has on its surface loose mill scale or dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

326.02.04 Bending Requirements. Bent bar reinforcement shall be cold bent to the shape shown on the Plans and unless otherwise provided on the Plans or by authorization. Bends shall be made in accordance with the ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures.

326.02.05 Placement and Support. All bar reinforcement shall be accurately placed in the positions shown on the Plans, and firmly held during the placing and setting of concrete. When the spacing of bars exceeds one foot in either direction, all intersections shall be ties. When the spacing of bars is 1 foot or less in both directions, alternate intersections shall be tied.

Distances from the vertical and horizontal forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks used for holding reinforcing bars from contact with the forms or between layers of bars shall be precast mortar blocks of approved shape and dimensions and shall have a compressive strength of not less than 3000 p.s.i. Metal chairs which are in contact with the exterior surface of the concrete shall be fabricated of either galvanized steel, or have the steel tips plastic coated to at least 3/4 inch into the concrete, or be of stainless steel conforming to the requirements of ASTM A 493 Type 430. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted. Reinforcement in any member shall be placed, and then inspected and approved by the Engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.

If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

326.02.06 Splices. All reinforcement bars shall be furnished in the full lengths indicated on the Plans. Splicing of bars, except where shown on the Plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible. All splices shall be in accordance with the latest edition of ACI Standard 318, unless modified by the Plans, Specifications, or Engineer. In lapped splices, the bars shall be placed in contact and wired together. Welding of reinforcing steel shall be done only if detailed on the Plans or authorized by the Engineer in writing. Welding shall conform to the Specifications of the American Welding Society.

Lapped splices in reinforcement shall not be used for sizes larger than number 11.

Splices in spiral steel shall be made by welding or by a lap of 1 1/2 turns.

Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than 1 1/2 mesh width.

326.02.07 Substitution. Substitution of different size bars will be permitted only with specified authorization by the Engineer. The bars substituted shall have an area equivalent to the design area or larger.

326.03 STRUCTURAL STEEL

326.03.01 Materials. Materials shall conform to Section 207 – “Structural Steel” – of these Specifications.

Turned bolts shall meet the material specifications set forth for Structural Rivet Steel. Anchor bolts, nuts, and washers shall be of structural steel, galvanized in accordance with ASTM Designation A 153. Bolts for fastening tubes to the rail post sockets shall be stainless steel.

Bridge or pedestrian rails and posts made of aluminum shall not be painted.

326.03.02 Shop Drawings. Shop drawings shall consist of shop detail erection and other working plans showing dimensions, sizes of material, details, and other information necessary for the complete fabrication and erection of the metal work. The drawings shall be prepared on sheets 22 inches wide by 36 inches. The original drawings may be made either on paper or on cloth, but the details must be drawn so that the prints will be clear and legible.

Unless otherwise requested, the Contractor shall submit to the Engineer for approval two sets of checked drawings. The Engineer reserves the right to refuse prints of shop drawings which are not clear and legible. Upon approval, the Contractor shall furnish the Engineer with the number of sets of shop drawings requested and the original tracings or reproducible negatives thereof. All shop plans shall be submitted for approval at least 15 working days before fabrication is started and no material shall be fabricated until the Plans have been finally approved by the Engineer. The shop drawing as approved by the Engineer shall become a part of the Contract provided, however, that any substitution of sections contemplated by the shop drawing different from sections shown on the Plans shall be made only when approved by the Engineer and, in such case, additional costs resulting from such substitution shall be borne by the Contractor.

In the event the Contractor elects to furnish bridge rail constructed of aluminum as provided herein and the plan sheets show only steel bridge rail, the Contractor shall submit the fabricator's design calculations to the Engineer in order that it may be verified that the railing and hardware conform to Section 1.1.9 – “Railings” – of the AASHTO Standard Specifications for Highway Bridges, current edition.

After approval there shall be no deviation from the shop drawings or changes made thereon without the prior written approval of the Engineer.

Approval of shop drawings shall be understood to be an acceptance of the character and sufficiency of the details and not a check of any dimensions. Checking shop drawings is intended as a means of facilitating the work and avoiding errors so far as possible, but it is expressly understood that it will not relieve the Contractor from total responsibility in regard to errors or omissions on said shop drawings.

The contract price shall include the cost of furnishing all shop drawings and the Contractor will be allowed no extra compensation for such drawings.

326.03.03 Notice of Fabrication. The Contractor shall give the Engineer 15 working days written notice of manufacturing of material at the mill so that inspection may be provided. No material shall be manufactured or fabrication begun without authorization by the Engineer. The Engineer may inspect the material, as provided for in ASTM Designation A 6, at his option. Material not inspected at the manufacturer shall be subject to inspection as provided for in Section 324.03.04 – “Inspection and Testing of Materials.” “Mill” means any rolling mill or foundry where material for the work is to be manufactured. Prior to the fabricator placing his order with the mill, he shall inquire with the Engineer if additional material will be required for testing. The additional material required for testing shall be at no additional cost to the Department. Prior to the beginning of fabrication, a 15 day written notice shall be provided by the Contractor to the Engineer. Any purchase of material prior to inspection at the mill or fabrication of any work without authorization from the Engineer shall be at the Contractor's risk.

326.03.04 Inspection and Testing of Materials. The Engineer will examine, and test as necessary, all material before fabrication. Adequate facilities and free access to the necessary work areas will be provided to the Engineer by the manufacturer and fabricator. Required test samples will be furnished free of charge. Material not inspected at the place of manufacture shall be subject to all chemical, physical, and workmanship requirements established for the material supplied. Materials or workmanship not in conformity with the specified product may be rejected. The Engineer may inspect and test all material by any visual, destructive, or non-destructive method to evaluate the material for its specified properties. Mill orders and certificates showing test values obtained must be furnished in triplicate to the Engineer. All certified test values must include physical and chemical results and steel making process used. Acceptance of any material at the mill or fabrication shop prior

to incorporation into the work shall not prevent the rejection of the material or finished member if defects are discovered.

Inspection in the fabrication shop is intended as a means of facilitating the work and avoiding errors so far as possible. It is expressly understood that shop inspection does not relieve the Contractor from responsibility for material or fabrication defects or errors and the necessity for replacement or correction of rejected materials and workmanship.

Shop inspection of rail pipe and tubes will in most cases be waived and the Contractor permitted to ship subject to inspection at the project site. The field inspection will cover the general appearance, size, thickness, etc., of the pipe and tubing. Conformance of chemical and mechanical properties to requirements of the Specifications will also be considered before the material is approved. Shop inspection of rail posts will be made on the first few rail post castings furnished for each project in order to establish a satisfactory class of finish and workmanship. When shop inspection is waived on a portion of the handrail posts for a project, a careful inspection will be made in the field to determine the acceptability of these post on the basis of the finish and workmanship as compared to that of the other posts previously inspected and approved.

Fabrication of aluminum alloy material shall, in general, conform to or be equivalent to fabrication methods and practices recommended in the handbooks of the major producers of aluminum materials and specifically the following requirements:

- (a) Material shall be sawed, routed, or milled.
- (b) Flame cutting is not permissible.
- (c) Tubing may be heated to a temperature not exceeding 400 degrees Fahrenheit for a period not exceeding 15 minutes to facilitate bending.
- (d) Holes in pipe and tubing shall be drilled. Holes in castings shall be cored and reamed, or drilled from the solid. Seats for pipe shall be finished smooth.

The fabrication and handling of aluminum materials in the shop and field shall be performed in a manner to prevent scoring or marring of the surfaces. An objectionable appearance resulting from such scoring or marring shall be cause for rejection of the material. Sleeves and rails shall be fabricated in lengths indicated on the Plans.

The finishing of rail posts shall be performed after fabrication is completed. All fins, pipes, and other casting irregularities and all drilling, reaming, and other fabrication marks shall be removed.

326.03.05 Handling and Transporting. The loading, transporting, unloading, storing, and handling of structural steel shall be conducted so that the metal will be kept clean and free from grease and other foreign material. When unloaded, the material shall be placed on skids, platforms, or other supports above the ground. In addition, the material shall be properly drained and protected from corrosion. All material for the project shall be stored separate for "in stock" materials. Girders and beams shall be placed upright above ground and stored. Other members, such as columns, chords, cross frames, wind bracing, etc., shall be supported above ground on skids placed near enough together to prevent injury from deflections. Different grades or classifications of material shall be color coded as provided for in ASTM Designation A 6. This color code must be transferred throughout fabrication. If the Contract covering the erection of the steel does not include the fabrication, the Contractor shall check the material received by him and report promptly in writing to the Engineer any shortage or injury discovered.

326.03.06 Straightening. Rolled material before being laid out or worked shall be straight. Methods of straightening shall be in accordance with ASTM Designation A 6.

Subassemblies and completed members shall be straight before being incorporated into the work. If straightening is necessary, it shall be done by methods acceptable to the Engineer and in accordance with AWS D1.1-80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition.

Details of methods proposed for straightening of rolled material, subassemblies, or completed members shall be submitted in writing to the Engineer prior to their use. In addition, a detailed procedure for correcting camber shall be submitted to the Engineer for approval. After straightening or correcting camber, evidence of fracture or other damage will be cause for rejection of the material.

If required, beams and girders shall be curved by either: (1) precutting curved flanges or (2) heat curving the members after fabrication. The heat curving shall be in accordance with Division II, Article 10.5 of AASHTO

Standard Specifications for Highway Bridges, Thirteenth Edition. The procedure used shall be submitted to the Engineer for review and approval.

326.03.07 Punching, Subpunching, Drilling, and Reaming. Unless otherwise specified, connections and splices (shop and field) of main truss or arch members, continuous beams, plate girders, rigid frames, and web splices shall either be subpunched (or subdrilled) and reamed while shop assembled or drilled to full size from the solid while assembled at the shop. Full size punching of holes will be allowed on intermediate stiffeners, bearing stiffeners, cross bracing, wind bracing, and diaphragms.

Punching and subpunching of structural steel conforming to ASTM A 36 shall not be permitted on material thicker than 7/8 inch or thicker than 3/4 inch for high strength structural steel. Holes subpunched for reaming shall be subpunched 1/4 inch less in diameter than the finished hole.

Reamed or drilled holes shall be cylindrical and perpendicular to the member. Oversize or slotted holes shall not be permitted unless specified on the Plans, except as noted in Subsection 324.03.08 – “High Strength Bolts.” Reamers shall be directed by mechanical means where practicable. Burrs on the outside surfaces shall be removed. Poor matching of holes shall be cause for rejection. Reaming and drilling shall be done by twist drills.

Unless otherwise specified, each individual (full length) truss, arch, continuous beam, or plate girder shall be assembled at the shop before reaming or drilling is commenced. During shop assembly, all members shall be supported at such intervals and in such manner as is necessary to avoid undesirable deflections.

326.03.08 Bolts and Bolted Connections

(a) General. Bolts shall be of such length that they will extend entirely through the nut but not more than 3/8 inch beyond. The Contractor shall furnish sufficient bolts of each type for each size and length to bolt such connections as called for with an ample surplus to replace those lost or rejected.

The holes, except holes in end diaphragms, shall be truly cylindrical. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread.

Bolt holes in end diaphragms shall be slotted 1/2 inch in addition to the dimensions shown on the Plans, in the direction to facilitate erection. At all locations where such slotted bolt holes are required, circular washers shall be placed on each side of the bolted connection and the necessary bolt length adjusted accordingly.

Bolts in end diaphragm to girder connections shall not be tightened until the deck pour has been completed.

All bolted connections shall be fastened with high-tensile strength bolts.

(b) High-Tensile Strength Bolts

1. General. This article covers the assembly of structural joints using ASTM A 325 or ASTM A 490 high strength bolts, or equivalent fasteners, tightened to a high tension.
2. Bolts, Nuts, and Washers. Bolts, nuts, and washers shall conform to the requirements of subsection ASTM A 325 – “High-Strength Bolts,” – except the use of lock-pin and collar fasteners shall not be permitted.
3. Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1 to 20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

When assembled, all joint surfaces including those adjacent to the bolt head, nuts, or washers, shall be free of scale, except tight mill scale, and shall also be free of burrs, dirt, and other foreign material that would prevent solid seating of the parts. Paint is permitted unconditionally in bearing-type connections.

In friction-type conditions the class, as defined below, indicating the condition of the contact surfaces shall be specified on the Plans. Where no class is specified all joint surfaces shall be free of scale, except tight mill scale, and shall not have vinyl wash.

Class A, B, and C (uncoated). Contact surfaces shall be free of oil, paint, lacquer, or other coatings.

Class D (hot dip galvanized and roughened). Contact surfaces shall be lightly scored by wire brushing or blasting after galvanizing and prior to assembly. The wire brushing treatment shall be a light application of manual or power brushing that marks or scores the surface but removes relatively little of the zinc coating. The blasting treatment shall be a light "brush-off" treatment which will produce a dull gray appearance. However, neither treatment should be severe enough to produce any break or discontinuity in the zinc surface.

Class E and F (blast-cleaned, zinc rich paint). Contact surfaces shall be coated with organic or inorganic zinc rich paint as defined in the Steel Structures Painting Council System SSPC 12.00.

Class G and H (blast-cleaned, metallized zinc or aluminum). Contact surfaces shall be coated in accordance with AWS C-2.2, Recommended Practice for Metallizing with Aluminum and Zinc for Protection of Iron and Steel, except that subsequent sealing treatments described in Section IV therein shall not be used.

Class I (vinyl-wash). Contact surfaces shall be coated in accordance with the provisions of the Steel Structures Painting Council Pretreatment Specifications SSPC PT3.

High-tensile strength bolts shall not be galvanized unless shown on the plans. ASTM A 325 and ASTM A 490 bolts shall not be galvanized nor shall they be used to connect galvanized material.

4. Installation

- a. Bolt Tension. When all fasteners in the joint are tight, each fastener shall be tightened to provide at least the minimum bolt tension shown in Table 1 for the size of fastener used.

If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

ASTM A 490 and galvanized ASTM A 325 bolts shall not be reused. Other ASTM A 325 bolts may be reused, but not more than once, if approved by the Engineer. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as a reuse.

- b. Washers. All fasteners shall have a hardened washer under the element (nut or bolt head) turned in tightening. Hardened washers shall be used under both the head and nut regardless of the element turned in the case of ASTM A 490 bolts if the material against which it bears has a specified yield strength of less than 40 p.s.i.

Where an outer face of the bolted parts has a slope of more than 1 to 20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of perpendicularity.

- c. Tightening by Use of a Load Indicating Fastener System. Tightening will be by a load indicating fastener system. Unless otherwise indicated, the authorized load indicating fastener shall be a specifically hardened washer with protrusions on one face. Tightening shall be by the manufacturer's methods and procedures and shall have the approval of the Engineer. Certification shall be supplied by the manufacturer that the fastener used is available to indicate that the bolt has been tightened to obtain the bolt tension in accordance with Table I.

TABLE I
BOLT TENSION
MINIMUM BOLT TENSION IN POUNDS¹

| Bolt Size, in Inches | ASTM A 325 Bolts, p.s.i. | ASTM A 490 Bolts, p.s.i. |
|----------------------|--------------------------|--------------------------|
| 1/2 | 12,050 | 14,900 |
| 5/8 | 19,200 | 23,700 |
| 3/4 | 28,400 | 35,100 |
| 7/8 | 39,250 | 48,500 |
| 1 | 51,500 | 623,600 |
| 1 1/8 | 56,450 | 80,100 |
| 1 1/4 | 71,700 | 101,800 |
| 1 3/8 | 85,450 | 121,300 |
| 1 1/2 | 104,000 | 147,500 |

¹ Equal to 70 percent of specified minimum tensile strength of bolts.

5. **Inspection.** The Engineer shall determine that the requirements of Subsection 506.03.10(b) a through 4 of this subsection are met in the work.

The Engineer shall observe the installation and tightening of bolts to determine that the approved procedure is properly used and shall determine that the correct indication of tension has been achieved.

326.03.09 Shop Assembly. Shop assembly of trusses, arches, continuous beams, plate girders, and rigid frames shall be according to Subsection 326.03.07 – “Punching, Subpunching, Drilling, and Reaming.” All members shall be match marked before being disassembled.

The several component parts of a built up member shall be straight and close fitting.

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before drilling and reaming. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operation. The member shall be free from twists, bends, and other deformations.

The drilling done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

Connecting parts in the shop for the purpose of reaming holes in field connections shall be match marked, and a diagram showing such marks shall be furnished to the Engineer.

A camber diagram shall be furnished to the Engineer showing the camber at each panel point in the cases of trusses, and at field splices and 1/10 points of span for beams, girders, and rigid frames. The final camber shall be checked on the fully assembled girders in the “no load” position for rolled beams and I-plate girders, and in the “dead load” position for box plate girders. The bolts in the field splice need not have the final tension applied. Only enough tension need be applied to adequately keep the assembled section together for the camber measurements.

Prior to fabrication, a handling procedure for box plate girders shall be submitted to the Engineer for approval. The procedure shall be such that no undue stresses are applied to the flange to web welds.

326.03.10 Edge Planing. Sheared edges of plates more than 5/8 inch in thickness and carrying calculated stress shall be planed to a depth of 1/4 inch. Re-entrant cuts shall be filleted to a radius of 3/4 inch.

326.03.11 Milled Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the American Standards Association surface roughness requirements as defined in ANSI B-46.1, Surface Roughness, Waviness, and Lay, Part I.

| | |
|---|------------|
| Steel slaps | ANSI 2,000 |
| Heavy plates in contact in shoes to be welded | ANSI 1,000 |
| Milled ends of compression members, stiffeners, and fillers | ANSI 500 |
| Bridge rollers and rockers | ANSI 250 |
| Pins and pin holes | ANSI 125 |
| Sliding bearings | ANSI 125 |

Surfaces of bronze bearing plates intended for sliding contact shall be planed parallel to the movement of the spans and polished.

326.03.12 Abutting Members. Abutting joints in compression members of trusses and in columns shall be milled.

Openings and abutting joints in tension members shall not exceed 1/4 inch.

Abutting joints of rolled beams, plate girders, and box plate girders shall not exceed 1/4 inch.

326.03.13 Flame Cutting. This work shall be in accordance with provisions of AWS D1.1-80 and revisions as modified by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition.

326.03.14 Length Tolerances. Floorbeams, stringers, and girders having end connection angles shall be built to the exact length shown on the Plans measured between the heels of the connection angles, with a permissible tolerance of plus zero inch to 1/16 inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than 3/8 inch, nor less than that shown on the Plans.

326.03.15 Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

326.03.16 Girder Top Flanges. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above backs of the flange angles and shall not be more than 1/8 inch below at any point.

Splices in webs of girders without cover plates shall be sealed on the top by welding.

At web splices, the clearance between the ends of the web plates shall not exceed 3/8 inch. The clearance at the top and bottom ends of web splice plates shall not exceed 1/4 inch.

326.03.17 Shear Stud Connectors. Stud shear connectors shall be of a design suitable for end welding and shall be end welded to steel beams, girders, or plates with automatically timed stud welding equipment. The type, size or diameter, and length of the stud shall be as specified in the Contract Documents. A maximum variation of 1 inch from the location shown will be accepted, provided the adjacent studs are not closer than 2 1/2 inches center to center. The clear distance between the edge of a girder flange and the edge of the shear connectors shall be not less than 1 inch. Fillet welds varying in size from 3/16 inch to 5/16 inch are satisfactory, provided the studs pass all other tests required. Adequate provision shall be made in the fabrication of structural members to compensate for loss of camber due to welding of the shear connectors.

Studs shall be painted or galvanized. The studs shall be free from rust, scale, rust pits, and oil at the time of welding and immediately before the concrete is placed. The beam surface to which the studs are welded shall be free from excessive mill scale, rust, dirt, paint, grease, or any other material which might impair the quality of the weld. When necessary to obtain satisfactory welds, the areas on the beam, girder, or plate to which the studs are to be welded shall be wire-brushed, peened, prickpunched, or ground free of scale or rust.

The Contractor shall submit to the Engineer for approval before installation information on the studs to be furnished as follows:

1. The name of the manufacturer.
2. A detailed description of the stud and shield.
3. A certification from the manufacturer that the stud is qualified as specified in AWS D 1.1. The certification must also indicate the heat from which the studs were manufactured.

Welding specifications and procedure requirements shall conform to AWS D1.1.

326.03.18 Welding

(a) General. All welding shall be performed in the fabrication shop, except as otherwise noted on the Plans or permitted by the Engineer.

Automatic welding shall be used for all flange to web welds.

Shop splices of flanges or webs of main members shall be limited to locations where section changes occur, where shown on the Plans, or as approved by the Engineer.

The weldments in butt splices of both webs and flanges shall be inspected and found satisfactory prior to performing web to flange connections.

Field splices shall be limited to the actual locations shown on the Plans.

The use of additional field or shop splices, if required, shall be reviewed and approved in writing by the Engineer prior to fabrication.

Welding shall conform to the provisions of AWS D1.1-80 and revisions thereto, as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition, except the use of electroslag weldments will not be allowed.

All groove welds on primary members shall be finished smooth and flush with the base metal on all surfaces by grinding in the direction of applied stress, leaving the surface free from depressions.

Extension bars of runoff tabs shall be used at the end of a joint in a manner that will ensure sound welds. Fillet welds on stiffeners or gusset plates shall be terminated 1/4 inch from the end of the plate or cope.

The minimum length of all welds shall be 2 inches.

All welding on structural steel shall be only at locations shown on the shop drawings, including tack welds. The welding of lifting lugs or attachments will not be allowed.

The fabricator shall submit to the Engineer for his review all welding procedures for prequalified welds at no additional cost to the Owner. In addition, the Engineer reserves the right to test any prequalified weld at no additional cost to the Owner.

Shear stud connectors shall not be placed on shop splices, but may be moved up to 3 inches either side of the splice if a conflict occurs.

Where weldments in both the web and flange fall at the same location, they shall be offset a minimum of 6 inches. When a stiffener falls at a location of a flange or web weldment, the stiffener shall be offset a minimum of 3 inches from the weldment.

Upon approval of the Engineer, shop splices may be located at points that are consistent with lengths of plate available from the mill and in areas of reduced tensile stress. To eliminate shop splices, the length of a thicker plate may extend to the end of a thinner plate or the end of a member. These changes, if approved by the Engineer, shall be shown on the shop drawings. Extra material and workmanship required by these changes shall be at no additional cost to the Owner.

(b) Inspection-Testing. All shop and field welds shall be inspected to the provisions of AWS D1.1-80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition, Nevada Test Methods NHD 900, 901, 903, and these Specifications.

Paragraph 6.1.3.1 of the AASHTO Welding Specifications is hereby deleted in its entirety and any reference to said paragraph in AWS or AASHTO is also deleted.

The Contractor shall visually inspect all welds and test welds in accordance with the requirements of this subsection of these Specifications. The Engineer will make the final evaluation of the acceptability of all welds.

(c) Quality Control. Prior to any fabrication, the Contractor shall submit in writing a quality control program to the Engineer. The program shall outline the quality control tasks to be performed by the Contractor to insure

that the work conforms to the Plans and these Specifications. The quality control program shall also identify the Contractor's personnel who will be responsible for performing the quality control tasks.

- (d) Supervision. Adequate supervision and inspection of all welds shall be provided by the Contractor to ensure satisfactory, consistent, and uniform workmanship. Repeated and chronic weld defects shall be considered as evidence that proper quality control and supervision procedures are not being provided.
- (e) Time of Inspection. Visual inspection shall be continuous. Nondestructive testing of welds shall begin immediately after welding operations are completed, except for ASTM A 514 and A 517 steels. Final nondestructive testing of welds for ASTM A 514 and A 517 steels shall not be performed until at least 96 hours have elapsed after completing welding operations.
- (f) Heat Numbers. Prior to nondestructive testing, the Contractor shall furnish to the Engineer heat numbers of all structural steel parts welded together to form a main member. Heat numbers of all plates separated into flange and web sections shall be transferred through steel stamping by the Contractor at his expense.
- (g) Visual Inspection of Welds. Visual inspection of welds will be performed by the Engineer at no expense to the Contractor, except as provided in the Contractor's quality control program. Inspection requirements and standards for visual acceptance shall be as stated in AWS D-1.1 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition, and Nevada Test Methods NHD 900, 901, and 903. All welds shall be inspected and accepted visually, and any required repairs made prior to performing any nondestructive testing for acceptance.
- (h) Testing Precedence. When both radiographic inspection and ultrasonic inspection are to be performed on a weld, radiographic inspection shall be performed prior to ultrasonic inspection except in flanges where acceptance is based on ultrasonic method.
- (i) Radiographic Inspection. All radiographic testing and inspection will be performed by the Contractor at his expense.
 - 1. Licensing Requirements. The agency performing the radiographic testing shall be currently licensed for the operation involving radioactive materials under the proper jurisdiction where such inspections are performed.
 - 2. Testing Procedures Submittal. Before beginning fabrication of structural steel components, the Contractor shall submit in writing to the Engineer for approval a copy of his proposed radiographic test procedures.
 - 3. Resume. The Contractor shall furnish to the Engineer a resume listing the specific radiographic equipment and outlining the particular radiographic procedures proposed for use on the work. The Contractor shall furnish a statement to the Engineer detailing the radiographic training and experience for each person to be employed in radiographic testing and certifying that each of these persons is a competent radiographer or radiographer's assistant.
 - 4. Scheduling. The Contractor shall schedule radiographic testing and notify the Engineer not less than 12 hours in advance of the scheduled time and place for this testing. The items to be radiographed and the radiographic agency to be utilized, unless otherwise authorized by the Engineer. Radiographic testing shall be scheduled during daylight hours only unless requested in writing by the Contractor and approved by the Engineer. Blanket approval for an extended period may be given at the discretion of the Engineer.

Butt welds in girder flanges and webs shall not be radiographically inspected until the rider flange or web section is cut to its finished width.

- 5. Extent of Inspection
 - a. Groove Welds. The Contractor shall furnish to the Engineer for his use in evaluating the acceptability of groove welds, radiographs, and radiographic reports for the following welds:

TABLE II
RADIOGRAPHIC WELD INSPECTION SCHEDULE

| Girder Material | Member | Tension / Compression | Weld Orientation | Percent Inspection |
|-----------------|--------|-----------------------|------------------|--------------------|
| All | Flange | Tension | Transverse | 10 |
| All | Flange | Compression | Transverse | 5 |

Percent inspection on flange welds indicated the percentage of the total number of welds in the structure. Each weld designated for radiographic testing shall be tested for the entire length of the weld. The inspector will designate which welds to be tested.

| Girder Material | Member | Tension / Compression | Weld Orientation | Percent Inspection |
|-----------------|--------|-----------------------|------------------|--------------------|
| All | Web | Tension | Transverse | 100 |
| All | Web | Compression | Transverse | 100 |
| All | Web | Tension | Longitudinal | 10 |
| All | Web | Compression | Longitudinal | 10 |

Percent inspection on web indicated the percentage of the length to be tested on each individual web weld; however, a minimum of one radiograph 17 inches in length at each end of all web welds is required. In addition, if the original radiographs show rejectable discontinuities, the area on each side of the defect for a minimum length of 17 inches shall be tested.

- b. Additional Radiographic Inspection. The Engineer may perform radiographic inspection in addition to such inspection performed by the Contractor. The Contractor shall make available, at no cost to the State, the facilities used in his operations for use by the Engineer in performing such additional inspection. In the event such additional radiographic inspection discloses defective welds, repairing of the defective welds and reradiographic inspection shall be performed by the Contractor at his expense.

6. Radiographic Procedure

- a. Requirement. The radiographic procedure used shall conform to the requirements in ASTM Designation E-94, and the requirements of these Specifications.
- b. Film. Radiographs made on material whose thickness is 0.9 inch or less shall be done on Type 1 industrial radiographic film.

Radiographs made on material whose thickness is 0.901 inch to 3.5 inches shall be done on Type II industrial radiographic film. All radiographic film shall conform to the requirements of ASTM Designation E-94. The film shall be wide enough to fully span the width of the weld with sufficient excess to allow the specified location markers and other identification to show on the film outside of the weld area, but in no case shall the film be less than 4 1/2 inches in width. The testing agency conducting the radiograph shall submit for approval all data concerning the film, including brand name and type, prior to any radiograph being performed on the project.

- c. Process and Detail. Radiographs shall be made by either X-ray or gamma ray. All radiographs shall determine quantitatively the size of defects having thickness equal to or greater than 2 percent of the thickness of the thinner of the part joined by the weld under examination. They shall be clean, free of film processing defects, shall have densities of not less than 1.5, and no more than three in the area of interest. Any gamma ray source used to radiograph welded material up to 3 inches in thickness shall not exceed 0.16 inch across its greatest diagonal dimension.

Radiographs shall show the following:

- (1) The 2T hole in each penetrometer.

- (2) The penetrometer identification number.
- (3) The radiograph identification and location marks below under "identification and Location Marks."
- d. Film Development. Radiographic film shall be developed within the time and temperature range recommended by the film manufacturer. Sight development will not be permitted. The film shall be manually hot air dried to the satisfaction of the Engineer. The use of automatic dryers will not be permitted.
- e. Dual Film Technique. In the event that the greatest and least thickness of a weld joining parts of different thickness cannot both be rendered with a single exposure on a single film having densities within the limits specified under "Process and Detail", a dual film or dual exposure technique shall be used. These techniques shall be calibrated to obtain the required density for both the greatest and the least thickness of the weld. When these techniques are employed, two extra penetrometers shall be used in addition to the two specified under "Penetrometers." The four penetrometers shall be positioned so that at least one penetrometer image appears at each end of each film on the plate thickness for which that film has been exposed.
- f. Penetrometers. Two or more penetrometers shall be used for each radiograph on a film 10 inches or more in length. Only one penetrometer need be used for radiographs on film less than 10 inches in length. Penetrometers shall be placed on the side of the work nearest the source of radiation located as shown in the current edition of AWS. Penetrometers shall conform to the requirements in Table III of this subsection of these Specifications. The thickness of each penetrometer shall be equal to or less than 2 percent of the thickness of the thinner of the parts joined by the weld under examination, but need not be less than 0.005 inch thick.

In each penetrometer there shall be three holes, one of which shall be of diameter equal to twice the nominal penetrometer thickness (2T), but not less than 1/16 inch for X-ray and 3/32 inch for gamma ray. The diameter of the two remaining holes shall be selected by the manufacturer. They will ordinarily be equal to three or four times the penetrometer thickness, but not be smaller than 1/16 inch. Smaller holes are permitted. These holes shall be true and normal to the surface and not chamfered. For weld thickness less than 1/2 inch, the penetrometer shall also contain a slit 1/4 inch long by 0.01 inch wide.

TABLE III
STANDARD PENETROMETER SIZES

| Weld Thickness Range | Thickness of Penetrometer on Source Side (inch) | Example of Penetrometer Identification |
|-----------------------|---|--|
| Up to 1/4 inclusive | 0.005 | 5 |
| Over 3/8 thru 1/2 | 0.0075 | 7 |
| Over 3/8 thru 1/2 | 0.010 | 10 |
| Over 1/2 thru 5/8 | 0.0125 | 12 |
| Over 3/4 thru 7/8 | 0.015 | 15 |
| Over 3/4 thru 7/8 | 0.0175 | 17 |
| Over 7/8 thru 1 | 0.020 | 20 |
| Over 1 thru 1-1/4 | 0.025 | 25 |
| Over 1 1/4 thru 1 1/2 | 0.030 | 30 |
| Over 1 1/2 thru 2 | 0.035 | 35 |
| Over 2 thru 2 1/2 | 0.040 | 40 |
| Over 2 1/2 thru 3 | 0.045 | 45 |
| Over 3 thru 4 | 0.050 | 50 |
| Over 4 thru 6 | 0.060 | 60 |
| Over 6 thru 8 | 0.080 | 80 |

g. Radiographic Exposure. Radiographs shall be made with a single source of radiation approximately centered with respect to the length of the weld being examined. The perpendicular distance from the radioactive source to the film shall be not less than seven times the maximum thickness of the weld under examination and the rays shall not penetrate the weld at an angle greater than 26 1/2 degrees from a line perpendicular to the weld surface. During exposure the film shall be placed at the opposite side to the source of radiation and as close to the surface of the weld as possible.

7. Identification and Location Marks

a. Fabrication. Radiographic identification for inspection of welds shall consist of the following:

- (1) Contract number.
- (2) Weld Identification Number. The weld identification number shall consist of a sequence of digits conforming to the following:
 - (a) The fabrication number of the girder in which the radiographed weld occurs, followed by a dash (-).
 - (b) Letter combination designating the section in which the radiographed section occurred. The section shall be designated by the letters TF (Top Flange), BF (Bottom Flange), or the word Web.
 - (c) The joint designation consisting of the letter W preceded by a space and followed by a number. The number shall designate the joint in which the radiographed weld occurs and shall correspond to the number of welded joints between the reference or work end of the section and the radiographed weld.
 - (d) All weld identification numbers will be steel stamped.
- (3) Identification of the company performing the radiograph.
- (4) Radiographer's initials.
- (5) Six numeric digits indicating "Month" – "Day" – "Year."

b. Erection. Radiograph identification for radiographs of welds performed after erection shall be designated by the Engineer.

c. Repairs. The weld identification number on radiographs of repaired welds shall be suffixed with the letter R and a number showing how many times the weld has been repaired.

d. Radiograph Location Marks. When complete radiographic coverage of a weld is specified, location or other supplementary match marks shall be placed to appear on the film in accordance with the provisions in Section 14 of ASTM Designation E94. Radiograph location marks will not be required for radiographs made at field construction sites. The location of radiographs made at field construction sites shall be indicated by a number added to the end of the weld identification number. Such a number, separated from the joint or splice number by a space, shall signify the location of radiographs on plate girder joints or splices when viewed ahead on line, as follows:

1. Right side bottom flange
2. Left side bottom flange
3. Left side top flange
4. Right side top flange
5. Web adjacent to top flange

In the event additional radiographs of a given web weld are required, these will be identified as consecutive location numbers starting with 7. The exact location of such radiographs shall be approved by the Engineer and noted in the radiographic reports.

e. Radiographic Identification (Miscellaneous). The radiograph identification and marking system for welds on other than plate girder structures shall be established by agreement between the Contractor and the Engineer before radiographic inspection begins.

8. Examination, Reports, and Disposition of Radiographs

a. Viewer. The Contractor shall provide a suitable high-intensity radiograph viewer at the place where radiographic inspection is performed.

b. Acceptance. Prior to acceptance by the Engineer of a weld subject to radiographic inspection by the Contractor, all radiographs including any that show unacceptable quality prior to repair, and a report interpreting them, shall be submitted to the Engineer.

c. Reports. The Contractor shall submit to the Engineer three or more copies of the radiographic report showing the results of radiographic tests performed during each shift. This radiographic report shall include the following information:

- (1) Date.
- (2) Name and address of the radiographic inspection agency.
- (3) Description of structure being inspected.
- (4) Location of structure or fabrication site.
- (5) Contract number.
- (6) The specification being used to accept or reject welds radiographically inspected.
- (7) Name and address of the fabricator.
- (8) The radioactive source, type, and size (either current or dated strength), or X-ray unit type and size.
- (9) Type of film used.
- (10) The names of technicians performing the radiograph
- (11) The NDT numbers for the reported radiographs.
- (12) The weld identification number for each radiograph.
- (13) The item radiographed (flanged, web, etc.) for each radiograph.
- (14) The thickness of the item radiographed for each radiograph.
- (15) The distance from the radioactive source or focal spot to the film for each radiograph.
- (16) An interpretation of each radiograph providing an analysis of:
 - (a) Cracks.
 - (b) Porosity or gas holes.
 - (c) Slag or inclusion.
 - (d) Lack of fusion.
 - (e) Incomplete penetration.
- (17) Acceptability of both weld and radiograph for each radiograph.
- (18) Remarks (if any) concerning any unusual observation or condition in the weld or radiograph.
- (19) Radiographer's signature.

- d. Packaging. Radiographs and reports shall be packaged in suitable envelopes and shall be clearly marked on the outside with the following identification:
 - (1) The Contract number.
 - (2) The fabricator.
 - (3) The NDT report numbers for the radiographs in the package.
- e. Disposition of Reports. After review and approval of radiographic reports, the Engineer will retain the original and two copies of the reports together with the radiographs. All additional copies of the reports will be returned to the Contractor.

(j) Ultrasonic Inspection of Welds

- 1. General. Ultrasonic inspection will be performed by the Engineer at no expense to the Contractor except for joint preparation. Inspection method shall be as provided for in AWS D1.1-80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, Third Edition.
- 2. Extent of Ultrasonic Inspection. Ultrasonic inspection will be performed on 100 percent of the total weld length of groove welds in all flange welds.
- 3. Location. The locations for ultrasonic inspection will overlap locations selected for radiographic inspection. Flange welds shall be accepted by ultrasonic method. Radiographs taken in areas of previously accepted welds shall be for documentation only.
- 4. Scheduling of Inspection. The Engineer will schedule ultrasonic inspection and evaluation at the request of the Contractor subject to the following conditions:
 - a. If the Contractor only provided time and space for ultrasonic inspection intermittently, each time he requires such inspection he shall submit his request to the Engineer not less than 24 hours in advance. This request shall identify the welds that are ready to be inspected so that the Engineer can verify the accessibility and preparation of these welds before he schedules the requested ultrasonic inspection.
 - b. If the Contractor schedules fabrication and erection at such a rate that he can support continuous ultrasonic inspection and evaluation, and if he provides time and space for this inspection to proceed in an uninterrupted manner, he shall maintain and provide the Engineer or the Engineer's agent with a 6 hour notice of the identity and location for each of the welds that are ready for inspection. This will allow time for the Engineer or his agent to optimize his ultrasonic inspection schedule.
- 5. Weld preparation. Ultrasonic inspection and evaluation will not be scheduled until welds have been prepared by the Contractor as follows:
 - a. Web-to-flange fillet welds within 6 inches of either side of the butt weld to be inspected shall be withheld until after ultrasonic inspection has been completed and the butt weld has been accepted.
 - b. All shear studs, stiffeners, brackets, bolt holes, and other projections or obstructions within the ultrasonic scanning zone shall be removed or left off until after ultrasonic inspection has been completed and the butt weld has been accepted.
 - c. Backup plates and run-off tabs, if any, shall be removed.
 - d. Welds shall be found flush and smooth with a maximum roughness not to exceed 250 micro-inches rms.
 - e. All loose mill scale, rust, dirt, grease, weld spatter, etc., shall be removed from the scanning zone and the flange or plate surface within the zone shall be finished flush.
 - f. Paint shall be removed.
- 6. Inspection Procedure. Ultrasonic inspection and evaluation by the Engineer will be performed in conformance with the following:

- a. Ultrasonic inspection and evaluation will be performed only during daylight hours unless otherwise allowed by the Engineer.
- b. Ultrasonic inspection and evaluation will not be performed at unsafe locations or locations not readily accessible.
- c. Ultrasonic inspection will not be performed in the presence of rain, snow, or blowing sand, or when the wind velocity exceed 10 mph, except under shelter approved by the Engineer.
- d. Ultrasonic inspection and evaluation will be performed only when the temperature of the steel is above 40 degrees F. but not above 120 degrees F.
- e. Prior to the initiation of ultrasonic inspection joints shall be visually inspected for surface defects and conformance to joint preparation requirements.

(k) Dye Penetrant Inspection of Welds. The use of dye penetrant inspection shall be at the discretion of the Engineer.

When dye penetrant inspection is required by the Engineer, the procedure ASTM E-165, and the standards set forth in AWS D1.1-80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Bridges, Third Edition, and Nevada Test Methods NHD 900, 901, and 903 shall control the work.

(l) Magnetic Particle Inspection of Welds. The use of magnetic particle inspection shall be at the discretion of the Engineer.

When magnetic particle inspection is required by the Engineer the procedure ASTM E709 and standards set forth in AWS D1.1-80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Bridges, Third Edition, and Nevada Test Methods NHD 900, 901, and 903 shall control the work.

(m) Marking of Welds for Repair. Defective welds will be clearly marked by the Engineer in the presence of the Contractor on the surface and side repairs will be made from. Markings will clearly indicate the length and depth of the defect. Defect length will be noted by a line on the surface directly over the defect, running the entire length of the defect. Depth from the noted surface will be marked (out of the weld area) with a suitable line or arrow referencing the applicable defect.

(n) Allowable Number of Repairs. When any weld has been repaired three times and rejected four times, hardness tests shall be performed to the Engineer or his authorized representative. Acceptable values shall be determined by the Engineer for weld metal and the heat affected zone depending on the type of base metal. If the hardness values exceed the permissible range then the weld and heat affected material.

326.03.19 Fit of Stiffeners. The fit of stiffeners shall be as specified in AWS D1.1-80 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Bridges, Third Edition.

326.03.20 Annealing and Stress Relieving. Annealing and stress relieving shall be as specified in Division II, Article 10.26 of the AASHTO Standard Specifications for Highway Bridges.

326.03.21 Pins and Rollers. Rollers shall be of structural carbon steel, and pins shall be of carbon steel forging meeting the requirements of Section 207. Pins and rollers shall be accurately turned to the dimensions shown on the Plans and shall be straight, smooth, and free from flaws. Final surface shall be produced by a finishing cut.

In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored full length along the axis after the forging has been cooled to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise specified.

The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than one 1/32 inch. Boring of holes in built up members shall be done after the bolting is completed.

The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins 5 inches or less in diameter, or more than 1/32 inch for larger pins.

Screw threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2m free fit, except that pin ends having a diameter of 1 3/8 inches or more shall be threaded six threads to the inch.

Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge. Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

326.03.22 Shop Painting. Unless otherwise provided the application of shop paints shall conform to the requirements of Section 322 -"Painting, Pavement Striping, and Marking." Surfaces to be in contact after shop bolting is completed shall be cleaned but not painted.

326.03.23 Identification. Each member shall have an erection mark permanently stamped to the metal for identification and an erection diagram shall be furnished with erection marks shown thereon. Painted erection marks will not be permitted. Members weighing more than 3 tons shall have the weight marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged. All girders must be shipped in a standing position, which position shall be maintained in subsequent operations.

326.03.24 Erection Methods. 15 days prior to the start of erection the Contractor shall inform the Engineer in writing as to the method of erection he proposes to follow, and as to the amount and character of the equipment he proposes to use, the adequacy of which shall be subject to the approval of the Engineer. Storage and handling of the beams or girders on the erection site shall conform to Subsections 324.03.05 – "Handling and Transporting" – and 326.03.09 – "Shop Assembly." The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety and adequacy of his methods or equipment or from carrying out the work in full accordance with the Plans and Specifications.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while bolting will not be permitted.

All work of erection shall be subject to inspection and the Contractor shall furnish facilities for such inspection of material and workmanship. Material and workmanship not previously inspected shall be inspected after its delivery to the site of the work.

The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting up bolts necessary for the expeditious handling of the work.

Anchor bolts for rail posts shall be galvanized high-strength bolts set with suitable templates in exact position and securely fixed to prevent displacement during the concreting operations. The areas of concrete upon which posts are to be set shall be dressed by grinding and rubbing to a true plane for the proper seating of the posts. All surfaces of aluminum alloy posts and adjustment shims to be in contact with concrete or with the steel anchor bolts, nuts, and washers shall be coated with aluminum insulating compound.

Rail posts shall be erected in sections. Erection of sections of rails and posts shall continue successfully until all or an approved portion of the required rail is erected. The rail shall then be aligned and the nuts on the anchor bolts tightened. In final adjustment no posts shall deviate more than 1/8 inch from true alignment and there shall be no abrupt break in alignment at any location. Aluminum shims may be slotted for ease in placing if approved by the Engineer.

326.03.25 Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which come upon it. The Contractor shall prepare and submit to the Engineer for approval plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

Holes for falsework and forms shall be shown on the shop drawings. Holes shall be located such that distortion of the web shall not occur. Temporary ties and struts shall be required when necessary to resist lateral loads and control relative deflections.

Welding of falsework supports shall be limited to compression flanges only, as approved by the Engineer.

Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish, and temporary buildings, replace or renew any fences damaged, restore in an acceptable manner all property, both public and private, which may have been damaged during the

prosecution of the work, and leave the structure site and adjacent highway in a neat and presentable condition satisfactory to the Engineer.

All excavated material or falsework placed in the stream channel before construction shall be removed by the Contractor before final acceptance.

At a time to be determined by the Engineer and when applicable, the Contractor shall remove and dispose of temporary cross frames between the box plate girders.

326.03.26 Bearing and Anchorage. Bridge bearing shall set in exact position as shown on the Plans and shall have full and even bearing on the masonry. Bridge bearing shall not be placed on masonry bearing areas which are irregular or improperly formed.

Cast iron, steel, or rolled steel bearings shall be bedded on the masonry with alternate layers of red lead and canvas, a single thickness of sheet lead, or preformed elastomeric bearing pads as shown on the Plans.

Surfaces designed for sliding movement, one upon the other, shall be given a field coat of graphite grease when placed in the structure.

The Contractor shall drill the holes and set and anchor bolts, except where the holes are formed or the bolts are built into the masonry. The bolts shall be set accurately and fixed with Portland Cement grout, completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit free movement of the span.

326.03.27 Field Assembly. If the contract covering the erection of the steel does not include the fabrication, the Contractor shall check the material received by him and report promptly in writing to the Engineer any shortage or injury discovered. The parts shall be accurately assembled as shown on the Plans and match-marks shall be followed. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.

Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber.

326.03.28 Minor Erection Misfits. The correction of minor misfits involving no harmful amounts of reaming, cutting, and chipping shall be considered a legitimate part of the erection. However, any error in the shop fabrication, or deformation resulting from handling and transportation, which prevents the proper assembling and fitting up of the parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Engineer and his approval of the method of correction obtained. The corrections shall be made in his presence. The Contractor shall be responsible for all misfits, errors, and injuries and shall make the necessary corrections and replacements.

326.03.29 Painting. Structural steel, unless otherwise specified, shall be painted as specified in Section 322 – “Painting, Pavement Striping, and Marking.”

326.04 MEASUREMENT OF QUANTITIES AND BASIS OF PAYMENT

326.04.01 Reinforcing Steel. Unless otherwise specified, no direct measurement or payment shall be made for reinforcing steel. Compensation for reinforcing steel shall be included in the unit price bid for the structure involved.

326.04.02 Structural Steel. Structural steel shall be measured and compensated for by the units bid and the unit prices established for structural steel in the Contract Documents. Units shall be measured by the pound, by the lineal foot, or by lump sum, unless otherwise directed by the Engineer.

327.01 DESCRIPTION. This work shall consist of furnishing and erecting new barbed wire (Type BW), woven wire mesh (Type WM), or chain link (Type CL) fence, including gates and related appurtenances; or reconstructing temporarily removed fences, all in conformity with these Specifications and the Plans. It is the intent of these Specifications, and the Standard Details that fences built in compliance meet the Nevada Statute definitions of a legal fence for the specific application.

327.01.01 Barbed wire fence (Type BW) shall consist of galvanized barbed and/or barbless wire, fastened to wood or metal posts or to a combination of the two kinds of posts as shown on the Plans, including related appurtenances. The numbers of strands and types of wire and positioning are shown on the Plans and further detailed in the Standard Details.

327.01.02 Woven wire mesh fence (Type WM) shall consist of a combination of wire mesh fence fabric with galvanized barbed and/or barbless wire fastened to wood or metal posts or to a combination of the two kinds of posts as shown on the Plans, including related appurtenances. The mesh fabric height and numbers and separations of barbed and/or barbless strands are indicated on the Plans and further detailed in the Standard Details.

327.01.03 Chain link fence (Type CL) shall consist of chain link fabric attached to metal posts and fastened to a specified top tensioning cable or top rail, and a bottom tensioning wire, including related appurtenances. The height of chain link fences shall be designated on the Plans. Barbed wire strands fastened to vertical and/or angled security arm extensions, if required, are indicated on the Plans and further detailed in the Standard Details. Selvage types and orientation, and special fabric types such as vinyl coating and/or slating, shall be as required in the Plans.

327.02 MATERIALS. Materials shall conform to the requirements specified in Section 209 – “Fence Materials” for the required type of fencing and appurtenances. Materials shall also comply with the Standard Details.

327.03 CONSTRUCTION REQUIREMENTS

327.03.01 Location of Fencing. Fencing and appurtenances shall be constructed in exact locations shown on the Plans. Where field evidence of property lines or rights-of-way appear to conflict with the Plans, the Contractor shall notify the Engineer in advance of clearing and construction in these locations.

327.03.02 Project Access and Protection of Existing Improvements. The Contractor shall be responsible for familiarizing himself, his representatives, and his subcontractors, with Plans and Contract Documents regarding access and environmental limitations, and existing above and below ground improvements, and to insure compliance. The Contractor shall notify USA Underground Service Alert (1-800-227-2600) 2-working days prior to attempting excavation or post driving in any area where underground utilities are known or suspected to be at risk. It shall be the Contractor's responsibility to take any such conditions or limitations into account and make allowances in prices bid. No direct payment will be made for such conditions.

327.03.03 Clearing and Grubbing. All trees, brush, and other obstructions which interfere with proper construction of fences shall be removed and disposed of in accordance with the requirements of Section 300 – “Clearing and Grubbing” of these specifications, except that no direct payment will be made for such work. Clearance may be limited in conformance with applicable project environmental constraints.

327.03.04 Fence Line Ground Surface Preparation. In addition to clearing and grubbing, the Contractor shall perform grading necessary to permit placement of the fence, fence fabric, gates, and other appurtenances, in compliance with the Plans, the Standard Details, and these Specifications. The prepared surface shall be adequately compacted, as necessary, to result in a stable surface for placement of fencing.

Grading and surface preparation shall not block or impede the existing surface drainage. Special grading and surface preparation limitations ranging from prohibition to limitations for width and depth are shown on the Plans. Where no specific requirements are provided, the Contractor shall, in advance of construction, secure the Engineer's approval of his site preparation plan and procedure. Unless otherwise directed, the Contractor shall distribute excess site preparation soil evenly along the fence including removal of berms, etc.

Fence line site grading for fence Type WM and CL is critical. The clearance between the bottom wire/fabric element and the ground on Type WM and CL should not exceed 4 inches in any case with an average or nominal clearance of 2 inches. Clearance should be evaluated prior to setting of any posts.

When noted in the project plans, surface grading may be scheduled for performance by others. Where this applies, fence construction shall not proceed until grading has been accepted and authority to proceed with fence construction has been issued in writing.

Surface preparation shall be considered a subsidiary obligation of the Contractor and no direct payment will be made for such work.

327.03.05 Placement of Posts

327.03.05.01 Alignment. Fence posts shall be located in the horizontal alignment shown on the Plans. Fence posts shall be plumb.

Steel "T" and "H" posts shall be oriented to permit wire fastening on the side directed.

327.03.05.02 Intervals. Fence posts shall be positioned at nominal intervals shown in the Standard Details for the fence required in the project Plans, except for spans adjacent to gates and other required interruptions in the normal pattern. The tolerance of fence post intervals shall be such that all top rails, diagonals, truss rods, braces, gates, and similar features are fully secured, seated, and functional.

327.03.05.03 Depths. Fence posts shall be placed at the depths shown on the Plans for the respective post types and uses. At a minimum, steel "T" posts shall be driven to a depth totally burying the attached spade anchor plate.

327.03.05.04 Excavations. Excavation for fence posts may be by any method selected by the Contractor unless otherwise required on the Plans, except that explosives may only be used with the advance written approval of the Engineer.

327.03.05.05 Backfill of Excavated Post Holes. Backfill material shall be clean backfill soil free of rocks over 3 inches in largest dimension, or one-third the annular opening, whichever is smaller. The backfill shall be tamped in place in layers not to exceed 4 inches and in such a manner as to firmly set the post. Sand backfill is acceptable only when use results in secure and stable post placement.

327.03.05.06 Concrete Post Anchorage. Concrete shall be placed in equal or greater depth and diameter as shown for the application in the plans. Concrete mix, placement, and cure procedures shall conform with Section 209, except as otherwise described herein. Posts may be anchored with either a PCC mix or an Engineer-approved commercial rapid set grout. Unusually dry post holes shall be saturated prior to placement of concrete. The concrete shall be adequately braced to prevent movement during the cure period. The concrete or grout shall be crowned and smoothly contoured around the posts to enhance drainage. The concrete and grout shall not shrink or crack. Posts shall not be loaded or stressed prior to curing the anchorage. Concrete and grout anchorage is not permitted for wood posts without written approval of the Engineer.

327.03.05.07 Drilling and Grouting Post Placement. Drilling and grouting is limited to steel posts in competent rock. The spade anchors may be removed from steel "T" type line posts prior to placement in drilled and grouted holes. For the Contractor-prepared grouting, the hole shall be not less than 2 inches in diameter larger than the post. For commercial premix rapid set grout, unless otherwise recommended by the manufacturer, the drilled hole shall be 1 inch in diameter, larger than the outside diameter of the post.

327.03.05.08 Grouting. Posts placed in holes drilled in competent rock shall be securely grouted with Contractor-prepared or approved commercial premix grout to full depth with rodding to insure all voids are filled. Grout mix and cure procedures shall be in accordance with the manufacturer's instructions and Section 202. The grout shall not crack or shrink. The grout shall be crowned around the post to enhance drainage. During the cure period, the post shall be adequately braced to prevent movement. Grouted posts shall not be loaded or stressed prior to curing.

327.03.05.09 Driving Fence Posts

- a. Steel "T" type and "H" type posts shall normally be driven in place, except when soil resistance is such that driving damages the posts, whether at base, top, or by bending. Where soil resistance is inadequate to result in average in-place post stability, the posts shall be set in concrete.
- b. Wooden posts may be driven only when machine pointed at the post production plant and where soil resistance is adequate to result in placement of undamaged posts at full depth and with stable placement.

327.03.05.10 Fence Gates. Fence gates shall be constructed of the type, material, size, and at locations shown on the Plans. Unless specifically prohibited on the Plans, the maximum interval between vehicular gates shall not exceed 1 fence mile. Such minimum interval gate locations shall be selected to provide usable cross country access for emergency vehicles. Unless specifically prohibited on the Plans, vehicular gates shall also be constructed adjacent to all cattle guards to permit passage of livestock and tracked

vehicles. Gates in fence shall be the same type material as the fence unless otherwise required in the Plans.

327.03.05.11 Grounding. When fence construction utilizes wood line posts, the fence fabric and fence wires shall be grounded. The grounding device shall consist of a metal fence post which shall be substituted for a regular fence post at intervals not to exceed 500 feet with not less than one metal post any length of fence over 200 feet between openings. Each line of barbed wire and alternate longitudinal wires of the fence fabric shall be tightly fastened to the metal post with 11 gauge, or heavier, galvanized steel wire. At each location where an electric transmission, distribution, or secondary line crossed fences with wood posts, the fence shall be grounded with a ground rod installed directly below the point of crossing. The rod shall be driven vertically until the top is 2 inches above the ground surface. A grounding conductor shall be used to connect each fence element to the ground rod. The connections shall be either brazed or fastened with approved noncorrosive clamps. When a power line runs parallel or nearly parallel to and within 100 feet of the wood post fence, the fence shall be grounded with a ground rod at each end post or at intervals not to exceed 1,500 feet. When the specified vertical penetration of the ground rod cannot be obtained, an equivalent horizontal grounding system approved by the Engineer shall be installed.

327.03.06 Fence wire and fabric shall be fastened on the side of the posts opposite the highway centerline unless otherwise directed by the Engineer.

327.03.07 Gate Reflectors. Each vehicular gate shall have three gate reflectors, situated as shown in the Standard Details, on the side of gates opposite the highway/road. Reflectors shall be firmly secured including resistance to wind deflection.

327.03.08 Connection. Existing cross fences shall be connected to the new fence. At bridges, cattle passes, culverts, and similar improvements fences shall be connected to the structure in such a manner as to control the passage of persons, livestock, and/or wildlife, as applies.

327.03.09 Site Conditions. The Contractor shall notify the Engineer in advance of attempting fence construction in any work area not identified on the Plans and characterized by inundation, swamp, deep mud, and similar conditions where routine post placement procedures will not result in average post withdrawal resistance, wind resistance, or lack of penetration resistance. Similar notice is also required when flood or other damage has changed site conditions substantially from those shown on the Plans and/or described in the contract documents.

327.03.10 Damage. The Contractor shall replace all damaged fence material and remove debris from the site. The Contractor shall repair any damage to existing improvement. No payment will be made for repair and replacement of damaged material.

327.03.11 Disposal of scrap fencing material, wire spools, banding, tags, and related debris shall be removed from the project and disposed of at an authorized location.

327.03.12 Reconstructed Fence. Reconstructed fences shall be erected using Engineer-approved salvaged materials and shall be constructed in accordance with the respective elements of the Specifications, the Standard Details, and the Plans. Any new materials necessary to rebuild the fence shall be furnished by the Contractor, and shall be in conformance with the applicable requirements for new construction.

327.03.13 Site Rehabilitation. Refer to project Plans for applicable site rehabilitation requirements, if any. Such requirements shall be considered Contractor's subsidiary obligations and no direct payment will be made.

327.04 WIRE FENCE TYPES BW AND WM

327.04.01 See Section 327.03 – “CONSTRUCTION REQUIREMENTS” – of this Specification Section.

327.04.02 Wire fence Structural Panels, General. Wood post braces in stress panels, end panels, and corner panels shall be either mortised and nailed, or drilled for equal depth placement of pairs of steel dowels as shown on the Standard Details.

When braces are mortised and nailed in placed, nail lengths shall be adequate to provide 1 1/2 to 2 1/2 inch anchorage into the second member. Dependent on brace post and mortise sizes, this will require nails between 40d and 60d in size. Mortise depths shall be approximately 30 percent of post diameter at the mortise but not less than 1 inch. Pre-drilling is required in the first member when undrilled installation tends to split the post or brace.

Diagonal tensioning wires for the various wood post stress, end, and corner panels shall be made using either barbed or unbarbed fence wire or 9 gauge smooth wire. Each diagonal shall be comprised of two strands of

wire, each double-wrapped around posts, and secured with four turns around the same wire with stapling both sides of posts. The wire loops shall be attached 4 inches from the top of one post to 4 inches above the ground on the second post. The diagonal tension wire shall then be tensioned by twisting at midway on the diagonal until the assembly is rigid.

327.04.03 Wire Fence End Panels. Wire fence end panels shall be of the type and material shown on the Plans and are required at all of the following locations.

327.04.03.01 At all fence line origins and terminations, except at junctions or connections with existing wire fence, an additional in-line-end section shall be centered and constructed in the existing fence resulting in one common post.

327.04.03.02 On both sides of all fence openings including gates, except that a stress panel may be substituted where the tangent tensioned fence segment is less than 165 feet (10 rods).

327.04.03.03 Adjacent to each side of all flood way break-away fence segments.

327.04.04 Wire Fence Stress Panels. Except where a stronger assembly is otherwise required, such as end section or corner assembly, wire fence stress panels are required as follows:

327.04.04.01 Intervals Not To Exceed. Type BW, 1320 feet (40 rods); Type WM, 660 feet (20 rods); or the nominal manufacturer's wire roll length, whichever is shorter.

327.04.04.02 At all vertical alignment abrupt grade breaks in excess of 10 degrees (22 percent). These include ridge crests, dips, bases of steep slopes, etc. Stress panels shall not be constructed in obvious high flood damage risk locations; therefore, minor field location adjustment may be required.

327.04.04.03 At all locations from or to which wire tensioning is applied prior to securing.

327.04.05 Fence Corners, Wire Fence. Corners shall be of the type and material shown on the Plans. This may include either or both wooden post and metal post corners. Unless otherwise shown on the Plans, the following criteria apply:

| Horizontal Alignment Deflection | Corner Type |
|---------------------------------|----------------|
| Below 10° | None Required |
| 10° to 30° | 3-Post Corner |
| Over 30° | *5-Post Corner |

* Except that where the tensioned fence tangent is 165 feet (10 rods) or less, that wing of the 5-post corner may be reduced to a stress panel equivalent or an unequal four post corner.

327.04.06 Wire Fence Flood Way Breakaway Sections. Except where otherwise provided for or specifically prohibited, active seasonal or store event flood channels with apparent flood debris shall have independent breakaway wire fence segments otherwise identical with the required fence. The terminal ends of each breakaway segment shall be stress panels which are not connected to adjacent end panels in the primary fence. No end panels or stress panels may be constructed in obviously high flood damage risk segments of the channel.

327.04.07 Special Drainage Crossing Treatment. Special details will be provided in the Plans which are customized to address site specific problems not provided for in these Specifications or the Standard Details. The Contractor shall notify the Engineer in advance of construction of all locations where the provisions in the Plans appear inappropriate for field conditions, especially in regard to drainage crossings.

327.04.08 Fence Wire Installation. Wire material and construction configuration shall be that shown in the Standard Details, as selected in the Plans, and conforming with Specification 207.

327.04.08.01 Vertical Wire Separation. Fence Types BW and WM shall have wire strands separated as shown on the Standard Details for the fence type selected on the Plans. These are nominal separations. The spacing intervals shall begin with the ground level as measured at each post. The lower strand shall not be permitted to contact the ground between posts. When the terrain irregularities are such that the distance between the lowest wire and the ground exceeds 20 inches, an additional strand shall be added at

or near ground level at the spanning posts. For greater distances, a minimum 50 pound rock dead man shall be suspended and secured to each longitudinal wire. See Standard Details.

327.04.08.02 Wire Tensioning. Each strand of barbed or barbless wire and Type WM wire mesh shall be tensioned until taunt and springy prior to fastening to the posts.

327.04.08.03 Wire Fastening.

- a. Each strand of wire in Type BW fence and each individual strand above the fabric in a Type WM fence shall be terminated and secured to the opposite end post in each stress panel, end panel, and corner panel. The wire shall be wrapped twice around the post followed with four tight turns around the same strand. Excess wire shall be trimmed.
- b. Each fence wire in Type BW fence and each individual strand in Type WM fence shall be secured to each wood post using a wire staple driven to full depth, except that staples in line posts shall not be overdriven resulting in crimping the wire or totally stopping lateral movement of the wire. Staples shall be oriented at a 45 degree diagonal, resulting in each staple leg in a different wood grain pattern.
- c. Each fence wire in Type BW fence and individual strands on Type WM fence shall be attached to each steel "T" post with a wire clip. Each fence wire shall be attached to each steel "H" post and tubular pipe steel post with a full wrap, then at least one full twist around the wire on each side of the post using tie wire.
- d. Wire mesh fabric shall be fastened to each wood and metal post in the same manner as described for Type BW fence for each post type, except that the top wire and the bottom wire are always fastened and other alternate longitudinal wires are fastened with not less than five fasteners per post.

327.04.08.04 Wire Splicing. Wire splicing shall be made by looping strands together with not less than four tight turns wrapped back on each loop. Acceptable splices should nearly match the original wire tensile strength. Between structural panels, splices are limited to not more than one single strand splice. Stress panels should be added where these limitations cannot be met or a new wire roll utilized.

327.04.08.05 Wire Stays. Wire stays are to be provided as shown on the Standard Details. Wire stays shall be twisted in place vertically beginning on the top strand. Individual strand separation requirements shall be maintained as the stay is attached. Stays shall be twisted until the stay does not extend above the top strand. Stays shall be trimmed at or above ground level.

327.04.09 Gates in Wire Fences. Wire gates and metal gates shall be constructed in conformance with the Standard Details except when modified in the Plans.

327.04.09.01 The wire gate hinge loops and latch loops shall permit full and free operation. The mechanical closer/latch shall be installed according to the manufacturer's instructions and shall, at a minimum, be firmly secured and conveniently operable. Reflectors shall be attached to the gate as shown in the Standard Details. Reflector fasteners shall be hog rings or equivalent. Wire stays shall be clipped at 4 inches above the ground.

327.04.09.02 Metal gate hinges and latches shall be secured and operate freely, unless otherwise required on the Plans. The gate swing path shall be unobstructed for at least a 100 degree angle in at least one direction. Vehicular gates shall be equipped with a gate stop and hold-open latch which shall be positioned and adequately secured to permit free operation. The gates and/or gate leaves shall be squared and free of warp or sag.

327.05 CHAIN LINK FENCE, TYPE CL

327.05.01 Refer to GENERAL FENCE CONSTRUCTION portion of this Specification Section.

327.05.02 All chain link fence accessories and components shall be fully compatible for both function and fit. Vinyl coated and slat material shall be specially protected from damage in the transport and installation process.

327.05.03 All posts shall be fitted with tips designed so as to fit securely over the posts and carry the top tension cable, except that the top of the H-section posts may be open-slotted in such a manner as to securely hold the top tension cable in position without vertical movement. Such slotting shall allow removal and replacement of a post without disturbing the top tension cable. Tubular posts shall be fitted with watertight tops. All posts shall be anchored in concrete or grout in accordance with these Specifications and the Standard Details for each application. The nominal post interval is 10 feet, except for slatted fence, which shall be at 8 foot intervals.

327.05.04 Horizontal fence line deflections of 20 degrees or more shall be considered corners and corner posts shall be provided.

327.05.05 End, corner, and gate posts shall be braced with galvanized braces used as compression members and galvanized truss rods with truss tighteners used as tension members. Line posts, at intervals of 500 feet, shall be braced and trussed in both directions as shown on the Plans. Braces are not required on fences 4 feet or less in height when top rails are provided on all panels.

327.05.06 The fabric gauge, height, and salvage shall be in accordance with the Standard Details and as shown on the Plans.

327.05.07 The fabric shall be stretched taut and securely fastened to the posts, and between posts the top edge of the fabric shall be fastened to the top tension cable or top rail, and the lower edge fastened to the bottom tension wire. Tension cable and wire shall be stretched tight with truss tightener as shown on the Plans. The bottom tension wire shall be installed on a straight grade between posts by excavating the high points of the ground and in no case will filling of depressions be permitted. Slatting shall be protected from damage. Any broken or distorted slats shall be replaced.

327.05.08 The fabric shall be fastened to the end, corner, and gate posts with steel stretcher bars and stretcher bar bands placed at 1 foot intervals, and to line posts tension cable, top rail, and tension wires with tie wires or metal bands. Tie wires or metal bands shall be spaced on line posts at intervals of approximately 14 inches and on tension cables and tension wires at intervals of approximately 18 inches.

327.05.09 Gates. The width of all gates shall be as shown on the Plans and as detailed in the Standard Details. The filler shall be chain-link fence fabric for chain-link fencing.

327.05.09.01 The gates shall be hung by hinges installed securely, permitting the gate to swing smoothly throughout a full 180-degree swing in both directions unless otherwise specified.

327.05.09.02 Gate Latches. All chain link gates shall have closing latches installed for smooth function and padlocking accessible from both sides. All vehicular gates shall have gate stops and hold-open latches on both sides installed to be easily fastened and released.

327.06 MEASUREMENT. Quantities of fence to be paid for will be determined for each type of fence by the linear foot from actual measurements. Measurements will be made parallel to the ground slope along the line of the completed fence, deducting the widths of openings and gates. No other separate measurement or direct payment will be made for clearing and grubbing, deadman, stress, end, or corner panels, or breakaway sections or any other related fence work, except gates.

Quantities of each gate type will be determined from actual count. A double leaf gate is a single gate. A gate unit complete in place shall include one gate with all necessary fittings, hardware, and gate and latch posts with braces.

327.07 BASIS OF PAYMENT. Accepted items of work, measured as specified, will be paid for at the Contract price per linear foot for each fence type constructed. Gates will be paid for at the contract unit price for each gate type.

The above prices and payments shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing fences with related appurtenances, and gates, complete in place, as shown on the Plans and as specified in these Specifications, the Plans, and the Standard Details.

329.01 GENERAL.

329.01.01 DESCRIPTION. This Section covers furnishing and construction of steel and precast *PCC* driven piles and constructing cast-in-place *PCC* drilled shaft piles.

This Section does not cover furnishing and construction of timber piles. Because of their flexibility, low ductility, and difficult cap connections, timber piles are not considered suitable where seismic considerations are critical. This does not preclude the use of timber piles where conditions are suitable, particularly for temporary construction. Where timber piles are to be used, the *Engineer* shall show specific design requirements on the *Plans* and in the *Special Technical Specifications*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

329.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

329.01.01.02 Terms.

Cast-in-Place *PCC* Piles. Cast-in-place *PCC* piles shall be defined as both steel shells driven permanently to provide the required driving resistance, then filled with *PCC*; and drilled shafts filled with *PCC*.

Pile Tips. Pile tips shall be defined as cast steel shoes.

Refusal. Refusal shall be defined as a driving resistance that exceeds 10 blows per inch at the highest stroke that will not overstress the pile.

329.01.02 DESIGN. This Subsection does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the resulting piles. The *Engineer* shall show specific design requirements on the *Plans* or specify these requirements in the *Special Provisions* and/or *Special Technical Specifications*.

329.01.02.01 PCC.

329.01.02.01.01 Composition of Mixtures. A mix design shall be submitted to the *Engineer* in accordance with Subsection 337.01 - “Mix Design”. The compressive strength at 28 *Days*, slump, target air content, aggregate gradation and type of cementitious material shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

329.01.02.02 Down Drag. The intent of pile design to include down drag shall be indicated by the *Engineer* in the *Plans*.

329.01.02.03 Load Testing. When required, test piles or shafts subject to static load testing shall be designated on the *Plans* and the associated requirements shall be specified in the *Special Provisions* and/or *Special Technical Specifications*.

329.01.03 SAFETY. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25 – “Safety”.

329.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the certificate has been reviewed and accepted by the *Engineer* prior to transport.

329.02.01 INSPECTION OF MATERIALS. The *Contractor* shall accommodate inspection of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable subsections of Section 336 – “Inspection and Testing”.

329.02.02 CARE OF MATERIALS.

329.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage” except as modified herein.

329.02.02.02 Handling of Precast PCC Piles. PCC for precast PCC piles shall be poured in smooth watertight forms, so supported as to prevent appreciable deformation or settlement during pouring or curing. When removed from the form, the piles shall present true, smooth, even surfaces free from honeycombs and voids and shall be such that a line stretched from butt to tip on any face will not be more than 1 inch from the face of the pile at any point.

PCC piles shall be kept continuously wet for at least 10 *Calendar Days* after pouring and shall be allowed to harden for at least 30 *Calendar Days* before being lifted or driven, except that this 30 *Day* requirement may be decreased if the specimen of PCC from which the piles were poured develops a compressive strength of at least 3,000 *PSI*.

Precast PCC piles shall be handled, stored, and transported such a manner to avoid excessive bending stresses, cracking, *Spalling* or other injurious result. Cracks wider than 0.007 inch shall be repaired by injecting epoxy under pressure. Piles materially damaged in handling or driving shall be replaced.

329.02.03 USE OF OTHER MATERIALS. The Contractor shall not use other materials and/or methods except as provided in Subsection 100.31.02.

329.02.04 CURING MATERIALS. Curing materials shall conform to Subsection 202.03.05 – “Curing Materials”.

329.02.05 STEEL. Steel shall conform to the applicable subsections of Subsection 210.03 – “Steel”.

329.02.05.01 Welding Materials. Welding materials shall conform to AWS D1.1.

329.02.06 PCC. PCC shall conform to Subsection 210.04 – “Precast or Cast-in-Place PCC”.

329.03 CONSTRUCTION.

329.03.01 SUBMITTALS.

329.03.01.01 Certificate of Compliance. The Contractor shall provide a certificate of compliance for each material in accordance with Subsection 100.31.01 – “Certificate of Compliance”.

329.03.01.02 Driven Piles. The Contractor shall submit the information contained in Section 508 – “Driven Piles”, Subsection 508.01.02 – “Submittals” of the *Silver Book* for review and approval at least 30 *Calendar Days* prior to driving piles, except as modified herein.

329.03.01.01.02.01 Qualifications of the Dynamic Consultant’s Personnel. Submittal of Qualification of the Dynamic Testing Consultant’s personnel is not required if the required nominal driving resistance of the piles in the field is to be determined based on the dynamic formula contained in Subsection 329.03.11.01.01.02 - “Nominal Driving Resistance”. Where high-strain dynamic testing is not required per the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, the preconstruction wave equation modeling shall be performed by a *Professional Engineer*.

329.03.01.03 Cast-in-Place Drilled Shafts. The Contractor shall submit the information required by Section 509 – “Drilled Shaft Foundations”, Subsections 509.01.02 – “Qualifications of Drilled Shaft Contractors” and 509.01.03 – “Submittals” of the *Silver Book* for review and approval at the schedule indicated in the subject subsections.

329.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable subsections of Section 336 – “Inspection and Testing”, except as modified herein.

329.03.02.01 Driven Piles.

329.03.02.01.01 Pile Driving Equipment. Pile driving equipment shall be examined before beginning pile driving by the *Inspector* to document good operating conditions and document their conformance to the approved submittal. Piles shall not be driven until all equipment has been examined and accepted by the *Engineer*.

329.03.02.01.02 High-Strain Dynamic Testing. When high-strain dynamic testing is required as shown in the *Plans* or specified in the *Special Provisions*, and/or *Special Technical Specifications*, the *Contractor* shall secure the services of an independent dynamic testing consultant to perform wave equation modeling, high-strain dynamic testing, and signal matching analysis, and to develop pile driving criteria.

329.03.03 WORKMANSHIP. Workmanship shall be in accordance with Section 100.17 – “Materials and Workmanship”.

329.03.04 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.21 – “Location of Work”.

329.03.05 SCHEDULING OF WORK. The Contractor shall prepare and provide to the *Engineer*, for approval, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

329.03.05.01 Pre-Activity Meeting. Before commencement of pile construction, a pre-activity meeting shall be scheduled by the *Engineer* a time and place satisfactory to the *Contractor*. At a minimum, the pre-activity meeting shall be attended by the *Contractor*, piling *Subcontractor* and the *Engineer*. Pile construction shall not be commenced until all action items resulting from the pre-activity meeting have been satisfactorily addressed.

329.03.06 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements shall be performed in accordance with Section 300 – “Site Preparation”. The Contractor shall protect items not removed in accordance with Section 301 – “Protection and Restoration” except as modified herein.

329.03.06.01 Driven Piles.

329.03.06.01.01 Potential for Damage Due to Vibration. When piles are to be driven near existing improvements that have a potential for damage by vibration induced by pile driving, special measures including, but not limited to, preconstruction survey, vibration monitoring and post construction survey may be required by the *Engineer*. When such special measures are required, the *Engineer* shall include details of their requirements in *Special Provisions* or *Special Technical Specifications*.

329.03.06.01.02 Noise Control. When piles are to be driven near areas subject to noise control, special measures including, but not limited to, monitoring of noise due to pile driving and noise reduction measures may be required by the *Engineer*. When such special measures are required, the *Engineer* shall include details of their requirements in *Special Provisions* or *Special Technical Specifications*.

329.03.07 CONSTRUCTION EQUIPMENT. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers, Methods and Equipment”, except as modified herein.

329.03.07.01 Driven Piles. The *Contractor* shall furnish equipment for pile driving and other devices for inspection and testing in accordance with Section 509 – “Driven Piles”, Subsection 508.03.02 – “Equipment” of the *Silver Book* except as modified herein.

329.03.07.01.01 High-Strain Dynamic Testing. When high-strain dynamic testing is required per the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, the dynamic testing consultant shall provide all equipment necessary for such testing. The equipment shall conform to the requirements of ASTM D4945. All the sensors shall be calibrated within 365 *Calendar Days* prior to the high-strain dynamic testing.

329.03.07.01.02 Precast PCC Pile Driving. Precast PCC piles shall be driven with a steam, air, or diesel hammer which shall develop an energy per blow at each full stroke of the piston of not less than 1 foot pound for each pound of weight driven. Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of the steam or air hammer shall be maintained in a condition that ensures the length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient steam or air hammers shall be removed from the work.

An adequate cushion cap shall be used in driving precast PCC piles. The top of the pile and the cap shall be so shaped that the blow of the hammer will be uniformly distributed to the entire top surface of the pile.

For precast PCC piles, tensile stresses shall not exceed 3 multiplied by the square root of f'_c of the PCC in PSI plus the effective prestress value ($3[f'_c]^{1/2}$ + prestress) and compressive stresses shall not exceed 85 percent of f'_c in PSI minus the effective prestress value (0.85 f'_c - prestress).

The *Engineer* will determine if the proposed hammer(s) to be used for pile driving is acceptable based on the review of the submitted preconstruction wave equation analysis and/or based on independent wave equation analysis by the *Engineer*. Approval of the hammer will be based on the following:

- A. The required number of hammer blows to provide the required nominal driving resistance shall be between 24 and 120 blows per foot (between 2 and 10 blows per inch).
- B. The driving stress in steel piles shall not exceed 90 percent of the yield strength and the driving stress in precast PCC piles shall not exceed the values provided above.

Acceptance of pile driving equipment shall not relieve the *Contractor* of responsibility to drive piles, free of damage, to the required nominal driving resistance and the minimum tip elevations shown in the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Each hammer used will be subject to submittal, review, and approval by the *Engineer*.

The striker plate and hammer cushion shall be removed from the helmet for inspection by the *Inspector*. The hammer cushion will be inspected when beginning pile driving at each structure or after each 100 hours of pile driving, whichever less. Hammer cushion shall be replaced when it becomes compressed in excess of 25 percent of its original thickness, is cracked, or begins disintegrating.

329.03.07.02 Cast-in-Place Drilled Shafts. The *Contractor* shall use excavation and drilling equipment in accordance with Section 509 – “Drilled Shaft Foundations”, Subsection 509.03.03 – “Equipment” of the *Silver Book*.

329.03.08 CONSTRUCTION LOADS. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

329.03.08.01 Driven Piles.

329.03.08.01.01 Down Drag. When down drag resistance in the fill and/or compressible soil layers is specified in the *Plans* and required to be accounted for in pile driving, piles shall be driven to overcome the side resistance in the subject fill and/or compressible soil layers. In this case, the required nominal driving resistance shall be equal to required nominal compressive resistance that is shown in the *Plans* plus the down drag resistance. Otherwise, the required nominal driving resistance shall be taken equal to the required nominal compressive resistance provided in the *Plans*.

329.03.09 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”, except as modified herein.

329.03.09.01 Driven Piles. Piles shall not be driven until the pile driving area has been prepared. Where applicable, the *Contractor* shall complete the pile cap excavation prior to driving piles. Unless otherwise directed or approved by the *Engineer*, the embankment shall be constructed to 1.5 feet above the bottom of the pile cap. When surcharging of abutment area prior to pile driving is shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, the *Contractor* shall place the surcharge and wait the required period of time.

329.03.09.02 Cast-in-Place Drilled Shafts. Unless otherwise shown on the *Plans* or specified in the *Special Provisions*, and/or *Special Technical Specifications* or approved by the *Engineer* in writing, drilled shafts shall be constructed after the placement of embankment fill when the shafts are to be installed in conjunction with embankment placement. Where drilled shafts are to be constructed prior to completion of embankment, pile caps or footings shall be constructed after embankment has been placed as near to final grade as possible. Any disturbed subgrade area shall be regraded and recompacted prior to PCC placement for the footing or pile cap.

329.03.10 EXCAVATION. Excavation shall be performed in accordance with Section 303- “Excavation”, except as modified herein.

329.03.10.02.01 Driven Piles.

329.03.10.02.02 Predrilling. If shown on the *Plans*, when needed to achieve the minimum tip elevations specified in the *Plans*, or if directed by the *Engineer*, the *Contractor* shall predrill at pile locations to the necessary depths. Predrilled holes shall generally be a size smaller than the diameter or diagonal of the pile cross section that is sufficient to allow penetration of pile to the necessary depth. When subsurface obstructions, such as boulders, rock layers or caliche, are encountered, the diameter of the holes may be increased to the least pile dimension that is adequate for pile installation. When approved by the *Engineer*, any void space shall be backfilled with fine aggregate conforming to Subsection 200.05.04 – “Fine Aggregates Backfilling” shall commence once the pile is inserted to the bottom of the predrilled hole and positioned and aligned. When lateral resistance provided by the upper segment of the driven piles is critical as determined by the *Engineer*, predrilling oversize holes shall be avoided. Do not impair capacity of adjacent in-place piles or damage adjacent structures by predrilling operations. Unless directed or approved by the *Engineer*, spudding, jetting, or blasting will not be permitted.

329.03.10.02 Cast-in-Place Drilled Shafts. Excavation for drilled shafts construction shall conform to Section 509 – “Drilled Shaft Foundations”, Subsections 509.03.02 – “Construction Methods”, 509.03.04 – “Excavation”, 509.03.06 – “Obstructions”, 509.03.08 – “Casings”, 509.03.09 – “Slurry”, and 509.03.15 – “Scheduling and Restrictions” of the *Silver Book*. The excavation shall also conform to Subsection 509.03.07 - “Exploration (Shaft Excavation)” of the *Silver Book* when it is indicated in the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* or when directed by the *Engineer*.

The *Contractor* shall dispose unsuitable or surplus material in accordance with Subsection 100.31.04 – “Material Disposal”.

329.03.11 PLACING OF MATERIALS.**329.03.11.01 Driven Piles.**

329.03.11.01.01 Driving Piles. The *Contractor* shall furnish and drive piles with the accepted pile driving equipment to the required nominal driving resistances and minimum tip elevations shown on the *Plans*.

329.03.11.01.01.01 Test Piles. When *Plans* designate test piles, test piles shall be installed prior to production piles using the same driving system as will be used to drive the production piles.

High-strain dynamic testing or load testing shall be performed when shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

Fuel setting of open-ended diesel hammers and the stroke setting of hydraulic hammer shall be reduced, as necessary, to avoid overstressing piles.

During driving, proper axial alignment of the hammer shall be maintained with the pile. When *Plans* designate battered piles, piles shall be driven battered (sloped) at the specified angle from vertical.

Unless otherwise shown in *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* or approved by the *Engineer*, individual piles in groups shall be installed starting from the center of the group and proceeding outwards progressively in all directions or starting at an outside row proceeding progressively across the group.

Piles shall be driven to the elevations shown on the *Plans* unless refusal occurs at a higher elevation. If the pile refuses prematurely, the *Contractor* shall verify that the hammer is operating properly.

Unless approved by the *Engineer* in writing, each pile must penetrate below the minimum pile tip elevation shown on the *Plans*. Predrilling may be used to obtain minimum tip elevation. When used to obtain minimum tip elevations, predrilling shall meet applicable requirements of Subsection 329.03.10.01.01 – “Predrilling”.

Piles shall be driven at locations and alignments shown on the *Plans* within the construction tolerances included in Subsection 329.04.01 – “Tolerance”. At shallow depth, while pile location and alignment can be corrected, the *Contractor* shall frequently stop driving to observe and, if necessary, correct pile alignment.

A minimum of 4 inches clearance shall be maintained between piles and any edge of pile cap. The pile cap size shall be increased to meet edge distance requirements as directed by the *Engineer* at no additional cost to the *Agency* and/or *Owner*.

Accurate level readings shall be taken to monitor pile heave resulting from pile driving. The *Contractor* shall monitor pile heave in accordance with Section 508 – “Driven Piles”, Subsection 508.03.04 – “Driving Piles” of the *Silver Book*.

329.03.11.01.01.02 Nominal Driving Resistance. Piles shall be driven to the depths necessary to obtain the required nominal driving resistance expressed in kips as determined by the modified Gates formula provided below or based on the driving criteria developed from the results of the high-strain dynamic testing.

$$\text{Nominal Driving Resistance} = [1.75 \times E^{\frac{1}{2}} \times \log (10/s)] - 100$$

The above dynamic formula shall not be used to determine the required nominal driving resistance when high-strain dynamic testing or other load testing is shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. When battered piles are designated on the *Plans*, driving criteria based on dynamic formula shall not be used for field verification of driven piles. Driving criteria for battered piles shall be developed based on high-strain dynamic testing.

The tip elevations specified in the *Plans* are approximate and are based on the static analysis performed by the *Engineer*. The *Engineer* will determine if each pile has the required nominal driving resistance based on the established driving criteria. If the required nominal driving resistance is not obtained during initial driving to the specified tip elevations, allow pile to set up for 24 hours or more and then restrike. During restrike, the required nominal resistance shall be determined using the first 10 hammer blows. If the required nominal driving resistance is still not obtained, drive the piles deeper as directed by the *Engineer* and perform a restrike. In general, piles driven to refusal and exhibiting no loss of driving resistance upon restrike will be assumed to have sufficient axial capacity. Warm up the hammer by striking another pile a minimum of 20 blows before restrike.

Within 3 *Calendar Days* of driving all piles within a group, the *Contractor* shall perform a survey to determine the accurate location and alignment of each pile within the group and submit to the *Engineer*.

329.03.11.01.01.03 Splicing and Cut Off. Steel piles may be built up from shorter lengths spliced together. Joined lengths shall be identical in cross section and aligned so that the axis of the pile is straight. Splicing a properly aligned section on a misaligned section will not be permitted. The entire cross section of each connection shall be welded in conformance with AWS D1.1. If lengths are added to lengths of pile previously installed, weld it while the splice is at least 3 feet above the ground to permit visual observation of the welded connection during driving.

Precast PCC piles shall be spliced in accordance with the details shown on the *Plans*.

Piles shall not be cut off until approved by the *Engineer*. Once approved, excess pile lengths shall be cut off such that pile heads are within 1 inch of cutoff elevations shown on the *Plans*.

The work of cutting off precast PCC piles shall be performed in such a manner as to avoid *Spalling* or damaging the pile below the cut off. In case of such damage, the pile shall be replaced or repaired as required by the *Engineer*.

When the cut off elevation for precast PCC pile is below the elevation of the bottom of the cap, the pile shall be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced PCC extension constructed as shown on the *Plans*.

All cut off lengths of piling shall remain the property of the *Contractor* and shall be disposed of outside the project limits.

329.03.11.01.02 Reinforcement and PCC Placement. Reinforcement and PCC placement shall not commence until after heaved piles have re-driven to their original position and all the piles in the group have been inspected and accepted by the *Engineer*.

Each pile will be inspected for damage, presence of water, soil, rock, or debris. If the bottom of the pipe pile cannot be seen or damage is suspected, the *Contractor* shall provide a down-hole camera for closer inspection.

Water, soil, rock, and debris shall be removed before placement of reinforcement and *PCC* in each pile. Reinforcing steel shall be placed as shown on the *Plans* before placing *PCC*. *PCC* for each pile shall be placed continuously to result in a dense and homogenous reinforced *PCC* section. *PCC* shall be vibrated within upper portion of the pile to a depth of 10 feet or 1/3 the length of the pile from cut off, whichever greater.

329.03.11.02 Cast-in-Place Drilled Shafts.

329.03.11.02.01 Reinforcement and PCC Placement for Drilled Shafts. Reinforcing steel and *PCC* placement shall be performed in accordance with the details shown on the *Plans* and Section 509 – “Drilled Shaft Foundations”, Subsections 509.03.11 – “Reinforcing Steel Cage Construction and Placement” and 509.03.12 – “Concrete Placement”, except as modified herein.

329.03.11.02.01.01 Curing. Curing of top surface of the shaft shall be performed in accordance with Section 311.03.10.05 – “Curing”.

329.03.11.01.01.02 Test Shafts. When *Plans* designate test shafts, test shafts shall be constructed prior to production shafts using the same methods and equipment to be used. Load testing requirements for test shafts will be included in *Special Provisions* and/or *Special Technical Specifications*.

329.03.12 WEATHER LIMITATIONS. No special weather limitations apply to the construction of piles.

329.03.13 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

329.03.14 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

329.04 ACCEPTANCE. The *Engineer* will make final determination on acceptance of driven piles and cast-in-place drilled shafts.

329.04.01 DRIVEN PILES. For acceptance, each driven pile shall be at its proper location and alignment, penetrate to minimum tip elevation, have the required nominal driving resistance, and be free of defects or damage. Driven piles shall not be accepted until all piles within a group are driven. Mispositioned or misaligned driven piles shall not be forced back into proper position/alignment.

329.04.01.01 Tolerance. The driven pile heads at cutoff elevation shall be within 2 inches of locations shown on the *Plans* for bent caps supported by piles and within 6 inches of locations shown on the *Plans* for all piles capped below final grade. Piles shall be driven such that the axial alignment of pile top is within 2 percent of the alignment shown on the *Plans*.

329.04.02 CAST-IN-PLACE DRILLED SHAFTS. For acceptance, each drilled shaft shall be constructed at the size, location, alignment, and depth/elevations specified in the *Plans*. Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. When integrity testing is required for drilled shafts per the *Plans* and/or *Specifications* or as directed by the *Engineer*, the shaft acceptance will also be based on the integrity test results.

329.04.02.01 Tolerance. Construction tolerances for drilled shafts shall conform to Section 509 – Drilled Shaft Foundations”, Subsection 509.03.10 – “Construction Tolerances”.

If the *Engineer* determines corrective measures are necessary, the *Contractor* shall submit a plan for remedial action for review. Modifications to piles caused by remedial action will require calculations and working drawings stamped by a *Professional Engineer*. Repair operations shall not be commenced until remedial correction procedures or designs are reviewed and accepted by the *Engineer*. The *Contractor* shall furnish all work necessary, including engineering analysis and redesign, to mitigate mispositioned, misaligned, defective, or damaged piles.

330.01 DESCRIPTION. This work shall consist of furnishing, framing, and installing timber of the kind, sizes, and dimensions and in accordance with the lines, grades, and sections shown on the Plans or specified in the Contract Documents.

330.02 MATERIALS. Materials shall meet the requirements of the following sections:

| Material | Section |
|----------------------|-------------|
| Structural Steel | Section 207 |
| Paint | Section 214 |
| Miscellaneous Metals | Section 207 |
| Timber | Section 208 |
| Timber Preservative | Section 208 |

If material lists or order lists are sent by the Contractor to the Engineer for checking or approval, such checking or approval by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of such lists. Any expense incident to the revision of materials furnished in accordance with such lists to make them comply with the Plans shall be borne by the Contractor.

Structural glued/laminated timber shall conform to the National Bureau of Standards, Voluntary Product Standard PS 56-73, for Structural Glued/Laminated Timber.

All framing lumber and structural timber, unless otherwise specified or shown on the Plans, shall be Douglas Fir or West Coast Hemlock or Larch.

Structural lumber and timber, solid sawn or glued/laminated, shall not be used in exposed permanent structures without a pressure preservative treatment, unless otherwise noted on the Plans or in the Special Provisions.

Timber connectors for treated timber structures, except those of malleable iron, shall be galvanized.

Split ring connectors of 2 1/2 inch inside diameter and 4 inch outside diameter shall be manufactured from hot rolled, low-carbon steel. Each ring shall form a closed true circle with the principal axis of the cross section of the ring metal parallel to the geometric axis of the ring. The metal section shall be beveled from the central portion toward the edges to a thickness less than the midsection. It shall be cut through in one place in its circumference to form a tongue and slot.

Shear-plate connectors of the pressed steel type, 2 5/8 inches in diameter, shall be manufactured from mild steel. Each plate shall be a true circle with a flange around the edge, extending at right angles to the face of the plate and extending from one face only, the plate portion having a central bolt hole and two small perforations on opposite sides of the hole and midway from the center and circumference.

Shear-plate connectors of the malleable iron type, 4 inches in diameter, shall be manufactured according to ASTM A 47, Grade 35018, for malleable iron castings. Each casting shall consist of a perforated round plate with a flange around the edge extending at right angles to the face of the plate and projecting from one face only, the plate portion having a central bolt hole reamed to size with an integral hub concentric to the bolt hole and extending from the same face as the flange.

Spike-grid timber connectors shall be manufactured according to ASTM A 47, Grade 35018, for malleable iron castings. They shall consist of four rows of opposing spikes forming a 4 1/8 inch square grid with 16 teeth that are held in place by fillets. Fillets for the flat grid in a cross section shall be diamond shaped. Fillets for the single curve grids shall be increased in depth to allow for curvature and shall maintain a thickness between the sloping faces of the fillets equal to the width of the fillet.

Circular grids of 3 1/4 inch diameter shall consist of eight opposing spikes equally spaced around the outer circumference and held in place by connecting fillets around the outer diameter and radial fillets projecting to a central circular fillet which forms a bolt hole opening of 1 1/4 inch. Fillets in a cross section shall be diamond shaped, except that the inner circular fillet may be flattened on one side to provide for manufacturer identification.

330.03 STORAGE OF MATERIALS. Lumber and timber on the site of the work shall be stored in piles.

Untreated material shall be open-stacked at least 12 inches above the ground surface and piled to shed water and prevent warping. When required by the Engineer, it shall be protected from the weather by moisture-resistant material.

Clear polyethylene films should not be used because wood members are subject to bleaching from sunlight. Individual wrappings should be slit or punctured on the lower side to permit drainage of water that may have accumulated.

Water-resistant wrapping used for the in-transit protection of glued/laminated members should be left intact until the members are enclosed within the building. If wrapping has to be removed at certain connection points during the erection, it should be replaced after the connection is made. If it is impractical to replace the wrapping, all of it should be removed to avoid the non-uniform appearance caused by sun and weather exposure.

Treated timber and piling shall be close-stacked and piled to prevent warping.

The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish.

330.04 WORKMANSHIP. The erection of structural timber framing requires experienced erection crews and proper lifting equipment. Workmanship shall be first class throughout. None but competent carpenters shall be employed, and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them.

The unloading and storage of structural timber framing before erection also demands care and good judgment. The following general precautions shall be adhered to:

1. Lift members or roll them on dollies or rollers out of railroad cars; do not drag or drop them. Unload trucks by lifting from the truck; do not dump or drop members.
2. If unloading with lifting equipment, use wide fabric or plastic belts or other slings that will not mar wood. If chains or cables are used, provide protective blocking or padding to sharp edges or sharp corners.
3. Guard against soiling, dirt, footprints, or abrasions. If members are wrapped, avoid tearing or damaging the protective material.

330.05 TREATED TIMBER. Treated timber and piling shall be carefully handled without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools. It shall be handled with rope sling. Cant hooks, peaveys, pikes, or hooks shall not be used.

All cutting, framing, and boring of treated timber shall be done before treatment, insofar as is practicable.

All cuts in treated piles or timbers and all abrasions, after being carefully trimmed, shall be covered with two applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch, or brush coated with a least two applications of hot creosote oil and covered with hot roofing pitch.

All bolt holes bored after treatment shall be treated with creosote oil by means of an approved pressure bolt hole treater.

Unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

Whenever, with the approval of the Engineer, forms or temporary braces are attached to treated timber with nails or spikes, the hole shall be filled by driving galvanized nails or spikes flush with the surface or plugging holes as required for bolt holes.

330.06 UNTREATED TIMBER. In structures of untreated timber, the following surfaces shall be thoroughly coated with two coats of hot creosote oil before assembling: ends, tops, and all contact surfaces of sills, caps, floors, and stringers, and all end joints and all contact surfaces of bracing and truss members. The back faces of bulkheads and all other timber which is to be in contact with earth, metal, or other timber shall be similarly treated.

Unless untreated timber is to be used in the construction within 3 days after date of delivery, it shall be painted on each end with a prime coat at the time of delivery.

330.07 HOLES FOR BOLTS, DOWELS, RODS, AND LAG SCREWS. Holes for round drift-holes and dowels shall be bored with a bit 1/16 inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

330.08 BOLTS AND WASHERS. A washer of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood.

The nuts of all bolts shall be effectively locked after they have been finally tightened.

Countersinking shall be done whenever smooth faces are required.

Horizontal recesses formed for countersinking shall be painted with hot creosote oil, and, after the bolts are screwed in place, shall be filled with hot pitch.

330.09 FRAMING AND FASTENING. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted. All framing must be true and plumb. Final tightening of alignment bolts should not be completed until the structure has been properly aligned.

Mud shall have true and even bearing on mud sills, piles, or pedestals. They shall be drift-bolted to mud sills or piles with bolts of not less than 3/4 inch diameter and extending into the mud sills or piles at least 6 inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

Posts shall be fastened to pedestals with dowels of not less than 3/4 inch diameter, extending at least 6 inches into the posts.

Posts shall be fastened to sills by one of the following methods, as indicated on the Plans:

- a. By dowels of not less than 3/4 inch diameter, extending at least 6 inches into posts and sills.
- b. By drift-holes of not less than 3/4 inch diameter driven diagonally through the base of the post and extending at least 9 inches into the sill.

330.10 CAPS. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift-bolts, as indicated on the Plans, extending at least 9 inches into the posts or piles. Drift-bolts shall be approximately in the center of the post or pile.

330.11 BRACING. The ends of bracing shall be bolted through the pile, post, or cap with a bolt of not less than 5/8 inch diameter. Intermediate intersections shall be bolted and spiked with wire or bolt spikes as indicated on the Plans. In all cases, spikes shall be used in addition to the bolts.

330.12 STRINGERS. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least 1/2 inch for the circulation of air and shall be securely fastened by drift-bolts where specified. When stringers are two panels in length, the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toenailed with at least two nails at each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified on the Plans, cross-bridging shall be placed at the center of each span.

330.13 PLANK FLOORS. Unless otherwise specified, flooring plank shall be surfaced on one side and on one edge. Single plank floors shall consist of a single thickness of plank supported by stringers or joists. The plank shall be laid heart side down with 1/4 inch openings between them for locally seasoned material and with tight joints for unseasoned material.

Each plank shall be securely spiked to each joist. The plank shall be carefully graded as to thickness and so laid that no two adjacent planks will vary in thickness more than 1/16 inch.

Two-ply timber plank floors shall consist of two layers of flooring supported on stringers or joists. The lower course shall be pressure-treated with a creosote oil. The top course may be laid either diagonal or parallel to the centerline of the roadway, as specified, and each floor piece shall be securely fastened to the lower course. Joints shall be staggered at least 3 feet. If the top flooring is placed parallel to the centerline of the roadway, special care shall be taken to securely fasten the ends of the flooring. These members shall be beveled at each end of the bridge.

330.14 LAMINATED FLOORS. Laminated floors shall be composed of 3 by 6 inch or 2 by 6 inch timbers, as indicated on the Plans and laid on edge at right angles to the centerline of the roadbed, unless otherwise shown on the Plans.

The flooring may be of random length and multiples of the stringer spacing with no single piece less than 6 feet long. All splices shall be made on the centerline of a stringer and shall not occur oftener than once in 6 inches on any one stringer.

Laminations shall be laid with a finished edge down. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than 1/8 inch from a true plane, except treated stringers, shall be surfaced to meet this requirement. Treated stringers which do not meet the requirements may be rejected, but shall not be framed or added after treatment. Each piece of flooring shall be fastened to the preceding strip at each end and at approximately 18 inch intervals with spikes, or nails shall be of sufficient length to pass through two strips and at least halfway through the third strip. If timber supports are used, each piece shall be toe-nailed to every other support with 20d or 30d nails. Care shall be taken to have each strip vertical and tight against the preceding one and bearing evenly on all supports.

330.15 TRUSSES. Trusses which are shipped partially or completely disassembled shall be assembled on the ground at the site before erection. Arches may be assembled on the ground or connections may be made after the half arches are in position. When trusses and arches are assembled on the ground at the site, they should be assembled on level blocking to permit connections to be fitted properly and tightened securely without damage. The end compression joints should be brought into full bearing and compression plates installed where specified.

Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection, and in vertical projection shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

Before erection, the assembly shall be checked for prescribed overall dimensions, prescribed camber, and accuracy of anchorage connections. Erection should be planned and executed in such a way that the close fit and neat appearance of joints and the structure as a whole will not be impaired.

Anchor bolts should be checked prior to start of erection.

Before erection begins, all supports and anchors should be complete, accessible, and free of obstructions. The weights and balance points of the structural timber framing should be determined before lifting begins so that proper equipment and lifting methods may be employed.

Unless otherwise directed by the Engineer, housings and railings shall be built after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

330.16 PAINTING. Outside stringers, wheel guards, rails, rail posts, and exposed surfaces of scupper blocks, filler blocks, and flooring of untreated timber or timber treated with preservative salts, shall be painted as specified in Section 324 – “Painting, Pavement Striping, and Marking.”

Ends of all pieces of untreated timber not otherwise painted shall be painted with one prime coat.

Metal parts shall be painted as specified in Section 324 – “Painting, Pavement Striping, and Marking.”

330.17 TIMBER CONNECTORS. Timber connectors shall be one of the following types, as specified on the Plans: the split ring, the shear plate, or the spike grid. The split ring and the shear plate shall be installed in precut grooves of dimensions as given herein or as recommended by the manufacturer. The spike grid shall be forced into the contact surfaces of the timbers and joined by means of pressure equipment. All connectors of this type at a joint shall be embedded simultaneously and uniformly.

Fabrication of all structures using connectors shall be done prior to treatment. When prefabricated from templates or shop details, bolt holes shall not be more than 1/16 inch from required placement. Bolt holes shall be 1/16 inch larger than bolt diameter. Bolt holes shall be bored perpendicular to the face of the timber.

Connector grooves in timber shall be cut concentric with the bolt hole, shall conform to the cross-sectional shape of the rings, and shall provide a snug fit. Inside groove diameter shall be larger than the nominal ring diameter in order that the ring will expand slightly during installation.

Timber, after fabrication, shall be stored in a manner that will prevent changes in the dimensions of the members before assembly.

Dimensions of material and details not otherwise specified shall meet with the approval of the Engineer.

330.18 MEASUREMENT OF QUANTITIES AND BASIS OF PAYMENT. Lumber and timber shall be measured in accordance with the Contract Documents.

Lumber and timber shall be compensated for at the lump sum or unit prices established in the Contract Documents or as directed by the Engineer. All prices shall be full compensation for furnishing all materials, including hardware, treating, erecting, and for all incidentals necessary for doing all the work involved, as shown on the Plans or established by the Engineer.

331.01 DESCRIPTION. This Section covers the installation of guardrail.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank. Guardrail shall conform to Section 618 – “Guardrail” of the *Silver Book*.

332.01 GENERAL.

332.01.01 DESCRIPTION. This Section covers the design, provision, and installation of new or replacement pipe systems utilizing trenchless technology.

This Section is for construction specification only and is not intended to be a "qualified products list" nor intended to encourage or discourage the use of any product or construction method.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

332.01.01.01 Definitions. Whenever the following terms are used in this Section, the intent and meaning shall be interpreted as follows:

332.01.01.01.01 Abbreviations and Codes. The intent and meaning of abbreviations and terms used in this Section shall be interpreted in accordance with Subsection 100.01.01.01 – "Abbreviations and Codes".

332.01.01.01.02 Specifications. The intent and meaning of specifications used in this Section shall be interpreted in accordance with Subsection 100.01.29 – "Specifications".

332.01.01.01.03 Trenchless Technology. Trenchless Technology shall be defined as the procedures for installing and/or replacing pipe using minimal excavation and minimal disturbance of the ground surface.

332.01.01.01.03.01 System Components. The following terms identify the system components and methods used in Trenchless Technology applications for pressurized and non-pressurized infrastructure.

332.01.01.01.03.01.01 Auger Boring. Auger boring shall be defined as a procedure for installing steel casing by advancing a bore from a drive pit to a reception pit by means of a rotating cutting head with limited steering capability.

332.01.01.01.03.01.02 Carrier Pipe. Carrier pipe shall be defined as the tube which carries the product being transported. Carrier pipes may be directly bored or rammed.

332.01.01.01.03.01.03 Casing. Casing shall be defined as a pipe used to line bore holes through which carrier pipes or ducts are installed

332.01.01.01.03.01.04 Cured In Place Pipe (CIPP). Cured in place pipe (CIPP) shall be defined as a jointless pipe lining inserted and cured within a host pipe.

332.01.01.01.03.01.05 Horizontal Directional Drilling. Horizontal directional drilling shall be defined as a procedure for accurately installing pipe in a shallow arc along a prescribed bore path by using a surface-launched drilling rig.

332.01.01.01.03.01.06 Host Conduit. Host conduit shall be defined as the existing pipe.

332.01.01.01.03.01.07 Jacking. Jacking shall be defined as the actual pushing of a pipe or casing in an excavated hole.

332.01.01.01.03.01.08 Mining. Mining shall be defined as the hand or mechanical removal of materials.

332.01.01.01.03.01.09 Piercing/Impact Moling. Piercing/Impact Moling shall be defined as a procedure to create a bore using a percussive hammer, generally of torpedo type, with a non-steered device that does not have a rigid attachment to the launch pit. This method relies upon the resistance of the ground friction for forward movement and soil displacement.

332.01.01.01.03.01.10 Pilot Tube Microtunneling. Pilot tube microtunneling shall be defined as a procedure for accurately installing pipe along the entire length of the bore with an inside

diameter between 4 and 36 inches by use of a guided pilot tube in the first stage. A two or three stage method may be used.

332.01.01.03.01.11 Pipe Bursting and Pipe Splitting. Pipe bursting and pipe splitting shall be defined as procedures for replacing existing pipe systems by fragmenting the existing host conduit, expanding the fragments into the surrounding soil, and installing the replacement pipe in its void.

332.01.01.03.01.12 Pipe Ramming. Pipe ramming shall be defined as procedure for installing pipe by driving an open-ended steel casing using a percussive hammer with no steering capability.

332.01.01.03.01.13 Replacement Pipe. Replacement pipe shall be defined as the new pipe to be installed to replace the host conduit.

332.01.01.03.01.14 Slip Lining. Slip lining shall be defined as a procedure for replacing pipe by inserting a replacement pipe with a smaller outside diameter into the host pipe.

332.01.01.03.01.15 Slurry Microtunneling. Slurry microtunneling shall be defined as a procedure for accurately installing pipe along the entire length of the bore with an inside diameter of 36 inches (non-man sized) or less that provides continuous support to the excavation face by applying mechanical or fluid pressure to balance groundwater and earth pressures by jacking the pipe behind a remotely controlled, steerable, laser-guided, articulated tunnel shield.

332.01.01.03.01.16 Vacuum Microtunneling. Vacuum microtunneling is defined as procedure for accurately installing pipe along the entire length of the bore utilizing a remotely steered guided bore using vacuum removal of the spoils.

332.01.02 MATERIALS. The materials used shall be approved and/or determined by the Engineer.

332.01.02.01 Inspection of Materials. The Contractor shall accommodate inspection of the materials in accordance with Subsections 100.16.03 – “Inspection Facilities” and the applicable subsections of Section 336 – “Inspection and Testing”.

332.01.03 CONSTRUCTION.

332.01.03.01 Submittals. The Contractor shall submit for review complete working drawings showing details of the proposed method of construction and the sequence of operations to be performed during construction, including the slurry microtunneling system to be used, location of working shafts, including method of excavation, shoring and bracing, and de-watering techniques that are proposed to be used. The following information shall also be included:

Manufacturer's literature describing in detail the slurry microtunneling system to be used.

Detailed description of projects on which this system has been used, including the names, addresses and telephone numbers of owner's representative for these projects.

Method of muck disposal.

Method of controlling ground water.

Shaft dimensions, locations, surface construction, profile, depth, method of excavation, and shoring and bracing.

The Engineer will base the review of submitted details and data with consideration of requirements for the completed work, utilities, and the possibility of unnecessary delays in the execution of the work to be constructed under this and subsequent contracts. Review and acceptance of the Contractor submittals by the Engineer shall not be construed in any way as relieving the Contractor of his responsibilities under this contract.

The Contractor shall supply the Engineer with technical data on the slurry microtunneling pipe to be used on this project. The Contractor shall also supply the Engineer with the name, address, and telephone number of five (5) contacts where the particular pipe material has been successfully installed for reference and verification.

The Contractor shall monitor all ground movements associated with the work and maintain these within permissible tolerances. It is recommended that surface settlement and heave monitoring points may be located along the line of the tunnel. If there is a concern of damage by settlement, these should be monitored after completion of the project. The Contractor, if required, shall install instrumentation, take readings, and provide the Engineer with copies, all in accordance with the specification

332.01.03.02 Construction Methods.

332.01.03.02.01 Auger Boring.

332.01.03.02.02 Horizontal Directional Drilling.

332.01.03.02.03 Pilot Microtunneling. This Subsection provides the minimum requirements for the trenchless installation of sanitary sewer pipe by pilot microtunneling. The Contractor shall have discretion to select the method of pilot microtunneled pipe installation, subject to approval by the Engineer.

332.01.03.02.03.01 General. Shafts shall be the minimum size possible commensurate with safe working practices and located as shown on the Plans. Jacking shafts can be as small as 8 feet to 12 feet in diameter. Site conditions, which allow for larger shafts, (i.e., 12 feet x 20 feet) may allow for increased production and therefore be more economical. Where no shaft locations are shown on the Plans, the contractor shall determine the locations of the shafts with the approval of the Engineer. Shaft locations shall, where possible, be kept clear of all intersections and be contained within a single lane of traffic in order to minimize the disruption to the flow of traffic. The contractor shall furnish and install all pump and related equipment to keep the jacking shaft free of water. The design of the shafts shall ensure safe exit and entry into the jacking and receiving shafts. Shoring of the shaft shall extend above grade or a railing provided at all shaft locations. Design of shaft shall provide sufficient backstop capacity to resist forces developed by the thrust jacks. Shoring (shaft lining plates) for jacking and receiving shafts shall be installed tight against excavation in an effort to prevent loss of soil/pipe support during launch and reception.

Any space between shoring (shaft liner plates) and excavation, adjacent to pipe installation, shall be filled with Controlled Low Strength Material. Removal of shoring must be accomplished without disturbing line or grade of the installed pipe.

Bedding-installed carrier pipes in the shaft must be properly bedded prior to backfill. Refer to the Plans for proper bedding details at shaft locations.

The over cut of the enlargement casing shall be limited to no more than 1-1/2 inches on the diameter of the product pipe to be installed.

332.01.03.02.03.02 Materials.

332.01.03.02.03.02.01 Pipe. Pipe used for pilot microtunneling shall conform to ASTM C1208 and be capable of withstanding all forces imposed upon them during the construction phase, as well as the final in-place loading conditions. All pipe shall withstand a compressive loading greater than the jacking load. The maximum jacking force shall be shown on the Plans or specified in the Special Provisions and/or Special Technical Specifications, as calculated by the following equation:

$$0.06 \times \pi \times OD \text{ (feet)} \times \text{longest drive length (feet)}$$

Pipe design shall include a minimum safety factor of 2.5.

The driving ends of the pipe and intermediate points must be protected against damage. The detailed method proposed to cushion and distribute the jacking force at the joint is subject to approval by the Engineer.

Any pipe showing signs of failure may be required to be jacked through to the reception shaft and removed. Other methods of pipe repair may be used subject to approval of the Engineer.

The pipe manufacturer shall be designated at the time of the bid. Any subsequent change of pipe manufacturer must be approved by the Engineer in writing.

332.01.03.02.03.02.02 Couplings. Coupling widths shall conform to Table 332.01.03.02.03.02.02-I.

Table 332.01.03.02.03.02.02-I

| Pipe Diameter (Inches) | Coupling Width (Inches) |
|------------------------|-------------------------|
| 4 | 4 |
| 6 through 12 | 6 |
| 15 and Greater | 10 |

332.01.03.02.03.02.03 Rubber Gaskets. Rubber Gaskets used for mainline connections or reconnecting services shall be Mission Rubber stainless steel shielded rubber couplings or approved equal.

332.01.03.02.03.02.04 Shear Ring. Shear rings shall be Series 300 stainless steel with a minimum thickness of 0.012 inches.

332.01.03.02.03.02.05 Tightening Bands. Tightening bands shall be Series 316 stainless steel with stainless steel nut and bolt tightening clamps. Shear ring and clamps shall meet all requirements of ASTM A240.

332.01.03.02.03.02.06 Jacking Frame. The jacking frame shall possess adequate strength to advance the pilot tube, the enlargement casing and the string of product pipe from the drive shaft to the receiver shaft. The jacking force shall be easily regulated down to the safe working load rating of the pipe. The frame shall develop a uniform distribution of jacking forces on the end of the pipe. The auger motor shall possess adequate torque to steer the pilot tube and adequate torque and speed to effectively auger the excavated material from the face of the bore to the drive shaft.

332.01.03.02.03.02.07 Pilot Tube. The pilot tubes shall be constructed of steel in rigid, but short sections to accommodate the small drive and receiver shafts. The tubes shall rigidly connect to each other, the steering tip, and the enlargement casing and have a clear inside diameter large enough to adequately view the lighted target. The tubes shall withstand the torque encountered in the steering process.

332.01.03.02.03.02.08 Enlargement Casing. The enlargement casing shall be constructed of steel to a diameter just larger than the product pipe and have a leading connection compatible with the pilot tube. The leading face of the casing shall possess several large openings for the soil to enter as it advances along the proposed alignment. An internal auger chamber shall funnel the excavated material into the temporary full diameter casings of the Three-Phase Process or into the internal auger casings of the Two-Phase Process. Structural members shall connect the leading edge of the casing to the pilot tube connections.

332.01.03.02.03.03 Soil Transportation System. The soil transportation system shall consist of an auger train operating inside the full diameter temporary steel casings of the Three-Phase System and an internal casing and auger train operating inside the product pipe. The internal casings of the Two-Phase Process shall be manufactured to minimize leakage of the excavated material into the product pipe.

332.01.03.02.03.04 Soil Removal. A soil removal system shall be provided to safely remove the excavated material from the drive shaft to the surface.

332.01.03.02.03.05 Hydraulic Power Unit. The hydraulic power unit shall rest on the surface and be connected to the jacking frame by hoses. The unit shall meet all applicable noise standards.

332.01.03.02.03.06 Lubrication System. A lubrication system shall be employed to minimize pipe friction to insure that pipe can be installed from the drive shaft to the receiver shaft within the safe working load rating of the pipe. The system may also be required to minimize the torque required to transport the excavated material to the drive shaft.

332.01.03.02.03.07 Line and Grade Control. The equipment must be capable of installing the pilot tubes to the desired line and grade with a tolerance of plus or minus 0.375 inches between manholes (300 linear feet).

332.01.03.02.03.08 Two Pass System.

332.01.03.02.03.08.01 Phase 1. The pilot tube shall be installed as described in Subsection 332.01.03.02.03.12.01 – “Phase 1”.

332.01.03.02.03.08.02 Phase 2. The enlargement casing shall be installed as described in Subsection 332.01.03.02.03.12.02 – “Phase 2”. Each product pipe shall be fitted with an internal protective-casing pipe to house the auger and prevent damage to the product pipe. The product pipe shall be installed directly behind the enlargement casing with the internal casing rigidly connected to the auger chamber of the enlargement casing. The internal casing shall be manufactured such that the excavated material does not leak excessively into the product pipe. The internal casing shall be fitted with a protective shoe to protect the product pipe from damage and to support the casing and auger at the centerline of the pipe. The product pipe shall be advanced along the proposed alignment with the jacking frame thus progressing the enlargement casing from the drive shaft to the receiver shaft with the pilot tubes being recovered in the receiver shaft. The excavated material shall be funneled into and conveyed through the internal casing to the drive shaft where it shall be removed from the shaft and disposed of at an approved location. Upon reaching the receiving shaft, the enlargement casing shall be removed, and the internal casings and augers retracted and recovered at the drive shaft.

332.01.03.02.03.09 Three Pass System.

332.01.03.02.03.09.01 Phase 1. A rigid steel pilot tube in approximately one-meter length shall be installed through the ground from the drive shaft to the reception shaft by earth displacement with the jacking frame. The alignment of the pilot tube shall be established with a theodolite mounted at the rear of the drive shaft and accurately set to the desired line and grade. The theodolite shall view a lighted target in the lead or steering pilot tube. A camera shall be fitted to the theodolite and shall transmit the image of the crosshair and the target onto a monitor screen to be viewed in the drive shaft by the operator. As the operator advances the pilot tube through the earth, the center of the target will drift from the crosshair as a result of the biased or slanted leading tip of the pilot tube. The operator shall rotate the pilot tube as required to orient the slanted steering tip toward the crosshair and continue to advance the pilot tube until it reaches the reception shaft.

332.01.03.02.03.09.02 Phase 2. An enlargement casing shall be rigidly connected to the final pilot tube and advanced into the earth behind the pilot tube. An auger shall be used inside the enlargement casing to remove the material being excavated. The auger shall be contained inside the limits of the enlargement casing as it progresses along the proposed alignment. A train of temporary steel casings, with an outside diameter very similar to the enlargement casing, is used to move the enlargement casing from the drive shaft to the reception shaft. The enlargement casing will cut a bore hole from the drive shaft to the reception shaft and the temporary casings will case the hole as it is cut. Each temporary casing shall be fitted with an internal auger to transport the excavated material to the drive shaft, where it shall be removed from the shaft and disposed of at an approved location. The pilot tubes shall be recovered in the reception shaft as the temporary casings are installed.

332.01.03.02.03.09.03 Phase 3. The product pipe shall be installed directly behind the final temporary casing pipe with the jacking frame. The casing pipes and augers shall be recovered in the reception shaft as the product pipes are installed.

332.01.03.02.03.09.04 Phase 3 (Optional). Should the product pipe size be larger than the casing OD used in Phase 2, a powered open face reaming head shall be used to increase the

size of the bore. This reaming head shall have an overcut OD sized approximately one (1) inch larger than the product pipe OD and be connected to the final temporary casing and internal auger at the drive shaft location. This reaming head shall allow excavated material into the face of the reaming head and funnel said material through the previously installed augers and casings. The powered cutting head will reverse auger direction and direct excavated material toward the reception shaft, where it shall be removed and disposed of at an approved location. Product pipe shall be lowered into the drive shaft and installed directly behind the powered cutting head. The product pipe shall be jacked, advancing the powered cutting head and auger casings toward the reception shaft. The casings and augers shall be recovered in the reception shaft as the product pipes are installed.

332.01.03.02.03.10 Submittals.

332.01.03.02.04 Pipe Bursting and Pipe Splitting. This Subsection includes furnishing all labor, materials, transportation and equipment necessary for the replacement of sanitary sewers, storm drains, and water mains by means of the installation of a new pipe in place of an existing host conduit utilizing pipe bursting and pipe splitting.

332.01.03.02.04.01 General. Pipe Bursting is a patented method and the Pipe Bursting Contractor must be licensed.

332.01.03.02.04.02 Materials.

332.01.03.02.04.02.01 Pipe. Pipe used for static pipe bursting shall conform to ASTM C1208 and be capable of withstanding all forces imposed upon them during the construction phase as well as the final in-place loading conditions. All pipe shall withstand a compressive loading greater than the jacking load. The maximum jacking force shall be shown on the Plans or specified in the Special Provisions and/or Special Technical Specifications, as calculated by the following equation:

$$0.06 \times \pi \times \text{OD (feet)} \times \text{longest drive length (feet)}$$

Pipe design shall include a minimum safety factor of 2.5.

The driving ends of the pipe and intermediate points must be protected against damage. The detailed method proposed to cushion and distribute the jacking force at the joint is subject to approval by the Engineer.

Any pipe showing signs of failure may be required to be jacked through to the reception shaft and removed. Other methods of pipe repair may be used subject to approval of the Engineer.

The pipe manufacturer shall be designated at the time of the bid. Any subsequent change of pipe manufacturer must be approved by the Engineer in writing.

332.01.03.02.04.02.01.01 Replacement Pipe. The replacement pipe shall meet the requirements of ASTM C-1208, standard specification for vitrified clay pipe and joints for use in jacking, sliplining, and tunnels, latest revision. The pipe shall have a minimum compressive strength of 7,000 psi. The pipe joint collar shall be manufactured of series 316 stainless steel. A factory supplied load distributing compression ring shall be placed at each joint of pipe.

332.01.03.02.04.02.02 Couplings. Coupling widths shall conform to Table 332.01.03.02.04.02.02-I.

Table 332.01.03.02.04.02.02-I

| Pipe Diameter (Inches) | Coupling Width (Inches) |
|------------------------|-------------------------|
| 4 | 4 |
| 6 through 12 | 6 |
| 15 and Greater | 10 |

332.01.03.02.04.02.03 Rubber Gaskets. Rubber Gaskets used for mainline connections or reconnecting services shall be Mission Rubber stainless steel shielded rubber couplings or approved equal.

332.01.03.02.04.02.04 Shear Ring. Shear rings shall be Series 300 stainless steel with a minimum thickness of 0.012 inches.

332.01.03.02.04.02.05 Tightening Bands. Tightening bands shall be Series 316 stainless steel with stainless steel nut and bolt tightening clamps. Shear ring and clamps shall meet all requirements of ASTM A240.

332.01.03.02.04.03 Submittals. The Contractor shall submit written descriptions of the construction method(s) and equipment to be used, pit dimensions, and location required for equipment and material access.

The Contractor shall submit written descriptions of the construction method(s) and equipment to be used to penetrate blockage and/or partially collapsed sections of the host conduit. This Work shall be accomplished without excavation from the surface unless written authorization is obtained from the Engineer (or owner) for surface excavations to remove blockages.

The Contractor shall submit complete working drawings showing details of the proposed method of construction and the sequence of operations to be performed during construction. Show the method of pipe bursting including the pipe bursting system to be used, location of working shafts, including method of excavation, shoring and bracing, and de-watering techniques that are proposed to be used. The following is not intended to limit, but to provide the minimum of, details which must be included:

The Contractor shall also warrant to the owner that the equipment used on this Contract, where covered by patents or license agreements if furnished in accordance with such agreements and that the prices included herein cover all applicable royalties and fees in accordance with such license agreements. The Contractor shall defend, indemnify and hold the owner harmless from and against any and all costs, loss, damage or expense arising out of or in any way connected with any claim of infringement of patent, trademark or violation of license agreement.

332.01.03.02.04.04 Service Connections. Service and appurtenant connections as shown on the Plans shall be located, excavated and exposed before pipe bursting operations commence. The excavation and support of excavation shall be in accordance with *Section - Excavation and Backfilling and Section - Temporary Excavation Support*.

All service and appurtenant connections attached to the host conduit shall be completely disconnected and isolated from the host conduit before pipe bursting operations commence. These service connections shall not be reconnected to the replacement pipe until installation and testing are complete.

After the replacement pipe has been completely installed and tested, all existing active services as indicated on the Plans or as identified by the Contractor shall be reconnected to the replacement pipe.

332.01.03.02.04.05 Flow Diversion/Bypass Pumping. The Contractor shall provide the diversion of flows.

332.01.03.02.04.06 Existing Structures. If the pipe bursting tool and the replacement pipe is to traverse any existing structure which is to remain in-place without interruptions during the pipe bursting operation (as shown on Plans), the conduit entrances and exits to the existing structure shall be opened out to the required dimensions, and modifications shall be made to the invert before the pipe bursting operations commence.

332.01.03.02.04.07 Pit Locations. Pit locations shall be adjacent manholes or at a service connection. Should the Contractor want to relocate any pit, the Contractor shall request from the owner such relocation.

332.01.03.02.04.08 Operation of Pipe Bursting Machine and Installation of Replacement Pipe.

The specific type of replacement pipe material shall be installed in the locations as shown on the Plans.

If there are a significant number of utilities in the area, the pipe bursting method shall limit vibrations transmitted to the surrounding soils. The peak particle velocity of ground vibrations resulting from pipe bursting operations shall be limited to 0.5 inches per second.

As the pipe bursting tool is advanced through the host conduit, the replacement pipe shall be advanced directly behind the tool to fill the void left by the fragmented host conduit.

332.01.03.02.04.09 Connections to Structures. Connections of the replacement pipe to existing structures shall be in accordance with *Section - Connections to Existing Structures*.

332.01.03.02.04.10 Openings to the Mainline. All taps made under this specification are to be accomplished using mechanical means. Under no circumstances will taps be made using a hammer, star drill, chisel or mallet. All taps will be made using a diamond studded cutter shell. The cutter shell may be powered either by a gasoline, hydraulic or 12 volt D.C. electric power unit. No A.C. power may be used for making taps. Precautions shall be taken when using a gasoline power unit to insure that the work area is properly ventilated and does not pose the potential risk to the worker.

332.01.03.02.04.11 Tapping Saddle. The tapping saddle to be attached to the mainline shall be made of rigid polyurethane or vitrified clay. The saddle shall have a curved attachment surface that conforms to the outside diameter of the mainline pipe. The saddle shall be attached using two part epoxy cement provided by the manufacturer that will be compatible to the saddle and mainline materials.

After the mainline has been exposed, all excess dirt shall be removed from the pipe surface. The opening shall be cut using the approved method as outlined above. Clear any excess moisture remaining from the drilling process. Dry fit the tap saddle to insure its compatibility to the mainline. Mix the two part epoxy cement per the manufacturer's recommendations. Spread the cement on the mainline adjacent to the opening as well as the contact surface of the tapping saddle. Securely press the saddle on the mainline. Any additional epoxy that remains may be spread on the interface between the tapping saddle and the mainline pipe. Either plug the saddle with an appropriate size plug or complete the service connection.

After the curing time has elapsed, backfill making sure not to dislocate the pipe or saddle from the mainline.

332.01.03.02.05 Slurry Microtunneling. This Subsection provides the minimum requirements for the trenchless installation of sanitary sewer pipe by slurry microtunneling. The Contractor shall have discretion to select the method of slurry microtunneled pipe installation, subject to approval by the Engineer.

332.01.03.02.05.01 General. Unless otherwise directed or approved by the Engineer, the minimum depth of cover for slurry microtunneling is six (6) feet or 1.5 times the OD of the pipe being installed, whichever is greater. All tunneling work shall be executed so as to minimize settlement or heave within the tolerance as shown on the Plans or specified in the Special Provisions and/or Special Technical Specifications.

The manufacturer of the specific equipment to be used shall be specified at the time of the bid. Any subsequent changes with respect to the slurry microtunneling equipment manufacturer must be approved in writing by the Engineer.

Excavating, shoring and bracing, and tunneling shall be so executed that both surface heave and settlement are minimized. Unless otherwise directed or approved by the Engineer, the Contractor shall install instrumentation, monitor the ground surface readings and provide a record of the readings to the Engineer.

The machine shall be operated so as to prevent either surface heave or loss of ground during tunneling and shall be steerable to maintain line and grade within the tolerances specified. This is achieved by continuously monitoring line, level inclination and steering attitude during the operation. When the

earth pressure slurry balance system is used, the composition of the slurry must be carefully monitored for specific gravity and viscosity

Unless otherwise directed or approved by the Engineer, the overcut on the tunneling shield shall not exceed one (1) inch on the radius without approval. The annular space created by the overcut shall be filled with the lubricant that is suitable for the soil type encountered.

All ground water encountered during the excavation of the tunnel must be balanced by the tunneling machine.

Slurry tunneling systems shall use a minimum volume of water in the slurry system.

The tunneling system must be capable of maintaining line and grade to 1" plus or minus over the distance of the drive.

Equipment operators shall be fully trained in the use of the equipment. All equipment shall be remotely controlled. No persons shall be directly in the tunnel shield.

A written record of each drive is to be kept. This record will include, as a minimum, the jacking force and drive length of each individual drive. These records are to be made available to the Owner or his designated representative upon request.

332.01.03.02.05.02 Materials.

332.01.03.02.05.02.01 Pipe. Pipe used for slurry microtunneling shall conform to ASTM C1208 and be capable of withstanding all forces imposed upon them during the construction phase as well as the final in-place loading conditions. All pipe shall withstand a compressive loading greater than the jacking load. The maximum jacking force shall be shown on the Plans and/or specified in the Special Provisions and/or Special Technical Specifications, as calculated by the following equation:

$$0.06 \times \pi \times \text{OD (feet)} \times \text{longest drive length (feet)}$$

Pipe design shall include a minimum safety factor of 2.5.

The driving ends of the pipe and intermediate points must be protected against damage. The detailed method proposed to cushion and distribute the jacking force at the joint is subject to approval by the Engineer.

Any pipe showing signs of failure may be required to be jacked through to the reception shaft and removed. Other methods of pipe repair may be used subject to approval of the Engineer.

The pipe manufacturer shall be designated at the time of the bid. Any subsequent change of pipe manufacturer must be approved by the Engineer in writing.

332.01.03.02.05.02.02 Tunnel Shield and Cutting Head. The tunnel shields may be driven either electrically or hydraulically. The shield is articulated to enable steering of the system. Steering rams and valves are controlled by a low pressure power pack located in the shield or by other approved means.

The tunnel shield shall be full faced with the capability of supporting the face both during excavation and during shutdown. The shield shall have the ability to balance the earth/water pressure at the face, either by the use of compressed air or slurry. The tunnel shield, which is connected to, and followed by, the pipe being installed, shall ensure that the soils being excavated through are fully supported at all times (without the use of any ground stabilization, de-watering, or other support techniques).

When soil conditions dictate, the tunnel shield must be capable of removing cobbles and boulders. The excavation system shall be fully capable of excavating all material that it will encounter.

The tunnel shield must be capable of keeping drift and rotation or roll to a minimum. The tunnel shield shall be articulated and maneuvered by trunnion mounted steering jacks or other approved

method to enable accurate control of line and grade. Line and grade shall be controlled by a laser beam transmitted from the drive shaft along the centerline of the pipe to a target mounted in the shield. The position of the laser on the target shall be transmitted back to the operator either electrically or by a closed circuit television. The operator shall also have other information including, roll pitch, steering attitude and position of valves (either open or closed).

A variety of cutting heads (moles) are available to allow microtunneling through all soil types. While available geotechnical data will be supplied by the Owner, choice of cutting heads and resulting efficiency of the slurry microtunneling operation will be the Contractor's responsibility.

332.01.03.02.05.03 **Soil Transport System.** There are two three types of soil transport systems.

332.01.03.02.05.03.01 Auger System. The Auger System is designed to remove the excavated soil by auger to the jacking shaft, where it is removed by conventional means. This system controls the stability of the face of the excavation by metering the amount of material which enters the auger. In water bearing sands or under the water table, air is injected at the face of the excavation to help control the amount of material being removed.

332.01.03.02.05.03.02 Slurry System. The Slurry System must be able to match the excavated soil transportation speed to the excavation rate to achieve a minimum velocity to prevent settlement of solids in the slurry lines and to balance the ground water pressure. This is achieved by using variable speed pumps, pressure control valves and a flow meter. A slurry bypass unit is included in the system to allow the direction of flow to be changed or isolated as necessary. The final state of the slurry system is the separation equipment that removes the soil from the water. This may be either tanks or lagoons upon approval of the Engineer.

332.01.03.02.05.04 Jacking System. The main jacks are located in the drive shaft and must be able to successfully push the tunneling shield together with a string of connected pipes. The capacity of the jacks and the rate of extension are synchronized with the excavation rate of the shield, which is determined by the particular soil conditions.

The jacking system, including any intermediate jacks used, shall be capable of continuously monitoring the jacking pressure, the rate of advancement and the distance jacked.

The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe.

The equipment shall have the capability of limiting the jacking force applied to the pipe/tunnel shield so as not to exceed the maximum compressive loads allowed for the pipe.

A lubrication system shall be provided that injects an approved lubricant at the rear of the tunneling shield to lower the friction developed on the exterior of the pipe during jacking.

The thrust reaction backstop shall be properly designed and constructed. The backstop shall be normal to the proposed pipe alignment. The thrust wall shall be designed to support the maximum obtainable jacking pressure developed by the main jacking system. Special care shall be taken when setting the pipe guide rails in the starter shaft to ensure correctness of the alignment, grade, and stability. The shield is not to be jacked until the PCC thrust block (if selected) and the treated soil zone (if required) in the driving shaft have attained their required strength.

The pipe shall be jacked in place without damaging the pipe joints or completed pipe section. Any pipe which has been damaged during installation shall be replaced by the Contractor.

332.01.03.02.05.05 Controls. The control equipment integrates the system of excavation and removal of soil and its simultaneous replacement by a pipe. As each pipe section is jacked forward, the control system synchronizes all of the operational functions to maintain the system in balance in such a way as to provide complete ground support at all times.

The system shall be laser controlled and monitored by the operator at all times. All functions of the system shall be monitored and transmitted to the remote operations console. The minimum information available to the operator on the consoles shall include rate of advance, length of conduit installed, thrust force, deviation from line and grade, role, inclination and valve positions.

332.01.03.02.05.06 Drive and Reception Shafts. Shafts shall be of the minimum size possible, commensurate with safe working practices, and be located as shown on the Plans. The maximum diameter for small diameter pipe jacking shafts shall be eight feet (8') or less, with an inside diameter no greater than 18 inches. For larger diameter pipes, the maximum size jacking shaft shall be fourteen and one half feet (14.5') or less, with an inside diameter greater than 18 inches. Other diameter jacking and receiving shafts may be used upon approval of the Engineer. Where no shaft locations are shown on the Plans, the Contractor shall determine the locations of the shafts with the approval of the Engineer. Shaft locations shall, where possible, be kept clear of all intersections and be contained within a single lane of traffic in order to minimize the disruption to the flow of traffic. The contractor shall furnish and install all pump and related equipment to keep the jacking shaft free of water. The design of the shafts shall ensure safe exit from the driving shaft and entry into the receiving shaft. Shoring of the shaft shall extend above grade or a railing shall be provided at all shaft locations. Design of shafts shall provide sufficient backstop capacity to resist forces developed by the thrust jacks.

Shoring for driving and receiving shafts shall be installed tight against the excavated walls in an effort to prevent loss of soil/pipe support during launch and reception. Removal of shoring must be accomplished without disturbing line or grade of the installed pipe.

Installed pipes in the shaft must be properly bedded prior to backfill. See the Plans for proper bedding detail at shaft locations.

The distance between the shafts is a function of the pipe size, depth of cover, and soil condition. The slurry microtunneling equipment manufacturer shall be consulted when determining the distances between the shafts.

Shafts and jacking pits shall be adequately ventilated. Air monitoring of the shafts or pits shall be conducted on a continuous basis. Threshold limits of the gas concentrations monitored shall be:

| Gas | Concentration (Percent) |
|------------------|-------------------------|
| Carbon Monoxide | 0.005 Maximum |
| Methane | 0.250 Maximum |
| Hydrogen Sulfide | 0.001 Maximum |
| Oxygen | 20.00 Minimum |

All jacking shaft and receiving shaft sizes and configurations shall be specified at the time of the bid. Any subsequent changes to shaft size or configuration must be approved in writing by the Engineer.

332.01.03.02.07 Vacuum Microtunneling.

332.01.03.02.08 Manhole CIPM Lining This subsection covers the rehabilitation of sanitary sewer manholes, as authorized by the ENGINEER, using cured-in-place manhole (CIPM) liners, quality control, and assurance testing. Manhole CIPM lining is an alternative to Manhole Preformed Structural Liners.

332.01.03.02.08.01 General. Manhole lining work will take place after all CIPP work in pipelines. Omission of a specific item or component obviously necessary for the proper installation and functioning of the rehabilitation system shall not relieve the CONTRACTOR from the responsibility of supplying that specific item or component at no additional cost to the OWNER.

The lining system shall be applied by an Installer certified by the lining system manufacturer, including annual renewal. The training outline for the certification program shall be submitted to the ENGINEER for review. The CONTRACTOR shall provide evidence that the personnel performing the product installation for each project received the manufacturer's training for certification.

Liner failure is defined as blistering, cracking, embrittlement, softening or failure to adhere to the substrate.

332.01.03.02.08.02 Materials. The products furnished under this section will be installed in sanitary sewer manholes and will be exposed to the extremes in temperatures and humidity. In addition, the products will be exposed to corrosive, abrasive and reactive liquids and gasses

associated with wastewater conveyance and treatment. The products will be immersed in wastewater and the product surfaces are subject to splashing of wastewater. Material must be able to withstand the environment into which it will be placed in service

CONTRACTOR shall exercise adequate care during transportation, handling and installation to ensure the liner material is not damaged. If any part or parts of the material becomes damaged before or during insertion, it shall be repaired or replaced at the CONTRACTOR's expense in accordance with the manufacturer's recommendations and approval by the Engineer before proceeding further.

Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat and cold. Flammable materials shall be stored in accordance with state and local codes. The ENGINEER shall reject materials exceeding the storage life recommended by the manufacturer and they shall be removed from the site and replaced at no additional cost to the Agency.

332.01.03.02.08.02.01 CIPM Liner The minimum allowable CIPM shall be composed of a multi-layered composite system meeting the requirements of Table 1 below. The CIPM system will incorporate layer(s) of structural fiberglass impregnated with modified epoxy resins and bonded to the existing substructure and a layer of non-porous PVC or membrane of special synthetic materials bonded together to protect the manhole from corrosion. There is no minimum or maximum manhole depth limit on this liner.

**TABLE 1.
TEST PROPERTY VALUES**

| ASTM D 695 | |
|--|---------------------------|
| Compressive Strength | 10,000 psi |
| Compressive Modulus | 1,000,000 psi |
| ASTM D 638 | |
| Tensile Strength | 11,500 psi |
| Tensile Modulus | 1,050,000 psi |
| ASTM D 2240 | |
| Minimum Uncured Liner Weight | 78 ounces per square yard |
| Minimum Field Cured Thickness ¹ | 0.122 inches |
| Epoxy Bond Strength | |
| Hardness | 82 shore D |
| Epoxy Bond Strength | 7,000 lbs |

¹ See paragraph 2.01.B for additional thickness requirement.

The CONTRACTOR shall assume external hydrostatic pressure on all manholes of 10 feet or the depth from the manhole invert to finished grade, whichever is less, and will include this measurement in determining liner thickness. In no cases shall liner be thinner than minimum field cured thickness required in Table 1. Calculations shall be stamped by a third-party Nevada Registered Engineer.

The design guide above is intended as a general manhole liner design guide and is not intended to limit the manufacturer's and authorized installer's judgment to use a heavier liner in determining the appropriate thickness and type of liners for individual structures based on the specific conditions encountered in each structure as authorized by the ENGINEER. Any variation of the above described liner type must be approved by the ENGINEER before Installer orders any material. Manufacturer or authorized installer shall not affect warranty requirement by using a thicker liner.

The liner shall be flexible, and have an elongation sufficient to bridge up to a 1/4- inch settling crack, without damage to the lining. The liner shall be able to bridge expansion cracks that may occur during its warranted life.

The CIPM liner must be impervious and without holes that will allow hidden corrosion on the concrete behind the liner, which can cause the eventual failure of the liner and the manhole.

The CIPM liner system shall be applied by a qualified, licensed applicator/installer trained in handling and application of the materials and experienced with sizing CIPM liners to custom fit the manhole.

Each liner shall be labeled by the liner manufacturer with the location of the liner manufacturer, name of the project, liner diameter, liner length, and the location where liner is to be installed.

Approved manufacturers:

1. Multiplexx Liner System, PVCP
2. Poly-Triplex Liner System, PTLS
3. Or equal.

332.01.03.02.08.02.02 Patching Material A premixed, nonshrink, cement-based patching material consisting of hydraulic cement and graded silica aggregates, with special plasticizing and accelerating agents. Material shall be suitable for vertical or overhead use.

The premixed material shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents. Material shall not promote corrosion of steel.

Set time as per ASTM C191 shall be less than 30 minutes. One hour compressive strength as per ASTM C190 shall be a minimum of 2,000 psi. The ultimate strength as per ASTM C109 shall be a minimum of 5,000 psi. Bond strengths as per ASTM C882, modified, shall be a minimum of 1,700 psi.

Approved manufacturers:

1. Quadex Aluminaliner;
2. Fosroc PRECO Patch;
3. Or equal

332.01.03.02.08.03 Construction Temporary bypass pumping and flow control as specified in Section xxxx.

332.01.03.02.08.03.01 Manhole Preparation CONTRACTOR shall clean manhole prior to lining as specified in Section 02562. The ENGINEER will inspect and approve the cleaning and preparation prior to any subsequent work.

The CONTRACTOR shall examine all surfaces to be lined or coated and shall correct all surface defects as specified in paragraph 3.03 before installing any lining.

CONTRACTOR shall notify the ENGINEER immediately of any noticeable disparity in the surface of the manhole that may interfere with the proper installation of the lining systems.

All surface defects that interfere with the application of the lining system shall be repaired including tie holds and honeycombing or otherwise defective concrete. All voids, holes, and rough or irregular surfaces shall be filled after cleaning.

All active hydrostatic water leakage shall be stopped in accordance with manufacturer's instruction.

The CONTRACTOR shall remove the existing manhole steps. The metal portion of all steps will be removed to 1/2-inch below the manhole wall surface, and any holes are to be patched flush prior to applying the CIPM liner system. The final coated surface shall have a smooth uniform appearance with no discoloration.

Prior to patching severe defects in the manhole, all loose and deteriorated material shall be removed and disposed of by the CONTRACTOR.

Patches shall be allowed to cure according to the manufacturer's specifications before continuing with the CIPM manhole rehabilitation process.

All incoming laterals and sewer main line openings shall be properly trimmed and patched. Patching shall provide a smooth transition for the liner connection to the pipe openings.

The bench areas shall be repaired as approved by the ENGINEER. Shelves and walls shall be repaired or refinished as appropriate patching material. The prepared surface of the shelves shall be smooth and sloped to allow for all bench areas to drain to the pipe invert.

If any barrel, cone, or cone/frame joints are not sealed, apply sealing system compatible with the liner system prior to lining to provide watertight seal.

332.01.03.02.08.03.02 CIPM Liner Installation The CONTRACTOR shall install the CIPM liner only in manholes designated for rehabilitation as shown on the Drawings.

CONTRACTOR's attention is drawn to the top limit of the liner that ends just below the bearing surface of the frame. Under no circumstances is the liner to touch the manhole cover and bear loads.

Liner material and components shall have been custom fabricated to fit the specific configuration of each structure. The CIPM lining of the structure shall result in a monolithic structure, bonded to the contours of the existing manhole structure. The liner shall be adequately bonded to the interior structure surface and be completely water tight from top (just below bearing surface of the frame) to the transition area where the shelf and invert channel connect, including sealing the manhole wall and shelf areas.

The CIPM lining of the structure shall result in a monolithic structure, bonded to the contours of the existing manhole structure. The liner shall be adequately bonded to the interior structure surface, and be completely water tight from the ring and cover area to the transition area where the shelf and invert channel connects, including completely sealing the manhole wall and shelf areas to the inlet and outlet pipes.

The installation of the approved CIPM liner system shall be in strict accordance with the manufacturer's written instructions. The work shall include sealing all inlet and outlet lines and benches, as needed, including all preparation, installation, curing and finish operations for the complete rehabilitation process. The curing process shall be completed within four hours of the time bypass pumping or inlet line plugging begins. Inlet and outlet lines must be reopened within one hour from the time the curing process is completed.

Linings shall be sealed to match CIPP in manhole if visible gaps are present. When lining deep manholes or where there is no CIPP in structure, lining should be installed to concrete channel and epoxy coating applied to all remaining exposed concrete in the manhole.

It shall be the responsibility of the CONTRACTOR to make sure that the CIPM liner completely seals the manhole, shelf, pipe inlet and outlets, and the lid ring frame in a monolithic method, as required, or as shown on the Drawings, and that no holes, cracks or seams in the liner are left unsealed, which would allow gases or fluids to flow behind the CIPM Liner.

A Manufacturer's Representative must be present during the first 25 percent of installations for the project or as deemed necessary by the ENGINEER

332.01.03.02.08.04 Submittals. The Contractor shall submit

Certificate of responsibility attesting that the CONTRACTOR has assigned and that the Installer accepts responsibility for installation of the CIPM lining system specified herein.

Manufacturer's certification attesting that the Installer is qualified and approved to install the products specified herein.

Training outline for the certification program.

Lining System Installation Plan. The Lining System Installation Plan shall be prepared that includes a description of the following:

1. Quality Assurance Procedures:
 - a. Detailed duties of the Installer's Quality Assurance Manager;
 - b. Detailed duties of the Manufacturer's Representative;
 - c. Training program to qualify personnel in the correct storage and handling of materials and the necessary safety requirements;
 - d. List of installation and testing equipment to be used, including inspections confirming satisfactory condition of equipment;
2. Criteria for acceptance of the preparation of manhole surfaces;
3. Method and material for sealing active leaks;
4. Detailed plan of surface preparation, including repair and reprofiling;
5. Details of installation, including required curing times;
6. Detailed environmental provisions such as shading from the sun;
7. Detailed scheduling provisions for environmental considerations such as working at night;
8. Testing procedures.

Name and address of third-party testing facility for CIPM liner testing. Manufacturer written warranties for all materials furnished under this section. Shop drawings that detail short- and long-term properties of all component liner materials. The Manufacturer shall submit the results of third-party testing to the ENGINEER of the same material composition(s) proposed for the project for the tests listed below.

1. Chemical Resistance Testing: The chemical resistance tests should be completed in accordance with ASTM D 543. Exposure shall be for a minimum of one month in each of the following fluids at 73.4°F. Concentrations given are percent weight:

| Chemical Solution | Concentration (Percent) |
|--------------------|-------------------------|
| Tap Water (pH 6-9) | 100 |
| Nitric Acid | 5 |
| Phosphoric Acid | 10 |
| Sulfuric Acid | 10 |
| Sodium Hydroxide | 10 |
| Gasoline | 100 |
| Vegetable Oil | 100 |
| Detergent | 0.1 |
| Soap | 0.1 |

2. After exposure to the solutions, specimens shall not exhibit any weight loss, spalling, cracking or blistering. Any changes to appearances such as color and texture shall be noted.
3. During this period, the CIPM test specimens should lose no more than 20 percent of their initial flexural strength and flexural modulus when tested in accordance with ASTM D 0790. Any changes to appearances such as color and texture shall be noted.

| Test Property | Test Method | Min. Test Value |
|-------------------|-------------|-----------------|
| Flexural Strength | ASTM D 0790 | 25,000 psi |
| Flexural Modulus | ASTM D 0790 | 1,000,000 psi |

Manufacturer's specification for liner systems containing instructions and quality control procedures meeting the following requirements:

1. Instruction must be written and published by the manufacturer for the purpose of giving complete instruction for the use and installation of the proposed linings for the conditions for which the lining is specified herein;
2. Instructions shall include at a minimum: recommendations for material storage, storage life, temperature control, material handling, installation, curing, finishing, surface preparation (including repairs and re-profiling), curing times between coats or applications, curing methods, special equipment, and design lining composite cured thickness;
3. Limitation, exceptions, precautions, and requirements that may adversely affect the performance of the lining shall be clearly and completely stated in the instructions.
4. Identification of any manufacturer's requirements that differ from these Specifications - the instructions shall clearly state where deviations are required.
5. Ambient temperature limitations for minimum and maximum conditions are to be included.

Material Safety Data Sheets (MSDS) for all products used in the lining system.

Certification and qualifications for testing for holidays and other discontinuities.

Schedule of manholes and CIPM liner thickness for each manhole. CONTRACTOR may submit alternate thicknesses to the ENGINEER for approval from those included in the Bid as per the manufacturer's recommendations prior to ordering any material.

Installed and cured liner test results meeting the requirements listed in this section.

Sewage diversion, if required, is submitted under Section 02550.

332.01.03.02.09 Manhole Preformed Structural Liner This section specifies the requirements for rehabilitating manholes with a preformed glass-fiber reinforced polyester structural liner. This product may be used as an alternate to the CIPM liner system as specified in Section 332.01.03.02.08

332.01.03.02.09.01 General. Furnish all labor, materials, equipment, and incidentals required to supply and install a preformed structural liner as specified herein.

Omission of a specific item or component obviously necessary for the proper installation and functioning of the manhole preformed structural liner system shall not relieve the CONTRACTOR from the responsibility of supplying that specific item or component at no additional cost to the OWNER.

The liner system shall be applied by an Installer certified by the Preformed Liner System manufacturer. The training outline for the certification program shall be submitted to the ENGINEER for review. The CONTRACTOR shall provide evidence that the personnel performing the product installation for each project received the manufacturer's training for certification.

Dimensions: The preformed structural liner shall be a circular cylinder, reduced at the top to a concentric circular manway not smaller than 22-inch inside diameter.

Liners shall be produced in whole foot increments of length +/- 2". Nominal inside diameters shall be 42-inch for 48-inch manholes 54-inch for 60-inch manholes, and 66-inch for 72-inch manholes. Tolerance on the inside diameter shall be +/- 2".

Configuration: The concentric manway reducer must provide a bearing surface on which polyester leveling rings and standard ring and cover may be supported and adjusted to grade. There shall be a lip inside or outside the bearing surface that fits the leveling rings and/or frame to prevent the leveling rings and/or frame from sliding sideways. The reducer shall be concentric and shall be joined to the barrel section at the factory with resin and glass fiber reinforcement, thus providing the required monolithic design.

Load Rating: The preformed liner shall be manufactured in one class of load rating. This class shall be AASHTO H-20 wheel load (minimum 16,000 pounds dynamic wheel load).

Marking and identification: All preformed liner shall be marked in letters no less than 1-inch in height with the following information:

1. Manufacturers identification.
2. Manufacturers serial number.
3. Preformed liner length.

Approved Manufacturers:

1. Sewer Shield Composite FWCI;
2. Containment Solutions;
3. Or approved equal.

Preformed liner cylinder, manway reducers, connectors, and leveling rings shall be produced from glass-fiber reinforced polyester resin.

Preformed Liner Reducer: Preformed liner reducers shall be concentric with respect to the larger portion of the preformed liner diameter.

Cover Ring and Support: The preformed liner shall provide an area from which a typical ring and cover can be supported without damage to the reinforced polyester liner.

Assembly Joints: Product components, i.e., cylinders, reducers, bottoms, and connectors, may be joined together to form a complete manhole liner.

Exterior Surface: The exterior surface shall be relatively smooth with no sharp projections. The exterior surface shall be free of blisters larger than 0.5-inch in diameter, delamination and no fibers shall be visible.

Interior Surface: The interior surfaces shall be resin rich with no exposed fibers. Interior surface shall be smooth. The surface shall be free of crazing, delamination, blisters larger than 0.5-inch in diameter, and wrinkles of 0.125-inch or greater in depth.

The preformed liner cylinder shall have the following minimum pipe-stiffness values when tested in accordance with ASTM 3753, Section 8.5 (Note 1).

| Manhole Length (ft) | psi |
|---------------------|------|
| 3 – 6 | 0.72 |
| 7 – 12 | 1.26 |
| 3 – 20 | 2.01 |
| 21 – 25 | 3.02 |
| 26 – 35 | 5.24 |

Thickness: Minimum of $\frac{3}{4}$ -inch thickness and maximum as needed to meet loading requirements at site.

Soundness: An air or water test shall be applied to the preformed liner test sample. While holding the pressure between 3-5 psi, the entire preformed liner must be inspected for leaks. Any leakage through the laminate is cause for failure of the test. Refer to ASTM 3753, Sec. 8.6.

Physical Properties:

| | |
|---------------------------------|-------------------------------|
| Flexural Strength: | Hoop: 4.5×10^3 psi |
| | Axial: 4.5×10^3 psi |
| Flexural Modulus of Elasticity: | Hoop: 1.4×10^6 psi |
| | Axial: 0.7×10^6 psi |
| Compressive Strength: | Hoop: 16.0×10^3 psi |
| | Axial: 10.0×10^3 psi |

The Manufacturer shall submit the result of the third-party testing to the ENGINEER.

The preformed liner shall meet the minimum chemical resistance requirements listed below. The Manufacturer shall submit the results of the Third-Party testing to the ENGINEER for test listed in paragraph B. Samples for testing shall be of materials identical to that proposed for actual construction.

Chemical resistance tests shall be completed in accordance with ASTM Test Method D 543 with the chemical solutions shown in Table 9.1. Exposure shall be for a minimum of one month at 73.4°F (23°C). During this period, the test specimens shall lose no more than 20% of their initial flexural strength and initial flexural modulus of elasticity.

Minimum Chemical Resistance Requirements

| Chemical Solution | Concentration, % |
|--------------------|------------------|
| Tap water (pH 6-9) | 100 |
| Nitric acid | 5 |
| Phosphoric acid | 10 |
| Sulfuric acid | 20 |
| Gasoline | 100 |
| Vegetable oil | 100 |
| Detergent | 0.1 |
| Soap | 0.1 |

332.01.03.02.09.02 Materials

Resin: The resins used shall be unsaturated, supplier certified, isophthalic polyester resins. Mixing lots of resin from different manufacturers, or "odd-lotting" of resins shall not be permitted. Quality-assurance records on the resin shall be maintained. Non-pigmented resin is required to allow for light or "sand" color of manhole surface. UV Inhibitors shall be added directly to resins. Exterior gel-coating shall not be permitted.

Reinforcing Materials: The reinforcing materials shall be commercial grade "E" type glass in the form of mat, continuous roving, chopped roving, roving fabric, or both, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

Surfacing Material: Shall be commercial grade chemical-resistant glass or organic surfacing mat having a coupling agent that will provide a suitable bond with the resin.

Fillers and Additives: Fillers, shall be inert to the environment and manhole construction, additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard. Calcium carbonate mixed by the fabricator shall not be permitted.

Laminate: Laminate shall consist of multiple layers of glass matting and resin. The surface exposed to the sewer/chemical environment shall be resin rich and shall have no exposed fibers.

Patching Material: A premixed, nonshrink, cement-based patching material consisting of hydraulic cement and graded silica aggregates, with special plasticizing and accelerating agents. Material shall be suitable for vertical or overhead use.

The premixed material shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents. Material shall not promote corrosion of steel.

Set time as per ASTM C191 shall be less than 30 minutes. One hour compressive strength as per ASTM C190 shall be a minimum of 2,000 psi. The ultimate strength as per ASTM C109 shall be a minimum of 5,000 psi. Bond strengths as per ASTM C882, modified, shall be a minimum of 1,700 psi.

Manufacturers:

1. IPA Systems, Octoconcrete, Philadelphia, PA
2. Fosroc PRECO Patch, Plainview, NY
3. Or equal.

332.01.03.02.09.02.01 Flowable Grout Chemical-resistant, hydrophobic, non-shrink, fast-setting, grouting material designed for unlimited pour depths, providing high flowability, good adhesion to concrete, and resists degradation by corrosive environment.

Compressive Strength: Achieve initial set within 6 hours and reach a minimum of 3,000 psi in 28 days when tested in accordance with ASTM C109.

Density: 56 to 58 pounds per cubic foot

Materials: Type V Portland Cement, and additives as required to meet this Specification.

332.01.03.02.09.03 Construction Do not drop or impact the preformed liner. Lift preformed liner with two slings or spreader bar in horizontal position or by use of 4" x 4" timber inserted crosswise inside the preformed liner to the underside of the collar with a chain attached to backhoe or other lifting device. Preformed liner may be rolled, however, insure that ground is smooth and free of rocks, debris, etc. Use of chains or cables in contact with preformed liner surface is prohibited

332.01.03.02.09.03.01 Lining System Installation Plan A Lining System Installation Plan shall be prepared that includes a description of the following:

1. Quality Assurance Procedures:
 - a. Duties of the Installer's Quality Assurance Manager;
 - b. Duties of the Manufacturer's Representative;
 - c. List of installation and testing equipment to be used, including inspections confirming satisfactory condition of equipment;
2. Criteria for acceptance of the preparation of manhole surfaces;
3. Plan for sewage diversion, if required;
4. Method and material for sealing active leaks;
5. Detailed plan of surface preparation;
6. Details of installation of the liner;
7. Detailed environment provisions;
8. Detailed scheduling provisions for environment considerations such as working at night;
9. Testing procedures.

332.01.03.02.09.03.02 Manhole Preparation and Installation Removal of Existing Steps: The CONTRACTOR shall remove the existing manhole steps. The metal portion of all steps will be removed to ½-inch below the manhole wall surface, and any holes are to be patched flush prior to applying the liner system. The final coated surface shall have a smooth uniform appearance with no discoloration.

Prepare Excavation: Excavate a square area around the top of the existing manhole and remove existing frame and cover, riser, and cone section. Align excavation with direction of the road and limit excavation to no more than 1-foot greater than barrel diameter along any one side.

Hydrostatic Leakage: All active hydrostatic water leakage shall be stopped in accordance with manufacturer's instruction.

Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the liner to be applied.

Preparation of Bench Area: Prior to patching severe defects in the manhole bench area, all loose and deteriorated material shall be removed and disposed of by the CONTRACTOR. The bench areas shall be repaired as approved by the ENGINEER. The installation shall be as specified in the installer's submittal. The prepared surface of the shelves shall be smooth and shall be sloped to allow for all bench areas to drain to the invert.

Debris from cleaning operations shall be collected within the manhole and disposed of at an approved off-site location. Hauling containers shall be watertight.

Manhole preformed liner installation shall follow the manufacturer's recommended procedures.

Preformed Liner Preparation: Cut bottom of the preformed liner to fit existing manhole invert as closely as possible. Make cutouts in rehabilitation manhole wall to accommodate existing inlets, drops and cleanouts.

Set Preformed Liner: Lower preformed liner into existing manhole and quick-setting grout mixture. The installer should place a 4-inch height of quick-setting grout above the initial bottom seal.

Liner Grouting: Fill the annular space between the preformed liner and the existing manhole with flowable grout. The grout mixture shall be poured in layers of not more than 12-inches in even lifts.

Lateral Restoration: All incoming laterals and sewer main line openings shall be properly trimmed and grouted with hydraulic or Portland Type V cement forming a fillet between the preformed liner and each pipe.

Repair of Shelves and Walls: Shelves and walls shall be repaired or refinished, if required, using chemical grout, hydraulic cement or Portland Type V cement.

Flowable backfill: Flowable backfill shall be placed evenly around any exposed portions of the manholes as specified in Section 02300.

Bring to Grade: Install frame and cover on flat shoulder of preformed liner using polyester leveling rings.

It shall be the responsibility of the CONTRACTOR to make sure that the preformed liner completely seals the manhole as required, and that no holes or cracks in the liner are left unsealed, which would allow gases or fluids to flow behind the preformed liner.

Surface Restoration: Provide 8-inch concrete collar to finish grade. Provide #4 reinforcement at 12-inch on center at center of concrete collar. Comply with drawing detail.

332.01.03.02.09.04 Submittals Shop drawings and equipment data: Product data and details of preformed structural liner conforming to the specified requirements.

The third-party test report, accompanied by a copy for the test results, that the preformed liner has been sampled, tested, and inspected in accordance with the provisions of ASTM 3753 and this specification, and meets all requirements. In case of conflicting requirements between this specification and ASTM 3753, this specification will govern.

The CONTRACTOR shall submit details showing how manhole benches shall be repaired to assure watertight seal with the preformed structural liner.

AASHTO H20 – Loading Results from a third-party independent testing facility for the design of structures located within roads based on designs expected for this project.

The CONTRACTOR shall submit written warranties as required herein. Manufacturer's Certification attesting that the Installer is qualified and approved to install the products specified herein.

Lining System Installation Plan as described in paragraph 1.07.

Manufacturer's specification containing instructions and quality control procedures meeting the following requirements.

Instructions must be written and published by the manufacturer for the purpose of giving complete instruction for the use and installation of the proposed liner for the conditions for which the liner is specified herein.

Instructions shall include at a minimum; surface preparation and special equipment.

Limitations, exceptions, precautions, and requirements that may adversely affect the performance of the lining shall be clearly and completely stated in the instructions. If the manufacturer's requirements differ from these Specifications, the instructions shall clearly state where deviations are required.

332.01.03.03 Bypass Pumping Contractor shall provide labor, materials, and supervision to temporarily bypass flow around the construction work in accordance with these Specifications.

Sanitary sewer mains shall remain in service at all times throughout the duration of the project. Contractor shall be responsible for diverting flow away from the limits of construction through the use of bypass pumping or flow diversions with prior approval by the Engineer.

Service to laterals shall be disrupted for a period of no more than 8 hours. Laterals within residential areas shall only be out of service between the hours of 8:00 am to 5:00 pm, Monday through Friday. Laterals within business areas shall be addressed on a case by case basis. If Contractor feels that it is necessary to disrupt lateral services for a period longer than 8 hours, Contractor shall provide alternate means of service without disrupting use of the service by the owner/resident.

The contractor may use ramps to cross streets, but must maintain two (2) lanes of traffic in each direction at all times during the Project. Contractor must provide and maintain lighting to illuminate the ramps at night and provide approved traffic control plans to safely direct traffic over the ramps.

No streets can be cut without permit.

Contractor shall maintain pedestrian and vehicular traffic and comply with ADA regulations for access to all residential and commercial property unless written approval is otherwise obtained from the property owner allowing for reduced access.

332.01.03.03.01 THE BYPASS PUMPING SYSTEM DESIGN CRITERIA

1. Discharge manifolds are acceptable
2. Intake manifolds are not acceptable
3. Use separate intakes for each pump with debris control
4. Aluminum pipe is unacceptable
5. Suction lines shall be steel reinforced pipe or better
6. Provide adequate intake line spacing (center to center) to avoid vortexing
7. Provide complete startup to shutdown full time monitoring of the pipeline and pumping installation
8. Provide a float switch, battery operated high level alarm with notification to cell phones and warning light
9. Provide redundant air release valves
10. Provide multiple fuel tanks with 24 hours of fuel supply
11. Protect discharge piping from vandalism and vehicular damage
12. Odor control will be as required

332.01.03.03.02 BYPASS PUMPING REQUIREMENTS Bypass routing shall be the responsibility of the Contractor. See sub-section XXXXX below for additional information.

Two different bypass pumping system criteria have been identified for this project. These criteria are identified below. Projects that are in environmentally sensitive areas or that have a high sewage flows will require one or more of these criteria as specified herein.

Criterion 1 Bypass Pumping System with flows equal to or less than 2.5 MGD (1735 GPM)

Contractor shall maintain on site, the following minimum requirements for all bypass pumping systems:

1. Sufficient equipment and materials to ensure continuous and successful operation of the bypass and dewatering systems. The COMPLETE bypass system, including all piping, shall be continuously monitored by Contractor personnel.
2. A system of pumps and piping operating on site to maintain a minimum 50% over capacity of the anticipated maximum flow (as determined by the Contractor). In addition, the Contractor shall have a standby pump, equal in capacity to the largest pump in the system, piped, plumbed and ready for operation. Standby pumps shall be fueled and operational at all times.
3. The Contractor shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, sewer plugs, piping, hoses and other parts of system hardware to ensure immediate repair or modification of any part of the system as necessary.

Criterion 2 Bypass Pumping System with flows greater than 2.5 MGD (1735 GPM)

In addition to the requirements identified under Criterion 1, Contractor shall design construct, operate and maintain the bypass system specified herein:

1. All bypass piping shall be fused HDPE piping.
2. The bypass piping system shall include multiple pipelines to convey 150% of the maximum anticipated flow (as determined by the Contractor). A minimum of one additional (spare) pipeline will be constructed and plumbed for immediate operation that is equal in diameter to the largest pipe size in use for the bypass setup. All other requirements shall be the same as identified under Criterion 1 of these specifications.

In areas where bypass piping crosses major streets, pipe must be laid in trench and backfilled with temporary trench patch. Ramps shall only be installed in locations approved by Engineer.

Contractor shall have the entire bypassing system in place and successfully tested for leaks before bypassing any sewage.

Prior to breaking down bypass ramps and/or hard piping, Contractor shall flush with potable water. Once flushed, hard piping shall be pigged using air to remove water.

1. The Contractor shall notify the Engineer 48 hours prior to commencing or shutting down any bypassing pumping operations.

Contractor shall repair, without cost to the City and/or private property owner, any damage that may result from their negligence, inadequate or improper installation, maintenance and operation of bypassing system, including mechanical or electrical failures. Contractor shall be responsible for immediate and proper cleanup should any spill occur, regardless of amount.

Engines shall be equipped with mufflers and/or plywood/Styrofoam noise panels enclosing the engines to keep the noise level within limits specified in local codes and ordinances.

All contacts between Owner's Maintenance Personnel and the Contractor on any sanitary sewer/storm drain matters shall be directed through the Engineer.

332.01.03.03.03 SUBMITTALS The Contractor shall submit, in accordance with Section XXXXX, of the Specifications, Contract Plans and complete design data showing methods and equipment proposed to be utilized in sewer bypassing for approval at the Pre-Construction Meeting. The submittal shall include the following information:

Written documentation indicating the scheme including location of pumps, temporary sewer plugs, bypass discharge lines, ramps, and lighting for ramps. The Submittal shall describe the method and location for draining the bypass pipelines upon completion of the work.

1. Capacities of pumps, prime movers, and standby equipment.
2. Design calculations proving adequacy of the system and selected equipment.
3. Standby power source.
4. Staffing plan.
5. Show suction and discharge points with elevations & stationing on the Contract Plans.
6. Provide pump performance curves.
7. Submit calculations to verify suction lift of pumps has not been exceeded.
8. Contractor shall submit proposed noise control and exhaust control plans for pumping equipment.
9. Contractor shall submit a proposed plan for disruption of sewer service laterals.

The actual design of the bypass arrangement shall be prepared by the Contractor or Subcontractor performing the work, and shall be submitted to the Engineer to determine conformance to project objectives. The Contractor shall be responsible for any Subcontractors design (if used) on this project. Means and methods of accomplishing the bypassing shall be the responsibility of the Contractor.

Approval of submitted plans for sewer connection and temporary rerouting shall in no way relieve the Contractor of their responsibility for the protection of adjacent properties, downstream drainage systems and water tributaries against sewage spill. Any litigation, claims, fines, etc. associated with any sewage spill shall be the responsibility of the Contractor.

332.01.03.03.04 PROTECTION All bypass flows shall be discharged as approved by the Engineer. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.

All pumps, generators, and other equipment shall be placed on new plastic tarps to protect against gasoline, oil, and hydraulic fluid spills. Spills and leaks shall be cleaned up immediately.

332.01.03.03.05 SCHEDULING The bypassing system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer. Contractor or Subcontractor responsible for bypass pumping shall have a representative on site to maintain and monitor the bypass pumping system until the bypassing of that specific pipeline is no longer required.

332.01.03.03.06 FLOW CONDITIONS The Contractor is responsible for obtaining current flow condition information at the time of construction. The City is not responsible for any deviations in quantity of sewage flow at any time during the construction period. Higher flows may be encountered depending on weather and other upstream conditions.

333.01 GENERAL.

333.01.01 DESCRIPTION. This Section covers the furnishing and planting trees, shrubs, and ground cover.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

333.01.01.01 Definitions. Whenever the following terms are used in this Section, the intent and meaning shall be defined as follows:

333.01.01.01.01 Abbreviations and Codes. Abbreviations shall be defined in accordance with Subsection 100.01.01.01 – “Abbreviations and Codes”.

333.01.01.01.02 Specifications. Specifications shall be defined in accordance with Subsection 100.01.29 – “Specifications”.

333.01.01.01.03 Landscape Architect. Landscape Architect shall be defined as a person licensed to practice landscape architecture in the State of Nevada, or the Owner's representative.

333.01.01.01.04 Nomenclature. Nomenclature for plant names and varieties shall be defined in accordance with the latest edition of “Standardized Plant Names” – as prepared by the American Joint Committee on Horticultural Nomenclature.

333.01.01.01.05 Plant Material Classification. Plant materials classifications shall be defined as follows:

333.01.01.01.05.01 Plants, Group A. Plants, Group A, shall be defined as canned plant material.

333.01.01.01.05.02 Plants, Group B. Plants, Group B, shall be defined as balled and burlapped plant material.

333.01.01.01.05.03 Plants, Group C. Plants, Group C, shall be defined as ground cover.

333.01.01.01.05.04 Plants, Group D. Plants, Group D, shall be defined as grass (turf).

333.01.01.01.05.05 Plants, Group E. Plants, Group E, shall be defined as grass (meadow).

333.01.02 DESIGN.

333.01.03 SAFETY. The Contractor shall be responsible for safety in accordance with Subsection 100.33.04 – “Safety”.

333.02 MATERIALS. The plant materials used shall be true to type or name as shown on the Plans and shall conform to the American Standard for Nursery Stock. No. 1 grade American Association of Nurserymen, Inc., latest edition, ASA Spec. Z 60.1. All plants shall be well-formed and shaped, free from disease, insects, and defects such as knots, sun-scald, windburn, injuries, abrasions, or disfigurements.

All plants shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations.

333.02.01 INSPECTION OF MATERIALS. The Contractor shall accommodate inspection of the materials in accordance with Subsections 100.16.03 – “Inspection Facilities” and the applicable subsections of Section 336 – “Inspection and Testing”.

333.02.02 CARE OF MATERIALS.

333.02.02.01 Handling and Shipping. Plants shall be packed for shipment according to standard practice for the type of plant being shipped. The root system of all plants shall not be permitted to dry out at any time. Plants shall be protected at all times against heat and freezing temperature, sun, wind, climatic, or seasonal conditions during transit. All plants balled and burlapped (B&B) shall at all times be handled by the ball of earth and not the plant. Broken or “make” balls will not be accepted. Container grown plants

shall be well developed with sufficient root development to hold the earth intact after removal from the container without being root bound.

All Group A-1, A-5, and A-15 plants are to be hardened material. This is to be accomplished by storing all plants in the immediate area of planting for a period of not less than 3 weeks prior to planting. Plants shall be stored in a licensed commercial nursery, or the Contractor may provide equivalent storage and care with written approval of the Engineer.

Prior to moving plants from nursery or storage area to job site, they shall be thoroughly sprayed with a solution of anti-desiccant/anti-transparent which will meet the requirements set forth in the Special Provisions or as directed by the Landscape Architect.

Packaged seed material shall be delivered in original containers showing analysis of mixture, percentage of pure seed, year of production, net weight, date of packaging, and location of packaging. Damaged packages are not acceptable.

333.02.02.02 Material Storage. Materials shall be stored in accordance with Subsection 100.17.02, except as modified herein.

333.02.02.02.01 Aggregates. Sufficient storage space shall be provided for the aggregate required. The storage yard shall be maintained neatly and orderly and separate aggregate stockpiles shall be readily accessible for sampling.

333.02.03 USE OF OTHER MATERIALS. The Contractor shall not use other materials and/or methods except as provided in Subsection 100.17.03, except as modified herein.

333.02.04 AGGREGATES. Aggregates shall conform to Subsection 200.01 – “Aggregates for Base”.

333.03 CONSTRUCTION.

333.03.01 SUBMITTALS.

333.03.01.01 Certificate of Compliance. A certificate of compliance shall be provided in accordance with Subsection 100.17.01 – “Certificate of Compliance”. The certificate of compliance shall be reviewed and accepted by the Agency or Design Engineer prior to unloading the associated material on-site.

Inspection certificates for plant diseases and infestations required by law shall accompany each shipment of plants, and certificates shall be delivered to the Landscape Architect.

333.03.02 INSPECTION AND TESTING. Inspection and testing shall be performed in accordance with Subsection 336.

All plant material shall meet standards throughout the life of the Contract. During inspections all plant material will be judged and rejections shall be based upon visual evaluation of root condition, plant size (above ground), insect and disease free condition, and general appearance, including, but not limited to, color, shape and pruning. A deficiency in any one or more of these areas shall be sufficient reason to reject selectively or by lot. No consideration will be given to the possibility of survival.

333.03.03 LIMIT OF WORK. The limit of work shall be in accordance with Subsection 100.18 – “Location of the Work”.

333.03.04 SCHEDULING OF WORK. The Contractor shall prepare and submit to the Agency or Engineer, for approval, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.21 – “Scheduling of Work”.

333.03.05 EXISTING IMPROVEMENTS AND SYSTEMS. Removal of existing improvements shall be performed in accordance with Section 300 – “Site Preparation”. The Contractor shall protect items not removed in accordance with Section 301 – “Protection of Items Not Removed”.

333.03.06 CONSTRUCTION EQUIPMENT. Equipment and tools necessary for handling materials and performing all parts of the work must meet the approval of the Engineer as to the design, capacity, and mechanical condition. This equipment shall be on the site, available for inspection, testing, and approval before work is started. All equipment, tools, and machinery shall be maintained in a satisfactory working condition.

333.03.06.01 Storage. Unless otherwise directed or approved by the Agency or Engineer, all portable construction equipment storage shall comply with clear zone guidelines in the AASHTO Roadside Design Guideline. Portable construction equipment and materials shall not be stored overnight in public rights-of-way unless approved in writing by the Maintaining Agency.

333.03.07 CONSTRUCTION LOADS. The Contractor's operations shall not produce a surcharge which would impact stability of adjacent improvements.

333.03.08 SUBGRADE PREPARATION. Subgrade preparation shall be performed in accordance with Section 302 – "Subgrade Preparation", except as modified herein.

333.03.09 EXCAVATION. Excavation shall be performed in accordance with Section 303- "Excavation", except as modified herein.

333.03.10 PLACING OF MATERIALS. Placing of material shall be performed in accordance with Section 304 – "Fill and Backfill", except as modified herein.

333.03.10.01

333.03.10.02

333.03.10.03

333.03.10.04 Protection.

333.03.12 WEATHER LIMITATIONS.

333.03.13 MAINTENANCE OF TRAFFIC. Maintenance of traffic shall be performed in accordance with Subsection 100.33.01 – "Maintenance of Traffic".

333.03.14 PROTECTION OF WORK AND CLEANING UP. Protection of work and cleaning up shall be in accordance with Section 100.37 – "Protection of Work and Cleaning Up", except as modified herein.

333.04 ACCEPTANCE.

333.04.01 Inspection of Plant Materials. The Contractor shall inform the Landscape Architect, as soon as practical, of the source of plant material for the project. At the Landscape Architect's option, an inspection of all plant materials at the source may be required prior to shipping of plants from the nursery. This inspection shall coordinate the judgment areas regarding size and quality of plant material between the Owner, the Contractor, and the Nursery. However, there will be no acceptance of any plant material during this inspection.

All plant material will be inspected by the Landscape Architect on arrival at the storage area. This inspection shall determine the acceptance or rejection of the plant material, is for quality of plant material only, and does not constitute final acceptance. Plants which are rejected shall be immediately removed from the holding area and replaced by the Contractor at his expense.

All plant material will be periodically inspected by the Landscape Architect from the time of arrival at the holding area, during planting, and through the plant establishment period. Plants may be individually rejected during this time based on mechanical damage, quality, or physical change of the plant which is not normal to the plant or to the season of the year. Plants which are rejected shall be immediately removed from either the holding area or the project and replaced by the Contractor at his expense.

333.04.02 Substitution of Plants. No substitution of plant material will be permitted unless evidence is submitted in writing to the Landscape Architect that a specified plant cannot be obtained along with proposal for equivalent material for substitution. If substitution is permitted, it can be made only with written approval by the Engineer.

333.04.03 Temporary Storage. Plant material delivered and accepted shall be planted immediately. Plants that cannot be planted within 1 day after arrival shall be "heeled-in" in accordance with accepted horticultural practice, and as follows:

- a. Balled and burlapped plants shall have the root ball protected by moist earth, sawdust, or other acceptable material.
- b. Canned plants shall be placed in and under shelter and kept moist.

Plants stored under temporary conditions shall be protected at all times from extreme weather conditions, and shall be kept moist.

333.04.04 Lumber. Lumber for header boards and plant boxes shall conform to the requirements of Section 208 – “Lumber and Preservative Treatment.”

333.04.05 Wrapping Materials. Tree wrap shall consist of two thicknesses of crepe paper 8 inches to 10 inches wide, cemented together with bituminous material. Twine for securing tree wrap shall be lightly tarred medium or coarse sisal yarn or duct tape.

333.04.06 Guying and Staking Material. Stakes for tree support shall be construction-grade redwood or shall conform to the requirements of Section 208 – “Lumber and Preservative Treatment.” Minimum nominal size shall be 2 feet by 2 feet or 2 1/2 inches in diameter by 9 feet long and pointed at one end. Guying wire shall be annealed, galvanized iron or 12 gauge steel. Hose shall be 22 ply 3/4 inch reinforced rubber or plastic.

333.05 SITE PREPARATION. This work shall consist of all work necessary, as set forth in the Contract Documents, to prepare the area for the actual landscaping work. Verify that all subgrade elevations have been established; beginning landscape work shall mean acceptance of existing conditions.

333.06 LAYOUT OF PLANTING. The Contractor will designate, by means of stakes or other approved markings, the ground location of each random placed plant. Area of massed or uniform solid plantings shall be marked at their outer extreme only. The Landscape Architect’s approval of plant stakeout will be required prior to the commencement of the preparation of planting areas.

In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, and the final planting of ground covers.

333.07 PREPARATION OF PLANTING AREAS. During the preparation of planting areas, all clods, rocks, or other debris over 1 inch in largest dimensions shall be removed from both cultivated areas and backfill material, and disposed of as directed by the Landscape Architect. In addition thereto, the following requirements will apply:

333.07.01 Planter Boxes. Backfill material shall consist of one part humus to three parts approved top soil by volume. This material shall be thoroughly and uniformly mixed before placing in the planter boxes. After placing in the planter box, the material shall be watered until it is completely saturated. Sufficient backfill mixture shall be added and adequately wet so that, after settlement has taken place, the material is no more than 2 inches below the top of the box.

333.07.02 Planting Beds. The soil preparation shall not be initiated until after all grading has been completed and the irrigation system has been installed, tested, adjusted by the Contractor, and accepted by the Landscape Architect. The ground surface within the area shall then be loosened and thoroughly cultivated to a depth of 6 inches. Repeat cultivation in areas where equipment has compacted subgrade.

When required, humus, commercial fertilizer, and other soil additives shall be incorporated at the rate specified in the Contract Documents, and shall be thoroughly and uniformly tilled into the soil to a depth of 6 inches. The area shall then be brought to a plane in conformance to the elevations shown on the Plans.

333.07.03 Seed Beds. The soil preparation shall be the same as specified for planting beds.

333.07.04 Planting Holes. Prior to digging holes, the proposed location of the irrigation lines shall be designated by means of stakes or other approved markings. In the event of conflict between individual plant holes and irrigation lines, the planting holes in question shall be dug prior to installing the irrigation lines.

Plant holes shall have vertical walls and flat bottoms. Tree planting holes shall be sized as necessary to accommodate tree ball and a 6 inch minimum of compacted top soil below the ball. Tree planting holes shall be three times greater than the width of the ball in diameter.

Shrub planting holes shall be a minimum of 16 inches in depth and increased as necessary to accommodate root balls and with at least 6 inch minimum of top soil below the ball. Shrub planting holes shall be 1 foot greater than the width of the ball in diameter.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the Contract Documents and shall be thoroughly and uniformly mixed with the native material removed from the holes prior to backfilling. After backfilling the holes, the material shall be saturated with water to the full depth of the holes and until ponding appears in the basin. Sufficient backfill material shall be placed so that, after planting and settlement has taken place, the basin will conform to the section as shown in the Plans.

333.07.05 Planting Trenches. Trenches shall be excavated to the dimensions as specified in 333.05.04 – “Planting Holes” – and shall be centered on the planting line as staked or otherwise marked.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the Contract Documents and shall be thoroughly and uniformly mixed with the native material removed from the trenches prior to the backfilling. After backfilling the trenches, the material shall be saturated with water to the full depth of the trench. Cross checks may be performed as necessary to permit ponding of water during the saturation period, but must be removed prior to planting. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the Plans.

333.08 PLANTING. No more plants shall be distributed within the project on any 1 day than can be planted and watered on that day.

Any planting done in soil that is too wet or dry or not properly conditioned as provided herein will not be accepted. No payment will be made for such planting, and any further planting work will be suspended until the Contractor has complied in every way with the Specifications.

(a) General.

1. Center plant for pit or trench.
2. Face for best effect.
3. Set plant plumb and hold rigidly in position until soil has been tamped firmly around ball or roots.
4. Use only planting soil for backfill.
5. Place sufficient planting soil under plant to bring top of root ball level to finish grade of surrounding soil.
6. Backfill pit with planting soil until 2/3 full and water each layer thoroughly to settle soil.
7. After soil settles, fill pit with planting soil mix, water, and leave pit surface even with finish grade of surrounding ground.
8. Watering basin.
 - a. Construct a topsoil berm 4 inches above finish grade, forming a watering basin with a level bottom around each plant.
 - b. Size: 2 feet (600mm) greater than diameter of ball or spread of roots if barerooted.

333.08.01 Plants (Group A). Nursery stakes supporting plants in containers shall be removed and the plants properly pruned as specified herein.

Containers shall be cut, at least twice, from top to bottom and plants shall be removed from the containers in such a manner that the ball of earth surrounding the roots is not broken, and they shall be planted and watered as hereinafter specified immediately after removal from the containers. Containers shall not be cut prior to delivery of the plants to the planting areas.

333.08.02 Plants (Group B). Balled and burlapped material shall have all strings or cords cut, and the burlap shall be laid back from the top half of the ball. This shall be done only after the plant is placed in its final position and before completion of the backfill.

333.08.03 Plant (Group C). As soon as each plant is removed from its container, it shall be planted in the prepared planting bed, in a hole previously prepared with a broad, blunt end trowel. The plant shall be carefully lifted with the trowel, inserted in the hole, and the earth shall be gently firmed around it to eliminate air pockets.

Plants brought to the job site in plastic or clay pots shall be tapped loose from their containers in such a manner that the ball of earth surrounding the roots is not broken, and then immediately planted. Plants which are brought to the job site in peat pots may be planted in the pots, provided the peat fiber is thoroughly wet. Plants which are brought to the job site in other cellulose fiber pots shall have the pots carefully removed by tapping or peeling before planting. No plants brought to the job site in flats, pony packs, or bare root will be accepted.

Plants shall be watered as hereinafter specified immediately after planting.

Roots of plants not in containers shall be kept moist and covered at all times and shall not be exposed to the air, except while actually being placed in the ground.

Plants shall be planted in such a manner that the roots will not be restricted or distorted. Soil shall not be compacted around the roots or ball of the plant during or after planting operations. Any plants which have settled deeper than specified above shall be raised back to the required level, or replaced, at the option of the Contractor.

333.08.04 Plants (Group D). The seed bed shall be in a moist, friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding, will not be accepted. No payment will be made for seeding when the soil condition is considered unsatisfactory, and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Lawn seed may be sown from standard mechanical grass seeding equipment and fertilized or applied together with mulch and fertilizer in a hydromulch solution.

After sowing, the seed shall be covered by light raking or dragging and seeded areas shall be compacted by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seed bed.

Humus mulch shall be evenly applied immediately after the seed bed has been compacted, with manure spreaders, mulch blowers, or other approved equipment. Humus shall be spread at the rate of 1 cubic yard per 1,000 square feet. As soon as mulch is in place, the surface of the seed bed is to be dampened with a fine spray from a nozzle until the mulch is thoroughly moist.

333.08.05 Plants (Group E). The seed ball shall be in a moist, friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or dry, or in a condition not generally accepted as satisfactory for seeding, will not be accepted. No payment will be made for seeding when soil condition is considered unsatisfactory, and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Seed may be sown from standard mechanical grass seeding equipment and fertilized or applied together with mulch and fertilizer in a hydromulch solution. After sowing, the seed shall be covered by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seed bed.

333.09 MULCHING. Mulch planting holes, trenches, planting beds, and areas within 2 days after planting. Cover watering basin or bed evenly with 4 inches of shredded bark mulch material. Water thoroughly immediately after mulching.

333.10 STAKING AND GUYING. All staking and guying shall be done concurrently with the planting operation.

333.10.01 Staking. Plants which are to be staked will be specified in the Special Provisions or indicated on the Plans.

The size, number of stakes, and the depth to be driven shall be as specified in the Special Provisions, indicated on the Plans, or as approved by the Landscape Architect.

The stakes shall be placed adjacent to plant pits in undisturbed soil in the case of Plants (Groups A and B).

333.10.02 Tree Ties. The method of attaching the ties to stakes and trees shall provide a firm connection, as shown in the Plans or as approved by the Landscape Architect.

333.10.03 Guying. All guying shall be done as specified in the Special Provisions, indicated on the Plans, or as approved by the Landscape Architect.

333.11 PRUNING. Prune the minimum necessary to remove injured twigs and branches, deadwood, and sucker growth.

Prune evergreen coniferous plants only at the direction of the Landscape Architect.

333.12 WRAPPING. Spirally wrap trees from the bottom of the trunk to the top (height of the second branch); overlap wrapping approximately 2 inches.

333.13 WATERING. If water is available from a new or existing irrigation system within the limits of the project, it may be obtained from such system free of charge. Where water is not available from such facilities, the Contractor shall make his own arrangements for furnishing and applying water and he shall pay all costs involved.

Valves at meters shall be kept closed at all times, except while the irrigation system is actually in use.

Precautions shall be taken during times when the irrigation system is on to prevent water from wetting vehicles, pedestrians, and pavement. Any erosion, slippage, or settlement of the soil caused by watering shall be repaired by the Contractor at his expense.

Compliance with the provisions in this Section shall not relieve the Contractor of his responsibility for his replacement of plants as provided hereinafter.

333.13.01 Plants (Groups A and B). All plants shall be watered immediately after planting. Water shall be applied in a moderate stream until the backfill soil around and below the roots or ball, or earth around each plant, is thoroughly saturated. Where watering is done with a hose, a metal or plastic pressure reducing device approved by the Landscape Architect shall be used. Under no circumstances shall the full force of the water from the open end of a hose be allowed to fall within the basin around any plant.

After the first watering, water shall be applied to all plants as often and in sufficient amounts as conditions may require to keep the soil set above, around, and below the root systems of the plant during the life of the Contract. After the installed irrigation system has been accepted, it may be used to water the planted area.

Any additional watering measures required to initially saturate the backfill, water the plants immediately after planting, or to maintain the plants in a satisfactory growing condition shall be anticipated and furnished by the Contractor at his expense.

333.13.02 Plants (Group C). As soon as all the perennials in a given area have been planted, water shall be applied to that area in a fine mist from an atomizing nozzle until the entire planting bed is saturated. This initial watering shall not be done with the installed irrigation system.

After the first watering, water shall be applied to the areas as often and in sufficient amount as conditions may require to keep the soil wet above, around, and below the root systems of the plants during the life of the Contract.

333.13.03 Plants (Groups D and E). The seed beds shall be kept in a moist, but not soggy, condition until after germination. After germination, water shall be applied to the areas as often and in sufficient amount as conditions may require during the life of the Contract.

The installed turf irrigation system may be used to water those areas as long as care is taken to prevent erosion or other damage to the area. However, should the irrigation system prove to be unsatisfactory, other means of watering, as approved by the Landscape Architect, shall be used until germination is complete and all grass has attained a height of 1 inch. After the uniform stand of grass which has attained a height of 1 inch has been achieved over the entire turf area, the installed turf irrigation system may be used to keep the area moist.

333.14 REPLACEMENTS

333.14.01 Plants (Groups A, B, and C). During the planting and plant establishment period of the project, all plants that show signs of failure to grow normally or which are so injured or damaged as to render them unsuitable for the purpose intended, as determined by the Landscape Architect, shall be removed and replaced in kind. The Landscape Architect will inspect the work on the first or second working day of each week during the planting and plant establishment periods, and will mark or otherwise indicate all plants to be replaced. The Contractor shall complete replacement of such plants as soon as possible, but in no case shall the Contractor take more than 2 weeks to complete the replacement.

Plants required to replace plants shall be furnished and planted by the Contractor at his expense.

333.14.02 Plants (Groups D and E). Seed areas shall be in a thriving condition, having been properly seeded, and having produced an acceptable rate of germination. The seed area will be considered to have produced an acceptable rate of germination if, during inspection, the Landscape Architect can select a 12 square foot area of the work and find no portion of that area to have more than 10 percent soil visible.

The Landscape Architect will inspect the turf at the time of the second cutting and the meadow area when the grass has reached a height of approximately 2 inches and will designate any areas which require reseeding. Seed used for reseeding shall be the same types and amounts as specified for the initial planting and shall be planted in accordance with the Special Provisions as directed by the Landscape Architect. The cost of the seed and actual reseeding shall be borne by the Contractor.

333.15 FERTILIZERS AND ADDITIVES. When fertilizers or additives are called for, they shall be applied at the rates as specified in the Special Provisions or as approved by the Landscape Architect.

333.16 PROTECTION OF EXISTING FACILITIES. Any existing buildings, equipment, piping, pipe covering, sprinkling systems, sewers, sidewalks, landscaping, utilities, roadways, or any other improvements of facilities damaged due to the Contractor's operations shall be repaired or replaced by the Contractor at his expense as directed by the Landscape Architect.

333.17 PLANT ESTABLISHMENT WORK. This work shall consist of watering and caring for all of the plants and planting areas, the replacement of plants, the weeding, and general maintenance as specified in the Contract Documents.

The plant establishment period shall begin at such time as all planting has been accomplished and all other work has been completed and the project is in a neat and clean condition.

The length of the plant establishment period shall be as specified in the Special Provisions.

The Landscape Architect will notify the Contractor in writing of the start of the plant establishment period, and will furnish statements regarding days credited to the plant establishment period after said notification.

The time required for plant establishment work shall be considered as included in the total time limit specified for the Contract. Any day upon which no work is required, as determined by the Landscape Architect, will be credited as one of the plant establishment days, regardless of whether or not the Contractor performs plant establishment work.

Any day when the Contractor fails to adequately water plants, replace unsuitable or damaged plants, perform weed control, adjust or replace bracing and ties, or other work as determined necessary by the Landscape Architect, will not be credited as one of the plant establishment days. No extension of Contract time will be granted beyond the final completion day by reason of failing to perform plant establishment work on days when such work is necessary.

All plants shall be kept watered, as indicated in Section 333.11 – "Watering" – of these Specifications.

Surplus earth, papers, trash, and debris which accumulates in the planted areas shall be removed and disposed of by the Contractor, and the planted areas shall be so cared for as to present a neat and clean condition at all times.

During the plant establishment period, trees and shrubs shall be pruned or headed back by the Contractor at his expense, when and as directed by the Landscape Architect.

In order to carry out the plant establishment work, the Contractor shall furnish sufficient men and adequate equipment to perform the work during the plant establishment period.

333.18 GUARANTEE. The Contractor shall guarantee all plant material through one full growing season after all plants are installed and Notice of Completion is filed. The Contractor shall inspect the site monthly to generally determine conditions of all plantings. If any changes in the overall maintenance program are required to improve the condition to an acceptable standard, the Contractor must notify the Owner in writing; otherwise, the Contractor accepts full responsibility for the condition of the plantings and must honor his guarantee for the 1 year period.

Replacement plants under this guarantee shall be granted one full growing season from date of installation. Repair damage to other plants during plant replacement shall be at no cost to the Owner.

333.19 MEASUREMENT OF QUANTITIES. The quantity of material and work shall be measured in accordance with the Contract Documents, and shall be either lump sum for the landscaped area complete in place, or by unit prices established for the individual components of the landscaped area.

333.20 BASIS OF PAYMENT. The accepted quantities shall be compensated for at the lump sum or unit price established in the Contract Documents.

333.21 IRRIGATION SYSTEMS

333.21.01 AUTOMATIC CONTROLLERS. When called for on the Plans, the Contractor shall furnish and install on a utility panel with a concrete base automatic controllers as herein specified. They shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments will be conveniently located for use by the operation. Controllers shall be enclosed in a weatherproof casing with hasp and lock or locking device. All locks or locking devices shall be master keyed and three sets of keys provided. Operating features shall include the following, unless specified otherwise:

- a. Each valve in the circuit shall be of adjustable setting to remain open for any desired period of time - from 1 minute or less to at least 90 minutes - with automatic starts up to three per program per day.
- b. The controller shall operate on 110-117 volts and shall be equipped with a circuit breaker or fusible connection to protect the controller from overloads.
- c. Controller shall have a battery backup system for power failure to maintain the program for 7 days.
- d. The controller shall have a master on-off switch to turn all stations off without disturbing the clock settings or automatic timing sequences.
- e. Controls shall allow any position to be operated manually both on or off whenever desired.
- f. Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one position to another.

333.21.02 SPRINKLER HEADS. Sprinkler heads shall be of the type, pattern, and coverage of the Plans. Heads are to be installed flush with grade, mounted on a triple swing joint consisting of threaded SCH 80 elbows with a minimum of 3 inch threaded nipples or be premanufactured assemblies. All heads in turf areas are to have rubber covers.

333.21.03 GATE VALVES. Valves 2 1/2 inches and smaller shall be of the same size as the pipes on which they are placed unless otherwise indicated on the Plans. Service rating for non-shock cold water shall be 200 p.s.i. These valves shall be all bronze, split wedge type, with rising stem and union bonnet.

Packing shall be teflon impregnated asbestos and the valve shall be capable of being repacked under pressure. Handwheels shall be malleable iron. Valves 2 1/2 inches and smaller shall be the threaded type and installed with a union on either side of the valve.

Gate valves 3 inches and larger shall be iron body, bronze mounted, double disc, parallel seat type with "O" ring seals and shall comply with AWWA Standards. These valves shall have a working pressure of 200 p.s.i. and a test pressure of 400 p.s.i. A shut-off rod, 6 feet in length that will fit a 2 inch wrench nut, shall be furnished by the Contractor.

333.21.04 CONTROL VALVES. Manual control valves shall be straight or angle pattern globe valves of all brass or bronze construction with replaceable compression disks. Manual control valves shall be of the same size as the pipes on which they are placed unless otherwise indicated on the Plans, and shall be provided with a union connection. Manual control valves shall be capable of withstanding a cold water working pressure of 150 p.s.i.

Electric control valves shall be of the diaphragm type, normally closed, 24 volt, 60 cycle. The valve solenoids shall operate with 18 to 30 volts of power. The solenoid shall be completely encapsulated for positive waterproofing. The valve body and bonnet shall be of solid brass, flange or threaded type. If threaded type is used, it shall be provided with a union connection. The time interval between opening and closing the valve shall not be less than 5 seconds. The solenoid plunger shall be spring loaded so the valve may operate when installed in any position and shall be constructed of stainless steel with neoprene seat. Valve bonnet shall have a bleed screw for manual operation and a manual flow control adjustment. Electric control valves shall be capable of withstanding a non-shock cold water working pressure of 150 p.s.i.

Each solenoid control valve shall be placed in a rectangular green plastic valve box with valve box extensions allowing at least 6 inches clear on all sides of the valve. The control wires shall have an additional 3 feet of wire coiled up for each wire in the valve box. All valve wiring splices shall be inside the valve box using DBY connectors or in a 9 inch round box.

333.21.05 QUICK COUPLER VALVES. The quick coupler valve shall be of brass or bronze construction with 3/4 inch female iron pipe bottom connection. The valve shall be of two piece construction with removable upper body. The valve body shall be designed with a single slot to receive hose swivel elbow. The Contractor shall provide one valve key and hose swivel elbow for every quick coupler in the construction contract.

333.21.06 VALVE BOXES. Valves boxes shall be reinforced fiberglass or plastic, with one piece bolt-down (not hinged) lids. The lid is to be clearly marked with "Irrigation" impregnated into the lid. Control valves and irrigation boxes are to be grouped as indicated and valve boxes are to be located in flat areas, if possible. If they have to be located on a slope, the top of the box must be flush with the grade and at the same slope. Wells or depressions in the slope to make the top of the valve boxes level are not permitted. Valve boxes shall have extensions as necessary to reach the depth indicated. Extensions shall be of the same material as the valve box. Valve boxes shall not rest directly on the pipe. One inch or greater clear space is required between the pipe and the valve box or valve box extension.

333.21.07 BACKFLOW PREVENTERS. The irrigation system is to be isolated from domestic water by a reduced pressure principal backflow prevention device. Double check or pressure vacuum breakers are not permitted for landscape use under the Uniform Plumbing Code. Backflow preventer shall be a minimum of 12 inches above grade. All pipes closer than 24 inches to the surface connecting to the backflow device shall be galvanized pipe. A galvanized union shall be placed on both sides of the backflow preventer. All galvanized pipe below the ground surface shall be taped to prevent electrolysis per the Uniform Plumbing Code. A 1 cubic foot minimum concrete thrust block shall be placed at each elbow and riser. A manual drain valve shall be placed on the main line on both sides of the backflow preventer.

All potable water lines for drinking fountains, rest rooms, etc., shall be provided a separate service line upstream of the backflow preventer. The potable water line shall have a manual shut off valve at the point of connection to the main line, and a manual drain valve on the service line.

333.21.08 DRAIN VALVES

a. **Manual Drain Valves.** Drain valves are to be metallic manual globe valves located at all low points in all main and submain irrigation lines under constant pressure. Each drain valve is to be placed in a 9 inch diameter round valve box with extensions or a 4 inch schedule 40 sleeve inside the round valve box extending to the valve. If a sleeve is used, the top of the sleeve shall be a minimum of 3 inches below the bottom of the valve box cover. The bottom of the sleeve shall have 1 inch vertical clearance above the main line so the sleeve does not rest directly on the main line pipe.

A gravel sump consisting of 3 cubic foot minimum gravel conforming to the requirements for Class B backfill as specified in Subsection 200.03.03 – "Bedding and Backfill Material" – shall be placed below each drain valve with filter fabric placed over the gravel sump.

b. **Automatic Drain Valves.** Automatic ball check drain valves shall be installed at all low points in lateral lines. Ball checks shall be spring loaded and shall close under pressure of 2 to 4 p.s.i. Valves shall be installed with a gravel sump as described above.

333.21.09 PIPING. All live pressure lines shall be located a minimum of 30 inches below grade. All lateral lines shall be a minimum of 24 inches below grade. All flexible drip lines shall be made of algae resistant PVC and placed a minimum of 8 inches below grade. Pipes shall be snaked in the trench. All pipes located in the same trench shall be laid at the same elevation and laterally spaced a minimum of 3 inches apart. Control wires and caps common wires are to be taped to the bottom of the mainline with PVC tape in 10 foot intervals. All pipe runs shall be continuous full length pieces with no splices, except at either end of a branch lateral or at a tee for an irrigation head.

During assembly of pipe joint, all pipe cuts shall be reamed out with a pipe reaming tool to restore the full inside diameter.

PVC Primer and PVC Solvent Cement shall be as approved by the PVC pipe manufacturer. All excess cement shall be wiped off the pipe at time of assembly. A concrete thrust block shall be placed at all bends in pressure main lines and at all lateral bends where lateral pipe diameter is larger than 2 1/2 inches.

All piping under pavement shall be installed in a SCH 40 PVC sleeve a minimum of 1 inch larger than the pipe. Sleeves shall be installed 24 inches below finish grade and extend 18 inches past the edge of pavement.

333.21.10 CONTROLLER WIRING. All control and common wires shall be direct-burial rated. All continuous wire runs under 500 feet shall be continuous with no splicing permitted. When splicing is required outside of a valve box, a 9 inch round valve box shall be installed for the splice. Each wire to be spliced shall have a 3 foot coil of extra wire. All splices shall use a waterproof splice similar to a DBY connector. When the wire follows a

main or irrigation line that has a 90 degree bend, 3 feet of excess wire shall be provided and buried at each elbow.

333.21.11 DRIP IRRIGATION LINES. All algae resistant PVC flexible lines shall be buried a minimum of 8 inches deep. All drip emitter taps and spaghetti lines shall be made with the tool manufactured by the emitter manufacturer. All drip lines shall be terminated with a flushing end plug in a 9 inch diameter valve box. Enough excess pipe shall be provided in the box so the flushing end plug can be directed outside the box when flushing.

333.21.12 DRIP EMITTERS. The gallon output shall be as shown on the Plans. For each plant, provide the following number of emitters per size as follows:

| | |
|---------------------|------------|
| | |
| 1-2 Gallon Shrub | 1 Emitter |
| 5 Gallon Shrub/Tree | 2 Emitters |
| 15 Gallon Tree | 3 Emitters |
| 24 Inch Box Tree | 4 Emitters |

Emitters are to be placed equally around the plant approximately 6 inches outside of the rootball. All drip distribution centers shall have a visible at grade cap/marker or valve box.

333.21.13 INSTALLATION. Piping layout indicated on drawings is diagrammatic. Route around structures or obstacles.

Trench for sprinkler system to insure proper grades and slopes to drain points.

Keep trenches free of debris, material, or obstructions that may damage pipe.

Care shall be exercised by the Contractor when excavating trenches near existing trees. Where roots are 2 inches and greater in diameter, except in the direct path of the pipe, the trench shall be hand excavated and tunneled. Trenches dug by machines adjacent to trees having roots 2 inches and less in diameter shall have the sides hand trimmed, making a clean cut of the roots. Trenches having exposed tree roots shall be backfilled within 24 hours unless adequately protected by moist burlap or canvas.

Where piping is installed in an open trench, excavation and backfill shall conform to the provisions in Section 305 – “Trench Excavation and Backfill.” The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe. During backfilling operations, the pipe shall be rigidly supported so that no movement of or damage to the pipe or joints will result.

Install piping, valves and controls, and sprinklers in accordance with the manufacturer's written instructions.

Solvent welded joints shall be made with solvent supplied by the manufacturer of the pipe. Care shall be exercised to clean both pipe and fitting to be joined. After the joint is made, excess solvent shall be wiped from the pipe and fitting, and the joint shall not be moved for a period of 15 minutes. No water shall be introduced into the system for a period of 12 hours.

Piping shall be installed to provide drainage. Slope exterior piping to drain toward drain valves.

On all plastic threaded connections, Permatex No. 2 silicone tape, or equal, shall be applied to the male thread.

Fittings shall be used on all bends in excess of 20 degrees. Where fittings are not used on lesser bends, the trench shall be of sufficient width to allow for an even bend.

Plastic pipe shall be laid to allow for expansion and contraction. Caution shall be exercised to support all plastic fittings and connections.

Where pipe is to be installed through existing paved areas, the subbase, base, and paving removed shall be replaced with material of equal quality. All pipe shall be cut straight and true. After cutting, the ends shall be reamed out to the full inside diameter of the pipe.

Foreign material shall be prevented from entering the irrigation system during installation. Immediately prior to assembly, all pipes, valves, and fittings shall be cleaned. All unattached ends of pipe, fittings, and valves shall be plugged or capped pending attachment of additional pipe or fittings. All lines shall be thoroughly flushed out

prior to attachment of terminal fittings. Use threaded Schedule 80 nipples for risers to each outlet to facilitate easy replacement.

After piping is installed and before sprinkler heads are installed and backfilling commences, open valves and use full head of water to flush out system. Backfill sprinkler system using sand to a depth of 3 inches (75 mm) over piping. Fill remainder of trenches to top of subgrade elevation with sub-soil.

Set sprinkler heads and box covers to finish grade. Adjust all heads for proper water flow at completion of work. Replace plantings or structure damaged by installation of sprinkler system.

333.21.14 FLUSHING AND TESTING. All main supply lines shall be flushed completely of foreign particles before placing section control valves, quick coupler valves and hose bibs. After flushing, and when valves are in place, all main supply lines shall be tested at 100 p.s.i. with valves closed. Pressure shall be maintained for a period of 2-consecutive hours. All joints showing leaks shall be cleaned, remade, and tested.

After installation of lateral lines, the piping shall be completely flushed of foreign particles before attaching sprinkler heads and drain valves. After flushing, section lines shall be tested with risers capped and drain valves closed. The test shall be made at maximum operating pressure for a period of 1 hour. Any pipe, fittings or joints showing leaks will not be accepted. All joints showing leaks shall be cleaned, remade and retested. Piping shall be flushed for 5 minutes before connection with the control valves.

Automatic controllers shall be tested by actual operation for a period of two weeks under normal operating conditions. Should adjustments be required, the Contractor shall do so according to manufacturer's direction and he shall test the system until operation is satisfactory.

333.21.15 ADJUSTING SYSTEM. Before final inspection, the Contractor shall adjust and balance all sprinklers to provide adequate and uniform coverage. Spray patterns shall be balanced by adjusting individual sprinkler heads with the adjustment screws or replacing nozzles to produce a uniform pattern. Unless otherwise specified, sprinkler spray patterns will not be permitted on pavement, walks, or structures.

333.21.16 CLEANING. Upon completion of work, remove excess debris, materials, equipment, apparatus, tools, and the like and leave premises clean, neat, and orderly.

333.21.17 SUBMITTALS. Provide Owner with complete Operation and Maintenance manuals with instructions covering full operation care and maintenance of system and controls with manufacturer's parts catalogs.

Instruct owner's designated maintenance personnel in proper operation of system.

335.01 GENERAL.

335.01.01 COMPOSITION OF MIXTURES. A mix design shall be performed and submitted to the Engineer in accordance with Subsections 337.01.01 "Mix Design" and the applicable requirements of Subsection 337.09 – "Masonry" to determine the composition of the mixture. No mortar or grout shall be placed without approval by the Engineer of a mix design.

335.01.02 MATERIALS. Materials used for the masonry construction shall conform to the requirements of the following Subsections:

| Material | Subsection |
|--|-----------------|
| Reinforcing Steel | 206; 326 |
| Concrete Building Brick | 202.02.06.05.01 |
| Solid Load Bearing Concrete Masonry Units | 202.02.06.05.02 |
| Hollow Load Bearing Concrete Masonry Units | 202.02.06.05.03 |
| Solid Load Bearing Clay Masonry Units | 202.02.06.05.04 |
| Sand-Lime Brick | 202.02.06.05.05 |

335.01.02.01 Concrete Masonry Units. Not less than five samples of masonry units, showing the full range of texture and color, shall be selected at the site by the Engineer. Units used in the work shall match approved samples.

335.01.03 Construction

- a. Materials – Delivery, Handling, Storage and Preparation. Storage, handling, and preparation at the site shall conform to the following:
 - 1. Moisture content of concrete masonry units at the time of delivery shall not exceed thirty (30) percent of the minimum absorption value of the units, and the Contractor shall provide the protection necessary to maintain concrete block masonry units in this condition until time of use. Masonry materials shall be stored so that at the time of use the materials are clean and structurally suitable for the intended use.
 - 2. All metal reinforcement shall be free from loose rust and other coatings that would inhibit reinforcing bond.
 - 3. At the time of laying, burned clay units and sand lime units shall have a rate of absorption not exceeding .025 ounce per square inch during a period of 1 minute. In the absorption test the surface of the unit shall be held 1/8 inch below the surface of the water.
 - 4. Concrete masonry units shall not be wetted unless otherwise approved.
 - 5. Materials shall be stored in a manner such that deterioration or intrusion of foreign materials is prevented and that the material will be capable of meeting applicable requirements at the time of mixing.
 - 6. The method of measuring materials for mortar and grout shall be such that proportions of the materials can be controlled.
 - 7. Mortar or grout mixed at the jobsite shall be mixed for a period of time not less than 3 minutes nor more than 10 minutes in a mechanical mixer with the amount of water required to provide the desired workability. Hand mixing of small amounts of mortar is permitted. Mortar may be retempered. Mortar or grout which has hardened or stiffened due to hydration of the cement shall not be used, but under no case shall mortar be used 2 1/2 hours, nor grout used 1 1/2 hours, after the initial mixing water has been added to the dry ingredients at the jobsite.
- b. Masonry Units. All work shall be performed in a workmanlike manner and in full compliance with the applicable building ordinances.

All masonry units shall be laid true, level, and plumb in accordance with the Plans.

Masonry units shall be cured, dry, and surfaces shall be clean and free of deleterious materials when laid in the walls.

During construction, all partially laid walls, as well as units in storage, shall be protected from moisture. All concrete block units and any partially laid walls which become wet during the construction shall be permitted to dry for at least 1 week, or longer if required by the weather conditions, before work is restarted.

Proper masonry units shall be used to provide for all windows, doors, bond beams, lintels, pilasters, etc., with a minimum of unit cutting. While masonry unit cutting is necessary, all 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 the use of 1/4 inch minimum diameter steel ties at 24 inches on center (maximum).

Mortar shall be sufficiently plastic and units shall be placed with sufficient pressure to exude mortar from the joint and produce joints that are straight, clean, and uniform in thickness. Deep furrowing which produces voids shall not be used.

The initial bed joint thickness shall be not less than 1/4 inch or more than 1 inch; subsequent bed joints shall be not less than 1/4 inch nor more than 5/8 inch in thickness.

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.

Solid masonry units shall have full head and bed joints.

All head and bed joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the shell.

Head joints of open-end units with beveled ends need not be mortared. The beveled ends shall form a grout key which permits grout within 5/8 inch of the face of the unit. The units shall be tightly butted to prevent leakage of grout.

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 bind. 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.

c. Placing Reinforcing Steel. Reinforcing steel shall be placed as indicated on the Plans and in accordance with Section 326.02 – “Reinforcing Steel”.

Reinforcement shall be placed prior to grouting. Bolts shall be accurately set with templates or by approved equivalent means and held in place to prevent movement.

Reinforcement shall be secured against displacement prior to grouting by wire positioners or other suitable devices at intervals not exceeding 200 bar diameters nor 10 feet.

Tolerances for the placement of steel in walls and flexural elements shall be plus or minus 1/2 inch for d equal to 8 inches or less, plus or minus 1 inch for d equal to 24 inches or less but greater than 8 inches, and plus or minus 1 1/4 inch for d greater than 24 inches.

Tolerance for longitudinal location of reinforcement shall be plus or minus 2 inches.

Dowels other than column dowels shall be lapped 40 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 cove. A dowel shall be provided in the foundation for each vertical bar.

Where horizontal courses are to be filled, metal stops shall be used. Use of paper stops will not be permitted. All horizontal reinforcing steel shall be laid in a course of bond beam blocks filled with grout.

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 and 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.

d. Grouting. Grouted masonry shall be constructed in such a manner that all elements of the masonry act together as a structural element.

Prior to grouting, the grout space shall be clean so that all spaces to be filled with grout do not contain mortar projections greater than 1/2 inch, mortar droppings, or other foreign materials. Grout shall be placed so that all spaces designated to be grouted shall be filled with grout and the grout shall be confirmed to those specific spaces.

Grout materials and water content shall be controlled to provide adequate fluidity for placement, without segregation of the constituents and shall be mixed thoroughly.

The grouting of any section of wall shall be completed in 1 day with no interruptions greater than 1 hour.

Between grout pours, a horizontal construction joint shall be formed by stopping all wythes at the same elevation and with the grout stopping a minimum of 1 1/2 inches below a mortar joint, except at top of wall. Where bond beams occur, stop grout pour a minimum of 1/2 inch below the top of the masonry.

When required by the Engineer, cleanouts shall be provided in the bottom course at every vertical bar but shall not be spaced more than 32 inches on center for solidly grouted masonry. When cleanouts are required, they shall be sealed after inspection and before grouting.

Units may be laid to the full height of the grout pour and grout shall be placed in a continuous pour in grout lifts not exceeding 6 feet.

All cells and spaces containing reinforcing bars shall be filled with grout.

Segregation of the grout materials and damage to the masonry shall be avoided during the grouting process.

Grout shall be consolidated by mechanical vibration during placing before loss of plasticity in a manner to fill the grout space. Grout pours greater than 12 inches shall be reconsolidated by mechanical vibration to minimize voids due to water loss. Grout pours 12 inches or less in height shall be mechanically vibrated, or puddled.

In multiwythe grouted masonry, vertical barriers of masonry shall be built across the grout space. The grouting of any section of wall between barriers shall be completed in 1 day with no interruption longer than 1 hour.

Grout shall not be handled nor pumped utilizing aluminum equipment unless it can be demonstrated with the materials and equipment to be used that there will be no deleterious effect on the strength of the grout.

e. Cold Weather Construction.

1. General. All materials shall be delivered in a usable condition and stored to prevent wetting by capillary action, rain and snow.

The tops of all walls not enclosed or sheltered shall be covered with a strong weather-resistive material at the end of each day or shutdown.

Partially completed walls shall be covered at all times when work is not in progress. Covers shall be draped over the wall and extend a minimum of 2 feet down both sides and shall be securely held in place, except when additional protection is required in 4.

2. Execution - Preparation. If ice or snow has inadvertently formed on masonry bed, it shall be thawed by application of heat carefully applied until top surface of the masonry is dry to the touch.

A section of masonry deemed frozen and damaged shall be removed before continuing construction of that section.

3. Construction. Masonry units shall be dry. Wet or frozen masonry units shall not be laid.

Air temperature 40 degrees Fahrenheit to 32 degrees Fahrenheit: Sand or mixing water shall be heated to produce mortar temperatures between 40 degrees Fahrenheit and 120 degrees Fahrenheit.

Air temperature 32 degrees Fahrenheit to 25 degrees Fahrenheit: Sand and mixing water shall be heated to produce mortar temperatures between 40 degrees Fahrenheit and 120 degrees Fahrenheit. Maintain temperatures of mortar on boards above freezing.

Air temperature 25 degrees Fahrenheit to 20 degrees Fahrenheit: Sand and mixing water shall be heated to produce mortar temperatures between 40 degrees Fahrenheit and 120 degrees Fahrenheit. Maintain mortar temperatures on boards above freezing. Salamanders or other sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 15 mph.

Air temperature 20 degrees Fahrenheit and below: Sand and mixing water shall be heated to provide mortar temperatures between 40 degrees Fahrenheit and 120 degrees Fahrenheit. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees Fahrenheit. Temperature of units when laid shall not be less than 20 degrees Fahrenheit.

4. Protection. When the mean daily air temperature is 40 degrees Fahrenheit to 32 degrees Fahrenheit, masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

When the mean daily air temperature is 32 degrees Fahrenheit to 25 degrees Fahrenheit, masonry shall be completely covered with weather-resistive membrane for 24 hours.

When the mean daily air temperature is 25 degrees Fahrenheit to 20 degrees Fahrenheit, masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

When the mean daily air temperature is 20 degrees Fahrenheit and below, masonry temperature shall be maintained above 32 degrees Fahrenheit for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

5. Placing grout and protection of grouted masonry. When air temperatures fall below 40 degrees Fahrenheit, grout mixing water and aggregate shall be heated to produce grout temperatures between 40 degrees Fahrenheit and 120 degrees Fahrenheit.

Masonry to be grouted shall be maintained above freezing during grout placement and for at least 24 hours after placement.

When atmospheric temperatures fall below 20 degrees Fahrenheit, enclosures shall be provided around the masonry during grout placement and for at least 24 hours after placement.

- f. Protection and Curing of Masonry. During construction operations, all adjoining work shall be protected for mortar droppings. Concrete block masonry shall be protected from the sun and rain. When approved in advance by the Engineer, completed masonry construction may be protected with a curing compound. Except in hot weather when it may be fog-sprayed sufficiently to dampen the surface, finished concrete block masonry shall not be wetted.
- g. Bricklaying. Brick shall be clean, wetted immediately before laying, and shall be laid on a full mortar bed with "push joints." In no event will slushing or grouting of joints be permitted, nor shall a joint be made by working-in mortar after the brick has been laid. Joints between courses of bricks shall be of a uniform thickness of 3/8 inch as nearly as possible. Joints on surfaces which are not to be plastered, or on any surface that will be exposed upon completion of the work, shall be neatly struck and pointed. In all cases, the work shall be well-bonded, and if new work is to be joined to the existing or unfinished work, the contact surfaces of the latter shall first be properly cleaned and moistened.

Brickwork shall not be constructed upon a concrete foundation until at least 24 hours after such foundation has been placed. No brick shall be laid in water nor shall water be permitted to stand or run on any brickwork until the mortar has thoroughly set, except as provided in Subsection 335.01.03 (h) – "Protection and Curing of Brickwork."

- h. Protection and Curing of Brickwork. During construction operations, all adjoining work shall be protected from mortar droppings. Brickwork shall be protected from the sun and rain.

Except in hot weather when it may be fog-sprayed sufficiently to dampen the surface, finished brick masonry shall not be wetted.

336.01 GENERAL.

336.01.01 DESCRIPTION. This Section covers the inspection and *Quality Control/Quality Assurance* testing performed during construction. All materials furnished and placed by the *Contractor* shall be subject to inspection, testing and approval by the *Engineer*.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

336.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

336.01.01.02 Terms.

Qualified Personnel. Qualified personnel shall be defined as (an) individual(s) with the applicable NAQTC qualification(s) or comparable Agency approved qualification program for the test(s) performed. ACI Grade I Technician certification is recognized by the NAQTC for PCC field testing.

336.01.02 SAMPLING AND TESTING. Random sampling and *Quality Assurance* testing shall be conducted after the *Contractor* has delivered materials to the *Site of Work*, except as modified herein, to document that they meet the *Specifications*. The *Contractor* shall furnish, at no additional cost to the *Agency* or *Owner*, any labor that may be required to enable the *Engineer* to make a thorough inspection of the materials.

Materials that do not meet the *Specifications* and are rejected shall be immediately removed from the site. The neglect or failure on the part of the *Engineer* to condemn or reject materials or work shall not be construed to imply an acceptance of the materials or work.

336.01.02.01 Laboratory Requirement. Sampling and testing for the following subjects shall be performed in an *Accredited Laboratory*:

- A. Soil;
- B. Aggregate;
- C. Asphalt Cement;
- D. Emulsified Asphalt;
- E. HMA;
- F. Hydraulic Cement;
- G. Slag Cement;
- H. Pozzolan;
- I. PCC;
- J. Unit Masonry;
- K. Iron; and
- L. Steel.

The laboratory accreditation requirement became effective March 1, 2008, for all public works construction, whether administered directly by the *Agency* or by the *Owner*. AAP is the AASHTO accreditation program utilizing laboratory assessment and proficiency sample services provided by the AMRL and the CCRL and, at the time of this publication, is the most widely recognized national accreditation program. A comparable laboratory accreditation program may be submitted to the *Agency* for review and approval.

Information regarding accreditation, including a complete list of the related tests, and an electronic directory of AASHTO accredited laboratories are available at www.amrl.net.

336.01.02.02 Personnel Requirement. Sampling and testing for the following subjects shall be performed by, or under the direct supervision of, Qualified Personnel:

- A. Soil;
- B. Aggregate;
- C. HMA; and
- D. PCC.

The personnel qualification requirement became effective January 1, 2002, for all public works construction, whether administered directly by the *Agency* or by the *Owner*. NAQTC is a non-profit organization whose

Executive Board members are representatives of the *Blue Book*, the *Orange Book* and the *Silver Book*; ACEC, and the Nevada AGC. At the time of publication, the NAQTC qualification program administered by the University of Nevada, Reno is the most widely recognized state qualification program. A comparable qualification program may be submitted to the Agency for review and approval.

Information regarding qualification including a complete list of the related tests, and an electronic registry of NAQTC qualified technicians is available at www.naqtc.unr.edu.

336.02 SITE PREPARATION, PROTECTION AND RESTORATION AND SUBGRADE PREPARATION.

336.02.01 GENERAL.

336.02.01.01 Inspection.

336.02.01.02 Sampling and Testing. Sampling and testing shall conform to the applicable requirements of Table 336.02.01.02-I.

Table 336.02.01.02-I

| Test | Test Method | Frequency |
|--|---------------------------|--|
| CBR | ASTM D1883 | As directed by the <i>Engineer</i> or shown on the <i>Plans</i> or specified in the <i>Special Provisions</i> and/or <i>Special Technical Specifications</i> |
| Density of Soil and Soil-Aggregate In-Place by Nuclear Method | ASTM D6938 | |
| Density and Unit Weight of Soil In-Place by Rubber Balloon Method | ASTM D2167 | |
| Density and Unit Weight of Soil In-Place by Sand Cone Method | ASTM D1556 | |
| Laboratory Compaction Characteristics of Soil Using Modified Effort ⁽¹⁾ | ASTM D1557 | |
| Liquid Limit, Plastic Limit and Plasticity Index of Soils | ASTM D4318 ⁽²⁾ | |
| Material in Mineral Aggregate Finer than No. 200 Sieve by Washing | ASTM C117 | |
| Material in Soils Finer than No. 200 Sieve by Washing | ASTM C1140 | |
| Moisture Content of Soil (Microwave Oven Method) | ASTM D4643 | |
| Moisture Content of Soil (Nuclear Method) | ASTM D6938 | |
| Moisture Content of Soil by Mass ⁽³⁾ | ASTM D2216 | |
| Particle Size Analysis of Soils | AASHTO T 88 | |
| pH | ASTM E70 | |
| Resistance Value and Expansion Pressure of Compacted Soils | ASTM D2844 | |
| Sampling Aggregate | ASTM D75 | |
| Sand Equivalent of Soils and Fine Aggregate | ASTM D2419 | |
| Sieve Analysis | ASTM C136 | |
| Specific Gravity of Soil Solids by Water Pycnometer | ASTM D854 | |

1. Moisture Density Relation of Soil Using 10 LB Rammer and 18 inch Drop.
2. Dry Method.
3. Oven Method.

336.02.02 SUBGRADE PREPARATION.

336.02.02.01 Inspection.

336.02.02.02 Sampling and Testing. Sampling and testing shall conform to Table 336.02.02.02-I.

Table 336.02.02.02-I

| Test | Test Method | Frequency |
|--|---------------------------|--|
| Laboratory Compaction Characteristics of Soil Using Modified Effort ⁽¹⁾ | ASTM D1557 | One test for each soil type |
| Density of Soil and Soil-Aggregate In-Place by Nuclear Method | ASTM D6938 ⁽²⁾ | One test for every 500 SY or fraction thereof prepared daily |
| Density and Unit Weight of Soil In-Place by Rubber Balloon Method | ASTM D2167 ⁽²⁾ | |
| Density and Unit Weight of Soil In-Place by Sand Cone Method | ASTM D1556 ⁽²⁾ | |

1. Moisture Density Relation of Soil Using 10 LB Rammer and 18 inch Drop.
2. Unless shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, method shall be selected by the *Engineer*.

336.03 FILL, BEDDING, BACKFILL AND RIPRAP.

336.03.01 GENERAL.

336.03.01.01 Inspection.

336.03.01.02 Sampling and Testing.

336.03.02 FILL.

336.03.02.01.01 Sampling and Testing. Sampling and testing shall conform to Table 336.03.02.01.01-I.

Table 336.03.02.01.01-I

| Test | Test Method | Frequency |
|--|---------------------------|--|
| Laboratory Compaction Characteristics of Soil Using Modified Effort ⁽¹⁾ | ASTM D1557 | One test for each material type and/or source |
| Density of Soil and Soil-Aggregate In-Place by Nuclear Method | ASTM D6938 ⁽²⁾ | One test for every 500 SY per lift or fraction thereof prepared daily ⁽³⁾ |
| Density and Unit Weight of Soil In-Place by Rubber Balloon Method | ASTM D2167 ⁽²⁾ | |
| Density and Unit Weight of Soil In-Place by Sand Cone Method | ASTM D1556 ⁽²⁾ | |

1. Moisture Density Relation of Soil Using 10 LB Rammer and 18 inch Drop.
2. Unless shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, method shall be selected by the *Engineer*.
3. As directed or approved by the *Engineer*, for mass grading projects, frequency may be adjusted.

336.03.03 BEDDING AND BACKFILL.

336.03.03.01 Inspection.

336.03.03.02 Sampling and Testing. Sampling and testing shall conform to the applicable requirements of Table 336.03.03.02-I.

Table 336.03.03.02-I

| Test | Test Method | Frequency |
|--|---------------------------|---|
| Laboratory Compaction Characteristics of Soil Using Modified Effort ⁽¹⁾ | ASTM D1557 | One test for each aggregate type and/or source |
| Density of Soil and Soil-Aggregate In-Place by Nuclear Method | ASTM D6938 ⁽²⁾ | Per foot of thickness, the more restrictive of: |
| Density and Unit Weight of Soil In-Place by Rubber Balloon Method | ASTM D2167 ⁽²⁾ | One test between manholes or valves or |
| Density and Unit Weight of Soil In-Place by Sand Cone Method | ASTM D1556 ⁽²⁾ | One test every 500 LF, including laterals |

1. Moisture Density Relation of Soil Using 10 LB Rammer and 18 inch Drop.
2. Unless shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, method shall be selected by the *Engineer*.

Testing shall be distributed along the pipe alignment and not clustered at a single location.

336.03.04 RIPRAP.

336.03.04.01 Inspection.

336.03.04.02 Sampling and Testing. Routine control of gradation shall be by visual inspection. If directed by the *Engineer*, however, the *Contractor* shall provide 2 samples of the material of at least 5 tons each, meeting the gradation specified. One sample shall be located at the *Site of Work*. One sample shall be located at the source. These samples shall be available for the duration of material placement for use as reference for judging the gradation of the material supplied. In the event that the material supplied appears different from the reference sample, the *Contractor* shall provide a sorting site, mechanical equipment and labor to assist in the evaluation of the gradation of the contents of a randomly selected truck.

To further determine material characteristics, stone may be subjected to petrographic analysis.

336.04 PIPE SYSTEMS.

336.05 STORM DRAINS, CULVERTS AND SANITARY SEWERS.

336.06 POTABLE WATER SYSTEMS.

GRAVITY LINES - PRESSURE TESTS

Description. This work shall consist of the testing of all sewers and appurtenances, such as manholes, tees, risers, and services for the purposes of determining whether or not the facility has been installed in such a manner as to meet hydrostatic requirements set forth herein. Testing of storm drains may be required at the request of the *Engineer* or *Agency*.

Responsibility of Contractor. The *Contractor* shall construct all sewers and appurtenances consistent with testing requirements contained herein. Any section tested, including manholes, which does not meet these requirements shall be repaired and retested at no cost to the *Agency* and/or *Owner* until the conditions set forth herein are met.

The *Contractor* shall furnish all labor, equipment, and materials necessary to perform pressure tests.

Hydrostatic or Air Pressure tests may be used as approved by the *Engineer*.

Hydrostatic Tests. Water to be used in these tests will be furnished to the *Contractor* free of charge at hydrants. The *Contractor* shall meet the requirements of Section 143 - "Utility Services" and respect the use of *Agency*-owned

or private hydrants. Where hydrants are not accessible, the *Contractor* shall provide necessary equipment for hauling water.

The hydrostatic tests shall be conducted in the presence of the *Engineer* or authorized representative.

336.06.01.01.01 Test Requirements

- A. General. The *Contractor* shall be required to test each section of gravity sanitary sewer for leakage by means of a hydraulic test. Gravity sanitary sewers shall be tested by water exfiltration or infiltration method. The *Engineer* may allow substitution of an air pressure test for the water exfiltration test.
- B. Exfiltration. Each section of sewer shall be tested between successive manholes by closing the lower end of the pipe to be tested and the inlet of the upper manhole with plugs. The test shall be made after the pipe has been bedded and backfilled to a minimum of 1 Foot above the crown of the pipe, unless otherwise allowed by the *Engineer*. Prior to the start of the test, the sewer may be filled with water to a height of 5 feet over the crown of the pipe or existing groundwater and allowed to stand for a period not to exceed 72 hours.

Hydrostatic head for test purposes shall be equivalent to a maximum head of 5 feet above the (a) crown of the pipe at the upper manhole, or (b) groundwater level at the time of the test, whichever is greater. Where the gradient of the sewer would allow the hydrostatic head to exceed 7 feet above the crown at the lower manhole, the allowable leakage will be increased in accordance with these Specifications.

Hydrostatic test head shall be maintained for a period of at least 1 hour, or for such a length of time as may be necessary to satisfy the *Engineer*. Test shall be acceptable if the maximum allowable exfiltration from the sewer line does not exceed 500 gallons per inch of pipe diameter per mile per 24 hours. For head in excess of 7 feet above the crown at the lower manhole, the allowable leakage will be increased at a rate of 80 gallons per inch of pipe diameter per mile per 24 hours.

When leakage or infiltration exceeds the amount allowed by the Specifications, the *Contractor* at no cost to the *Agency* and/or *Owner* shall locate the leaks and make necessary repairs or replacements to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

- C. Infiltration. Where the sewer is laid in groundwater, the *Engineer* shall require infiltration tests.

In areas where the groundwater is at least 2 feet above the crown of the pipe, the *Contractor* shall backfill to a depth to prevent floating of pipe and, in no case, less than 1 foot above the groundwater or 4 feet above the crown on the pipe, whichever is greater. After the initial backfilling has been completed, the *Engineer* will measure the amount of infiltration at the lower manhole of each section being tested.

The final decision as to the method of testing by means of infiltration shall be made by the *Engineer*.

The allowable leakage in the sewer lines shall be equal to the amount allowed when testing by means of the exfiltration test. Infiltration shall not exceed 200 gallons per mile per day per inch of diameter of pipe at 5-foot head.

Air Pressure Tests. The *Contractor* shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the *Engineer*, unless otherwise shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

The air test may be dangerous if the line tested is not prepared properly or proper procedures are not followed. It is extremely important that plugs be installed and braced in such a way as to prevent blowouts. No one shall be allowed in or near manholes during pressurization, testing, or depressurization.

The *Contractor* shall submit to the governing *Agency* for approval a plan of safety in writing for any air test on pipe sizes above 24 inches in diameter.

The *Contractor* may conduct an initial air test of the sewer main line after densification of the backfill, but prior to installation of the house connection sewers. Such test will be considered for the *Contractor's* convenience and need not be performed in the presence of the *Engineer*.

Test Requirements. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the main line and the upper ends of all house connections for sanitary sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

The final leakage test of the main line and branching house connection sewers shall be conducted in the presence of the *Engineer* in the following manner:

Air shall be introduced into the pipeline until 3.0 *PSI* gauge pressure has been reached, at which time the flow of air shall be reduced and the internal air pressure shall be maintained between 2.5 and 3.5 *PSI* (gauge) for at least 2 minutes to allow the air temperature to come to equilibrium with the temperature of the pipe walls. Pressure in the pipeline shall be constantly monitored by a gate and hose arrangement separate from hose used to introduce air into the line. Pressure in the pipeline shall not be allowed to exceed 5 *PSI* (gauge).

After the temperature has stabilized and no air leaks at the plugs have been found, the air pressure shall be permitted to drop and, when the internal pressure has reached 2.5 *PSI* (gauge), the line shall be disconnected from the air source and a stop watch or sweep-second-hand watch shall be used to determine the time lapse required for the air pressure to drop to 1.5 *PSI* (gauge).

If the time lapse (in seconds) required for the air pressure to decrease from 2.5 to 1.5 *PSI* (gauge) exceeds that shown in the following table, the pipe shall be presumed to be within acceptable limits for leakage.

If the time lapse is less than that shown in the table, the *Contractor* shall make the necessary corrections to reduce the leakage to acceptance limits.

T = time in seconds for pressure to drop from 2.5 to 1.5 *PSI* (gauge).

D = *ID* of pipe in inches.

336.06.01 PRESSURE LINE - PRESSURE AND LEAKAGE TESTS.

336.06.01.01 Description. Test pressure shall not be less than 1 1/4 times the working pressure at the highest point along the test section.

Test pressure shall not exceed pipe or thrust-restraint design pressures.

The hydrostatic test shall have a minimum duration of 2 hours.

Test pressure shall not vary by more than ± 5 *PSI* for the duration of the test.

Valves shall not be operated in either direction at differential pressure exceeding the rated valve working pressure. For tests at these pressures, the test setup shall include provision independent of the valve to reduce the line pressure to the rated valve pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or fully opened if desired.

TABLE
LOW PRESSURE AIR TEST FOR SEWERS
Time (T) in Seconds

| Main Line | | 4-Inch House Connection | | | | | Main Line | | 6-Inch House Connection | | | | |
|-------------|-----|-------------------------|---------|---------|---------|---------|-------------|-----|-------------------------|---------|---------|---------|---------|
| Dia. Length | | House Connection Length | | | | | Dia. Length | | House Connection Length | | | | |
| In. | Ft. | 0 ft. | 100 ft. | 200 ft. | 300 ft. | 400 ft. | In. | Ft. | 0 ft. | 100 ft. | 200 ft. | 300 ft. | 400 ft. |
| 8 | 0 | 0 | 20 | 40 | 50 | 70 | 8 | 0 | 0 | 40 | 80 | 100 | 100 |
| | 50 | 40 | 50 | 70 | 90 | 80 | | 50 | 40 | 70 | 110 | 110 | 110 |
| | 100 | 70 | 90 | 100 | 100 | 90 | | 100 | 70 | 110 | 120 | 110 | 110 |
| | 150 | 110 | 120 | 110 | 100 | 100 | | 150 | 110 | 120 | 120 | 120 | 110 |
| | 200 | 140 | 120 | 110 | 110 | 100 | | 200 | 140 | 130 | 120 | 120 | 120 |
| | 300 | 140 | 130 | 120 | 110 | 110 | | 300 | 140 | 130 | 120 | 120 | 120 |
| | 400 | 140 | 130 | 120 | 120 | 110 | | 400 | 140 | 130 | 130 | 120 | 120 |
| 10 | 50 | 50 | 70 | 90 | 100 | 90 | 10 | 50 | 50 | 90 | 120 | 120 | 110 |
| | 100 | 110 | 130 | 120 | 110 | 110 | | 100 | 110 | 140 | 130 | 130 | 120 |
| | 200 | 170 | 150 | 140 | 130 | 120 | | 200 | 170 | 150 | 140 | 140 | 130 |
| | 300 | 170 | 160 | 150 | 140 | 130 | | 300 | 170 | 160 | 150 | 140 | 140 |
| | 400 | 170 | 160 | 150 | 150 | 140 | | 400 | 170 | 160 | 150 | 150 | 140 |
| 12 | 50 | 80 | 100 | 110 | 110 | 110 | 12 | 50 | 80 | 120 | 140 | 130 | 120 |
| | 100 | 160 | 170 | 150 | 140 | 130 | | 100 | 160 | 170 | 150 | 140 | 140 |
| | 200 | 200 | 180 | 170 | 160 | 150 | | 200 | 200 | 180 | 170 | 160 | 150 |
| | 300 | 200 | 190 | 180 | 170 | 160 | | 300 | 200 | 190 | 180 | 170 | 160 |
| | 400 | 200 | 190 | 180 | 180 | 170 | | 400 | 200 | 190 | 180 | 180 | 170 |
| 15 | 50 | 120 | 140 | 160 | 140 | 130 | 15 | 50 | 120 | 160 | 160 | 150 | 140 |
| | 100 | 250 | 220 | 190 | 170 | 160 | | 100 | 250 | 210 | 190 | 170 | 160 |
| | 200 | 260 | 230 | 220 | 200 | 190 | | 200 | 260 | 230 | 210 | 200 | 190 |
| | 300 | 260 | 240 | 230 | 220 | 210 | | 300 | 260 | 240 | 220 | 210 | 200 |
| | 400 | 260 | 240 | 230 | 220 | 220 | | 400 | 260 | 240 | 230 | 220 | 210 |
| 18 | 50 | 180 | 200 | 190 | 170 | 150 | 18 | 50 | 180 | 220 | 190 | 170 | 160 |
| | 100 | 310 | 260 | 230 | 210 | 190 | | 100 | 310 | 260 | 220 | 200 | 190 |
| | 200 | 310 | 280 | 260 | 250 | 230 | | 200 | 310 | 280 | 260 | 240 | 220 |
| | 300 | 310 | 290 | 280 | 260 | 250 | | 300 | 310 | 290 | 270 | 260 | 240 |
| | 400 | 310 | 290 | 280 | 270 | 260 | | 400 | 310 | 290 | 280 | 270 | 260 |
| 21 | 50 | 240 | 260 | 230 | 200 | 180 | 21 | 50 | 240 | 260 | 220 | 200 | 180 |
| | 100 | 360 | 310 | 280 | 250 | 230 | | 100 | 360 | 300 | 260 | 240 | 220 |
| | 200 | 360 | 330 | 310 | 290 | 280 | | 200 | 360 | 330 | 300 | 280 | 260 |
| | 300 | 360 | 340 | 320 | 310 | 300 | | 300 | 360 | 330 | 320 | 300 | 290 |
| | 400 | 360 | 340 | 330 | 320 | 310 | | 400 | 360 | 340 | 330 | 310 | 300 |
| 24 | 50 | 320 | 320 | 270 | 240 | 210 | 24 | 50 | 320 | 310 | 260 | 220 | 200 |
| | 100 | 410 | 360 | 320 | 290 | 270 | | 100 | 410 | 350 | 310 | 280 | 260 |
| | 200 | 410 | 380 | 360 | 340 | 320 | | 200 | 410 | 370 | 350 | 320 | 310 |
| | 300 | 410 | 390 | 370 | 360 | 350 | | 300 | 410 | 380 | 360 | 350 | 330 |
| | 400 | 410 | 390 | 380 | 370 | 360 | | 400 | 410 | 390 | 370 | 360 | 350 |

Test pressure shall not exceed the rated pressure of the valves when the pressure boundary of the test section includes closed, resilient-seated gate valves or butterfly valves.

Pressurization. After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 1 1/2 times the working pressure at the point of testing. Each valved section of pipe shall be slowly filled with water, and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the *Engineer*. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. It is good practice to allow the system to stabilize at the test pressure before conducting the leakage test.

Air Removal. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place at the discretion of the *Engineer*.

Examination. Any exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until it is satisfactory to the *Engineer*.

Leakage Defined. Leakage shall be defined as the quantity of water that must be supplied within 5 *PSI* of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

Allowable Leakage. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{CSD\sqrt{P}}{133,200}$$

Where:

L = allowable leakage, in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of the pipe, in inches

P = average test pressure during the leakage test, in pounds per square inch (gauge)

C = 1.0 for ductile iron pipe; 0.90 for C900 PVC pipe

These formulas are based on an allowable leakage of 11.65 gpd/mi/in. of nominal diameter at a pressure of 150 *PSI*.

Allowable leakage at various pressure per 1,000 feet of Pipeline shall conform to Table 336.03.08.06-I.

TABLE
ALLOWABLE LEAKAGE (GPH/1000 Ft)

| PSI | Nominal Pipe Diameter – Inches | | | | | | | | | | | | | | | |
|-----|--------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 1.6 | 1.8 | 20 | 24 | 30 | 36 | 42 | 48 | 54 |
| 450 | 0.48 | 0.64 | 0.95 | 1.27 | 1.59 | 1.91 | 2.23 | 2.55 | 2.87 | 3.18 | 3.82 | 4.78 | 5.73 | 6.69 | 7.64 | 8.60 |
| 400 | 0.45 | 0.60 | 0.90 | 1.20 | 1.50 | 1.80 | 2.10 | 2.40 | 2.70 | 3.00 | 3.60 | 4.50 | 5.41 | 6.31 | 7.21 | 8.11 |
| 350 | 0.42 | 0.56 | 0.84 | 1.12 | 1.40 | 1.69 | 1.97 | 2.25 | 2.53 | 2.81 | 3.37 | 4.21 | 5.06 | 5.90 | 6.74 | 7.58 |

| | Nominal Pipe Diameter – Inches | | | | | | | | | | | | | | | |
|-----|--------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 300 | 0.39 | 0.52 | 0.78 | 1.04 | 1.30 | 1.56 | 1.82 | 2.08 | 2.34 | 2.60 | 3.12 | 3.90 | 4.68 | 5.46 | 6.24 |
| 275 | 0.37 | 0.50 | 0.75 | 1.00 | 1.24 | 1.49 | 1.74 | 1.99 | 2.24 | 2.49 | 2.99 | 3.73 | 4.48 | 5.23 | 5.98 | 6.72 |
| 250 | 0.36 | 0.47 | 0.71 | 0.95 | 1.19 | 1.42 | 1.66 | 1.90 | 2.14 | 2.37 | 2.85 | 3.56 | 4.27 | 4.99 | 5.70 | 6.41 |
| 225 | 0.34 | 0.45 | 0.68 | 0.90 | 1.13 | 1.35 | 1.58 | 1.80 | 2.03 | 2.25 | 2.70 | 3.38 | 4.05 | 4.73 | 5.41 | 6.03 |
| 200 | 0.32 | 0.43 | 0.64 | 0.85 | 1.06 | 1.28 | 1.48 | 1.70 | 1.91 | 2.12 | 2.55 | 3.19 | 3.82 | 4.46 | 5.09 | 5.73 |
| 175 | 0.30 | 0.40 | 0.59 | 0.80 | 0.99 | 1.19 | 1.39 | 1.59 | 1.79 | 1.98 | 2.38 | 2.98 | 3.58 | 4.17 | 4.77 | 5.36 |
| 150 | 0.28 | 0.37 | 0.55 | 0.74 | 0.92 | 1.10 | 1.29 | 1.47 | 1.66 | 1.84 | 2.21 | 2.76 | 3.31 | 3.86 | 4.41 | 4.97 |
| 125 | 0.25 | 0.34 | 0.50 | 0.67 | 0.84 | 1.01 | 1.18 | 1.34 | 1.51 | 1.68 | 2.01 | 2.52 | 3.02 | 3.53 | 4.03 | 4.53 |
| 100 | 0.13 | 0.30 | 0.45 | 0.60 | 0.75 | 0.90 | 1.05 | 1.20 | 1.35 | 1.50 | 1.80 | 2.25 | 2.70 | 3.15 | 3.60 | 4.05 |

1. Average Test Pressure.
2. For C900 and C905 PVC pipe, multiply the values in the table by 0.90.
3. If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.
 - A. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gpd/in. of nominal valve size shall be allowed.
 - B. When hydrants are in the test section, the test shall be made against closed hydrant valves.
 - C. Acceptance of Installation. Acceptance shall be determined on the basis of allowable leakage. If any test of laid pipe discloses leakage greater than that specified in this section, the *Contractor* shall, at no cost to the *Agency* and/or *Owner*, locate and make approved repairs as necessary until the leakage is within the specified allowance.
 - D. All visible leaks are to be repaired, regardless of the amount of leakage.

PLASTIC PIPE DEFLECTION TEST.

Deflection Test for Plastic Pipe and Fittings. Installed pipe shall be tested to insure that vertical deflections for plastic pipe do not exceed the maximum allowable deflection. Maximum allowable deflections shall be governed by the mandrel requirements stated herein and shall nominally be:

1. Three percent of the maximum average ID for ABS or PVC Composite Pipe.
2. For all plastic pipe other than ABS or PVC Composite Pipe, the percentage listed of the maximum average ID.

| Nominal Pipe Size | Percentage |
|---------------------------------------|------------|
| Up to and including 12 Inch | 5.0 |
| Over 12 Inch to and including 30 Inch | 4.0 |
| Over 30 Inch | 3.0 |

The maximum base inside diameter shall be equal to the average OD minus 2 times the minimum wall thickness in accordance with ASTM Standards and other manufacturing tolerances for determining maximum allowable deflections. See Appendix XI and table XI.I of ASTM D 3034 and Appendix X2 and Table X2.1 of ASTM F 679.

Deflection tests shall be performed not sooner than 30 days after completion of placement and compaction of backfill. The pipe shall be cleaned and inspected for offsets and obstructions prior to testing.

For all pipes less than 24 Inch *ID*, a mandrel shall be pulled through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. If the mandrel fails to pass, the pipe will be deemed to be over-deflected. Prior to use, the mandrel shall be approved by the *Engineer* or by another entity approved by the *Engineer*. Use of an uncertified mandrel or a mandrel altered or modified after certification will invalidate the test.

Any over-deflected pipe shall be uncovered and, if not damaged, reinstalled.

Damaged pipe shall not be reinstalled, but shall be removed from the *Site of Work*. Any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any over-deflection, shall be uncovered, removed from the *Site of Work*, and replaced with new pipe.

The mandrel shall:

1. Have an odd number of legs (9 legs minimum) and be a rigid, nonadjustable mandrel having an effective length not less than its nominal diameter.
2. Be fabricated of steel; be fitted with pulling rings at each end; be stamped or engraved on some segment, other than a runner, indicating the pipe material specification, nominal size, and mandrel *OD* (e.g., PVC D 3034-8" - 7.524", ABS Composite D 2680-10" - 9.584"); and be furnished in a suitable carrying case labeled with the same data as stamped or engraved on the mandrel. For the pipe *IDs* nominally 24 Inch and larger, deflections shall be determined by a method submitted to and approved by the *Engineer*. If a mandrel is selected, the minimum diameter, length, and other requirements shall conform to the dimensions and requirements as stated above.

336.07 AGGREGATES.

336.07.01 GENERAL.

336.07.01.01 Inspection.

336.07.01.02 Sampling and Testing. Sampling and testing for source acceptance shall conform to the applicable requirements of Table 336.07.01.02-I.

Table 336.07.01.02-I

| Test | Test Method | Frequency |
|--|---------------------------|--|
| Fractured Particles in Coarse Aggregate | ASTM D5821 | As directed by the <i>Engineer</i> or shown on the <i>Plans</i> or specified in the <i>Special Provisions</i> and/or <i>Special Technical Specifications</i> |
| Laboratory Compaction Characteristics of Soil Using Modified Effort ⁽¹⁾ | ASTM D1557 | |
| Liquid Limit, Plastic Limit and Plasticity Index of Soils | ASTM D4318 ⁽²⁾ | |
| Material in Mineral Aggregate Finer than No. 200 Sieve by Washing | ASTM C117 | |
| Moisture Content of Soil (Microwave Oven Method) | ASTM D4643 | |
| Moisture Content of Soil by Mass ⁽³⁾ | ASTM D2216 | |
| Resistance to Degradation | ASTM C131 ⁽⁴⁾ | |
| Resistance Value and Expansion Pressure of Compacted Soils | ASTM D2844 | |
| Sampling Aggregate | ASTM D75 | |
| Sieve Analysis | ASTM C136 | |

1. Moisture Density Relation of Soil Using 10 LB Rammer and 18 inch Drop.

2. Dry Method.

3. Oven Method.

4. 500 Revolutions.

336.07.02 UNTREATED AGGREGATE BASE COURSES.

336.07.02.01 Inspection.

336.07.02.02 Sampling and Testing. Sampling and testing shall conform to Table 336.08.02.02-I.

Table 336.07.02.02-I

| Test | Test Method | Frequency |
|--|---------------------------|---|
| Laboratory Compaction Characteristics of Soil Using Modified Effort ⁽¹⁾ | ASTM D1557 | One test for each aggregate type and/or source |
| Density of Soil and Soil-Aggregate In-Place by Nuclear Method | ASTM D6938 ⁽²⁾ | One test for every 250 LF of PCC flatwork or curb or fraction thereof prepared daily |
| Density and Unit Weight of Soil In-Place by Rubber Balloon Method | ASTM D2167 ⁽²⁾ | |
| Density and Unit Weight of Soil In-Place by Sand Cone Method | ASTM D1556 ⁽²⁾ | One test for every 500 lane-feet of roadway per lift or fraction thereof prepared daily |

1. Moisture Density Relation of Soil Using 10 LB Rammer and 18 inch Drop.
2. Unless shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, method shall be selected by the *Engineer*.

336.08 CEMENT TREATED BASE COURSES.

336.08.01 INSPECTION.

336.08.02 SAMPLING AND TESTING. Sampling and testing shall conform to Table 336.08.02.02-I.

Table 336.08.02.02-I

| Test | Test Method | Frequency |
|--|---------------------------|---|
| Laboratory Compaction Characteristics of Soil Using Modified Effort ⁽¹⁾ | ASTM D1557 | One test for each aggregate mixture and/or source |
| Density of Soil and Soil-Aggregate In-Place by Nuclear Method | ASTM D6938 ⁽²⁾ | One test for every 500 lane-feet of roadway per lift or fraction thereof prepared daily |
| Density and Unit Weight of Soil In-Place by Rubber Balloon Method | ASTM D2167 ⁽²⁾ | |
| Density and Unit Weight of Soil In-Place by Sand Cone Method | ASTM D1556 ⁽²⁾ | |

1. Moisture Density Relation of Soil Using 10 LB Rammer and 18 inch Drop.
2. Unless shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, method shall be selected by the *Engineer*.

336.09 ATPB.

336.09.01 INSPECTION.

336.09.02 SAMPLING AND TESTING. Sampling and testing shall conform to Table 336.09.02-I.

Table 336.09.02-I

| Test | Test Method | Frequency |
|---|-------------|-----------|
| Material in Mineral Aggregate Finer than No. 200 Sieve by Washing | ASTM C117 | 1 per lot |
| Sampling Aggregate | ASTM D75 | 1 per lot |
| Sieve Analysis | ASTM C136 | 1 per lot |

336.10 PCC.

336.10.01 SAMPLING AND TESTING. Sampling and testing shall conform to Table 336.10.01-I.

Table 336.10.01-I

| Test | Test Method | Frequency |
|---|---------------------------------|--|
| Air Content of Fresh Concrete (Pressure Method) | ASTM C231 | PCC shall be sampled and tested for conformance every 50 CY per mix or fraction thereof placed daily |
| Air Content of Fresh Concrete (Volumetric Method) | ASTM C173 | |
| Compressive Strength of Molded Concrete Cylinders | ASTM C39 | |
| Making & Curing Concrete Compression & Flexure Test Specimen in the Field | ASTM C31 ^{(1) (2) (3)} | |
| Sampling Fresh Concrete | ASTM C172 | |
| Slump of Portland Cement Concrete | ASTM C143 | |
| Temperature | ASTM C1064 | |
| Unit Weight and Yield | ASTM C138 | |

1. A minimum of two 6 x 12 Inch or three 4 x 8 Inch test cylinders shall be prepared for testing at 28 Days for design acceptance.
2. The diameter of cylindrically molded specimens shall be at least equal to four times the nominal maximum size of the aggregate.
3. Slump, air content, and temperature tests shall also be performed at the time of sampling.

During field curing, cylinders shall be protected from the elements in a container equipped with a thermometer capable of recording the high and low temperature experienced during the storage period. Records of thermometer readings shall be made available upon request.

Unless otherwise directed or approved by the *Engineer* the cylinder from each set shall be tested at 7 Days, one at 14 Days, and the remaining cylinders at 28 Days; unless the first 28 day test indicates that the specified compressive strength has not been attained. In the event the specified strength has not been attained in 28 Days, the remaining cylinder(s) shall be tested at 56 Days.

When the final compressive strength test indicates that the specified compressive strength has not been attained, supplemental cores may be obtained from adjacent areas. The *Engineer* and *Contractor* shall agree on the method of payment prior to obtaining the cores. Three cores shall be taken for each location that the compressive strength test result is challenged. Unless otherwise directed or approved by the *Agency*, cores shall be obtained and moisture conditioned in accordance with ASTM C42. It is recommended, that the diameter of cored specimens or the width of sawed specimens be at least equal to four times the nominal maximum size of the aggregate.

PCC in the area represented by the cores shall be considered structurally adequate and in compliance with specification documents if the average of the three cores is equal to at least 85 percent of the required minimum design strength, and no single core is less than 75 percent of the design strength. To check testing accuracy, locations represented by erratic core strengths may be retested. Should the cores document that the compressive strength of PCC is structurally adequate, the *Contractor* may request compensation for the expenses associated with the cores. Should the average compressive strength of the additional cores prove deficient, the work shall be subject to rejection.

336.11 PCC FLATWORK, CURBS, DITCHES AND SLOPE PAVING.

- 336.11.01 INSPECTION.
- 336.11.02 SAMPLING AND TESTING.

336.12 PCCP.

- 336.12.01 INSPECTION.
- 336.12.02 SAMPLING AND TESTING.

336.13 PCC STRUCTURES.

- 336.13.01 INSPECTION.
- 336.13.02 SAMPLING AND TESTING.

336.14 MONOLITHIC PRECAST RC BOX.

- 336.14.01 INSPECTION.
- 336.14.02 SAMPLING AND TESTING.

336.15 SEGMENTED PRECAST BOX.

- 336.15.01 INSPECTION.
- 336.15.02 SAMPLING AND TESTING.

336.16 PRIME AND TACK COAT.

- 336.16.01 INSPECTION.
- 336.16.02 SAMPLING AND TESTING.

336.17 BITUMINOUS ROADMIX.

- 336.17.01 INSPECTION.
- 336.17.02 SAMPLING AND TESTING.

336.18 HMA.

- 336.18.01 INSPECTION.
- 336.18.02 SAMPLING AND TESTING. Sampling and testing shall conform to Table 336.18.02-I.

Table 336.18.02-I

| Test | Test Method | Frequency |
|---|----------------------------------|---------------|
| Sampling Bituminous Paving Mixtures | ASTM D979 ⁽¹⁾ | 1 per lot |
| Air Voids in Compacted Dense and Open Bituminous Paving Mixtures | ASTM D3203 | |
| Asphalt Content of Hot-Mix Asphalt by Ignition Method | ASTM D6307 ⁽²⁾ | 1 per lot |
| Quantitative Extraction of Bitumen from Bituminous Paving Mixtures | ASTM D2172 ⁽²⁾ | |
| Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures | ASTM D2726 Compacted Pavement | 1 set per lot |

| Test | Test Method | Frequency |
|---|---|---|
| | ASTM D2726 Lab molded | 1 per 2,000 tons, or 1 per day whichever is more |
| Marshall Stability and Flow of Bituminous Mixtures | ASTM D6927 | 1 per 2,000 tons, or 1 per day whichever is more |
| Mechanical Size Analysis of Extracted Aggregate | ASTM D5444 | 1 per lot |
| Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures | ASTM D2041 ⁽³⁾⁽⁴⁾ | 1 per lot |
| Thickness or Height of Compacted Bituminous Paving Mixture Specimens | ASTM D3549 ⁽⁵⁾ Compacted Pavement | 1 set per lot |
| | ASTM D3549 ⁽⁶⁾ Lab Molded | 1 per 2,000 tons, or 1 per day whichever is more |
| Sampling Bituminous Materials | ASTM D140 | As directed |
| | | |

1. A minimum of three locations shall be sampled within a 20-Foot traverse of the paver. However, no samples will be taken within 1 Foot of either edge of paver width. The sample shall be taken such that the material sampled will represent a single lot. When samples are obtained by more than one testing laboratory, the samples shall be split from a single sample or taken at the same time and at locations immediately adjacent to each other.
2. Unless shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, method shall be selected by the *Engineer*.
3. Test duration shall be 15 minutes unless stripping is noted in which case the test will be discontinued when stripping is first observed (note: an automatic timer is recommended).
4. The supplemental "dry back" procedure shall not be used.
5. Thickness shall be determined using Method A to the nearest 0.05 Inch for individual samples with the average for the lot rounded to the nearest 0.1 Inch. Averages ending in 0.05 shall be rounded up. For laboratory compacted specimens for air voids analysis, the thickness shall be reported to the 0.01 inch.
6. Thickness shall be determined and reported using Method A to the nearest 0.01 Inch

336.18.02.01 Shipping. Samples shall be transported in containers constructed to preclude heat loss or eliminate contamination of any part of the sample, or damage to the contents from mishandling during shipment.

336.18.02.01.01 Required Information. Samples shall have individual identification attached giving the following information at a minimum:

- A. Project name, highway or street name, and other pertinent geographical information;
- B. *Contractor* placing the *HMA*;
- C. *HMA* plant location and mix Identification;
- D. Point at which sampled, for samples taken from roadway, both by station and location transversely in pavement; lift and specified thickness, sample location;
- E. Quantity represented and lot number;
- F. Date sampled;
- G. Personnel name(s);
- H. Other parties obtaining sample(s) representative of the lot and if split or individual samples(s); and
- I. Temperature of the *HMA* upon sampling.

The temperature of the *HMA* as received in the laboratory shall be recorded and reported.

An approximate sample size of 50 pounds or more shall be obtained such that a 25 pound sample is available for retesting at a later date. All samples shall be retained until the entire project is accepted.

336.18.02.02 Laboratory Testing of HMA. The testing agency shall make every effort to provide test results in a timely manner. Mix properties and Marshall test results should be provided within 24 hours of HMA placement. *Rice Relative Compaction* results should be provided within 48 hours of obtaining cut samples.

336.18.02.02.01 Preparing Field Sample. The HMA sample received by the laboratory shall be split or quartered, such that enough material is available to perform required tests with a minimum excess of 2,000 grams of HMA.

336.18.02.02.02 Theoretical Maximum (Rice) Specific Gravity. At least one *Theoretical Maximum (Rice) Specific Gravity* determination shall be made for each lot to be tested.

336.18.02.02.03 Mix Properties. Bituminous Mixtures shall be tested in accordance with the frequencies shown in Table 336.20.02-I. As directed or approved by the *Engineer* the frequency may be adjusted.

336.18.02.02.03.01 Ignition Oven Correction Factors. Laboratories testing HMA shall request and obtain representative samples of all materials used in the production of the HMA, including, but not limited to, aggregates (virgin and recycled), binder and additives, for determination of equipment specific ignition oven correction factors in accordance with AASHTO T 308 for each type of aggregate used.

336.18.02.02.03.02 Marshall Compaction. The field sample shall be reheated to the associated mix design compaction temperature for Marshall testing in a covered container in an oven. Duration of reheating of the sample and the oven temperature shall be noted on the test report.

The mold assembly, hammers and pedestal shall conform to *ASTM D6926*. Molds and hammers shall be heated to a temperature between 200-300°F. A filter paper should be placed in the bottom of the mold and the amount of HMA to achieve a 2-1/2 Inch compacted sample shall be placed in the mold. It may be necessary to adjust the mass of HMA placed in the mold by splitting or quartering to ensure a 2-1/2 inch specimen is achieved. Specimens outside the range of 2.450-2.550 inches in measured thickness shall be considered invalid for relative compaction determination.

Spade the mixture vigorously with a heated spatula 15 times around the perimeter and ten times over the interior. Smooth the surface of the mix with a heated spatula to a slightly rounded shape. Temperatures of the HMA immediately prior to compaction shall be within 5° F of the compaction temperature used in the preparation of the mix design.

Compact the specimens with a properly correlated single mechanical compactor with a fixed base or by a manually held, hand-operated Marshall compaction hammer. If a dispute arises a manually operated, hand-held Marshall compaction hammer shall be the referee method.

In addition to the procedures outlined in *ASTM D6926*, Section 1.3, the number of compaction blows to be applied by a mechanical Marshall hammer shall be adjusted to produce Marshall unit weights within 1 pound of a manually held hand-operated Marshall compaction hammer on a similar mix. At a minimum, this correlation shall be performed annually for each mechanical hammer at 50 and 75 blows on each type of mix for each aggregate source. Correlation records shall be made available upon request.

A minimum of three specimens shall be compacted for each HMA sample taken. The compacted samples may be extruded from the molds once the molds have reached approximately 120° F.

Specimens shall be corrected for stability based on Table 1 of *ASTM D6927*. The height of the specimens shall be determined by Method A of *ASTM D3549* using properly calibrated calipers.

336.18.02.02.04 Marshall Density. The range of specific gravity test results of the three Marshall specimens shall not exceed 0.020. One specimen may be eliminated from the set of Marshall specimens when averaging the specific gravity values and analyzing the validity of the set of specimens.

Note: The eliminated specimen must be obviously different than the other two; otherwise the entire set shall be rerun.

An additional set of Marshall specimens shall be prepared in accordance with the above procedures if specimens do not conform to thickness range requirements.

Record and report the specimen set average dry mass in grams to the nearest 0.1 gram, and measured thickness to the nearest 0.01 inch on the test result summary.

336.18.02.02.05 Relative Compaction. Relative compaction of the compacted layer shall be determined by dividing the specific gravity of a cut sample by the *Theoretical Maximum (Rice) Specific Gravity* representative of lot from which the sample was obtained expressed as a percentage to the nearest 0.1 percent. At least three cut samples shall be obtained at random representative locations within the lot. Cut samples which are vertically comprised of more than one lot placed shall be divided at the interface(s) of the lot(s) and each lot shall be individually tested.

The average *Rice Relative Compaction* of each lot will be based on the average of the relative compaction determinations, rounded to the nearest 1 percent. *Rice Relative Compaction* which averages exactly 0.5 percent and greater shall be rounded up to the nearest 1 percent; *Rice Relative Compaction* which averages less than 0.5 percent shall be rounded down to the nearest 1 percent. At the *Engineer's* option, *Rice Relative Compaction* may be reported to the nearest 0.1 percent for informational purposes; however, evaluation for acceptance and mitigation shall be based on the *Rice Relative Compaction* of the lot rounded to the nearest 1 percent.

In the event that *Rice Relative Compaction* of the lot based on the initial cut samples obtained does not conform to Subsection 320.04.02 – “Relative Compaction”, supplemental cut samples may be obtained. The *Engineer* and *Contractor* shall agree on the method of payment prior to obtaining the cut samples. The *Engineer* and *Contractor* shall agree if the supplemental results will be used in determining the *Rice Relative Compaction* of the lot or to isolate areas of low relative compaction and select the sample locations.

Results of all tests performed by qualified personnel in an *Accredited Laboratory* shall be accepted for determination of the *Rice Relative Compaction* of the lot. All supplemental results will be used in addition to, not in lieu of, the relative compaction obtained on the initial cut samples.

336.18.02.02.06 Thickness. Compacted *HMA* layer thickness of the lot shall be determined from the average of the thicknesses of the random cut samples obtained for relative compaction determination.

Individual cut samples shall be measured to the nearest 0.05". Individual cut samples shall be recorded and reported to the nearest 0.05" in accordance with the Table 336.18.02.02.06-I.

Table 336.18.02.02.06-I

| Recorded Individual Measurements | | Reported Thickness ⁽¹⁾ |
|---|--------------------------------------|-----------------------------------|
| Using Apparatus Capable of 2 Decimal Places | Using Apparatus Capable of 1/16 Inch | |
| 2.23" to 2.27" | 2-4/16" = 2.250" | 2.25" |
| 2.28" to 2.32" | 2-5/16" = 2.313" | 2.30" |
| 2.33" to 2.37" | --- | 2.35" |
| 2.38" to 2.42" | 2-6/16" = 2.375" | 2.40" |
| 2.43" to 2.47" | 2-7/16" = 2.438" | 2.45" |
| 2.48" to 2.52" | 2-8/16" = 2.500" | 2.50" |

1. Rounded.

For purpose of acceptance and mitigation, the average of the rounded thickness measurements of the 3 cut samples for each lot shall be reported to the nearest 0.1". A number ending in 0.05" shall be rounded up. For example, both 2.35" and 2.40" are rounded to 2.4".

In the event that average thickness of the lot based on the initial cut samples obtained does not conform to Subsection 320.04.03 – “Thickness”, supplemental cut samples may be obtained. The *Engineer* and

Contractor shall agree on the method of payment prior to obtaining the cut samples. The *Engineer* and *Contractor* shall agree if the supplemental results will be used in determining the average thickness of the lot or to isolate areas of insufficient thickness and select the sample locations.

All supplemental results will be used in addition to, not in lieu of, the thicknesses of the initial cut samples.

336.18.02.02.06.01 Thickness Greater Than $\frac{1}{2}$ Inch Less Than Specified Minimum Thickness.

In the event that a cut sample is greater than $\frac{1}{2}$ inch less than the specified minimum thickness, three supplemental cut samples shall be obtained within a 15' radius of the sample that is deficient. The *Engineer* and *Contractor* shall agree if the supplemental results will be used in determining the thickness of the lot or to isolate areas of deficient thickness and select the sample locations. When used for lot thickness determination, the initial cut sample thickness shall be averaged with the thicknesses of the three supplemental cut samples and the resultant value shall be averaged with the thicknesses of the remaining initial cut samples.

336.18.02.03 RAP Used in HMA. In addition to conformance to Subsections 336.03.04.01 – “Field Sampling of HMA” and 336.03.04.02 – “Laboratory Testing of HMA”, process control testing shall be performed on the stockpiled RAP used in HMA.

336.18.02.03.01 General. Regardless of the percentage of RAP incorporated in the HMA, each finished RAP stockpile shall be tested to verify production of a uniform material. One representative sample shall be obtained for every 1000 tons of RAP in a stockpile, with a minimum number of 3 samples per stockpile. The following tests shall be performed on each sample:

| | |
|---|------------|
| | |
| Standard Practice for Sampling Aggregates | ASTM D75 |
| Bitumen Ratio | ASTM D6307 |
| Or ¹ | |
| Quantitative Extraction of Bitumen from Bituminous Mixtures | ASTM D2172 |
| Extracted Aggregate Gradation | ASTM D5444 |

The individual values as determined during stockpile testing should not vary more than 2 percent between the high and low values for bitumen ratio.

Note 1: Perform both ASTM D6307 and ASTM D2172 on at least 3 split samples per stockpile for the establishment of the ignition oven correction factor.

In addition, a composite sample shall be obtained from the material created f ASTM D6307 or ASTM D2172 as described above, representing no more than 5000 tons of RAP. The following tests shall be performed:

| | |
|---|-----------|
| | |
| Bulk Specific Gravity of Coarse Aggregate | ASTM C127 |
| Bulk Specific Gravity of Fine Aggregate | ASTM C128 |

RAP aggregate shall have a minimum combined aggregate bulk specific gravity of 2.470.

Any subsequent or additional testing of RAP required for mix design purposes shall be conducted on representative samples taken from the RAP stockpile.

336.18.02.03.02 HMA Containing Greater Than 15 Percent RAP By Dry Weight of Aggregate. For RAP to be incorporated in a recycled bituminous plantmix in an amount greater than 15 percent by dry weight of aggregate, 1 representative sample shall be obtained for every 5000 tons of RAP in a stockpile, with a minimum of 1 sample per stockpile. The testing program shall include the performance of one of the following test sets:

| | |
|--|--------------|
| Quantitative Extraction of Bitumen from Bituminous Mixtures | ASTM D2172 |
| Recovery of Asphalt from Solvent by the Abson Method | ASTM D1856 |
| Performance Graded Asphalt Binder | AASHTO M 320 |
| Appendix of Superpave Volumetric Mix Design (Blending Charts) | AASHTO M 323 |
| Or | |
| Quantitative Extraction of Bitumen from Bituminous Mixtures | ASTM D2172 |
| Practice for Recovery of Asphalt from Solution using the Rotary Evaporator | ASTM D5404 |
| Performance Graded Asphalt Binder | AASHTO M 320 |
| Appendix of Superpave Volumetric Mix Design (Blending Charts) | AASHTO M 323 |

The blend of *RAP* binder and virgin asphalt binder shall meet the original binder grade as specified by the *Engineer*.

Unless otherwise directed or approved by the *Engineer*, combined aggregate blend, including *RAP*, shall be sampled at the plant daily, and shall be tested to determine conformance with gradation, liquid limit, and plasticity index specifications.

336.19 PILING.

336.19.01 INSPECTION.

336.19.01.01 PCC.

336.19.01.02 Driven Piles. During pile driving, the *Inspector* will verify each pile is driven to penetrate minimum tip elevations shown on the *Plans* and to provide the required nominal driving resistance based on the established driving criteria. The daily field reports by the *Inspector* shall contain all pertinent information including daily pile driving activities, relevant communications, progress operations, equipment and materials used in the work and continuous pile driving record for each pile driven. As a minimum, the continuous pile driving record for each pile shall contain structure name or number, pile group or substructure location, pile number, ground elevation at pile location and number hammer blows per each foot of pile penetration. As soon as driving of all piles in a group are completed, the *Inspector* shall prepare a pile driving record for the subject group summarizing all pertinent information including, but not limited to, the number of hammer blows for last foot of penetration for each pile, estimated nominal driving resistance values for each pile based on established driving criteria, pile tip elevations, number of splices, pile cutoff elevations, and pile conditions after pile cut off. The *Contractor* shall provide any assistance and equipment that may be necessary for the *Inspector* to prepare and submit daily field reports.

336.19.01.03 Cast-in-Place Drilled Shafts. The *Contractor* shall provide any assistance that may be necessary for the *Inspector* to prepare and submit daily field reports containing pertinent information required by Section 509 – “Drilled Shaft Foundations”, Subsection 509.03.13 – Inspection Report” of the *Silver Book*.

The proper condition of the excavated shaft will be verified by the *Inspector* after completion of shaft excavation and prior to placement of reinforcing steel and PCC. The shaft inspection will be performed after cleaning by visual inspection or other methods deemed appropriate, The *Contractor* shall provide all equipment for checking the dimensions and alignment of each shaft and also to perform verification of the base of shaft. The *Contractor* shall use the equipment to all measurements as directed.

336.19.02 SAMPLING AND TESTING.

336.19.02.01 PCC. Sampling and testing of the PCC shall be performed in accordance with Subsection 336.11.02 – “Sampling and Testing”.

336.19.02.02 Driven Piles.

336.19.02.02.01 High-Strain Dynamic Testing. When high-strain dynamic testing is required as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*, the

testing shall be performed in accordance with Section 508 – “Driven Piles”, Subsection 508.03.06 - “High-Strain Dynamic Testing” of the *Silver Book*.

336.19.02.03 Cast-in-Place Drilled Shafts.

336.19.02.03.01 Integrity Testing. When integrity testing is required as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* or directed by the *Engineer*, the testing shall be performed using a nondestructive testing method in accordance with Section 509 – “Drilled Shaft Foundations”, Subsection 509.03.14 – “Integrity Testing” of the *Silver Book* except as modified herein.

336.19.02.03.01.01 Testing Organization. Unless indicated otherwise in the *Special Provisions* and/or *Special Technical Specifications*, the *Agency* or the *Owner* shall secure and pay for the services of a qualified testing organization with pertinent experience to perform integrity testing. Integrity testing and subsequent analysis shall be performed by a *Professional Engineer* with relevant experience or other experienced personnel under the supervision of a *Professional Engineer*.

336.19.02.04 Load Testing. When required, static load testing shall be performed on the test piles/shaft designated on the *Plans* in accordance with *Special Provisions* and/or *Special Technical Specifications*.

336.20 TRENCHLESS TECHNOLOGY.

336.20.01 INSPECTION.

336.20.02 SAMPLING AND TESTING.

336.21 LANDSCAPE AND IRRIGATION.

336.21.01 INSPECTION.

336.21.02 SAMPLING AND TESTING.

336.22 GUNITE AND SHOTCRETE.

336.22.01 INSPECTION.

336.22.02 SAMPLING AND TESTING. The strength of air placed concrete shall be determined from cores cut from the completed work and/or cores cut from test panels as directed by the *Engineer*. At least one set of test specimens shall be obtained for each day's work from each nozzleman employed.

Panels prepared for core tests shall be constructed by the *Contractor* of material that is representative of that used in the structure. The size of the test panel shall be as directed by the *Engineer*. Four Inch diameter (minimum) core specimens shall be obtained from the completed work or test panels and tested in accordance with *ASTM C42*. Core holes in the completed work shall be repaired with mortar. A minimum of three specimens shall be tested at 28 Days.

When the final compressive strength test indicates that the specified compressive strength has not been attained, additional cores may be obtained from adjacent areas. The *Engineer* and *Contractor* shall agree on the method of payment prior to obtaining the cores. Cores shall be obtained and moisture conditioned in accordance with *ASTM C42*. Should the additional cores prove deficient, the work shall be subject to rejection.

336.23 MASONRY CONSTRUCTION.

336.23.01 INSPECTION.

336.23.02 SAMPLING AND TESTING.

336.24 TRAFFIC CONTROL.

336.24.01 INSPECTION.

336.24.02 SAMPLING AND TESTING.

336.25 PCC PRESERVATION.

336.25.01 INSPECTION.

336.25.02 SAMPLING AND TESTING.

336.26 HMA PAVEMENT PRESERVATION.

336.26.01 INSPECTION.

336.26.02 SAMPLING AND TESTING.

336.27 MACHINE CALIBRATION AND VERIFICATION.

336.27.01 CALIBRATION. Each slurry mixing unit to be used in performance of the work shall be calibrated in the presence of the Engineer or Agency prior to construction. Previous calibration documentation covering the exact materials to be used may be accepted provided they were made during the calendar year. The documentation shall include an individual calibration of each material at various settings, which can be related to the machine's metering device(s). No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

336.27.02 VERIFICATION. Test strips will be made by each machine after calibration and prior to construction. Test strips shall be a portion of the project. Samples of the slurry seal will be taken and verification made as to mix consistency and proportioning. Verification of rate of application will also be made. Upon failure of any of the tests, additional test strips, at no cost to the Owner or Agency, will be required until each unit is authorized to work. Any unit failing to pass the tests after the third trial will not be permitted to work on the project. Test strips must be accepted or rejected within 24 hours after application.

337.01 GENERAL.

337.01.01 MIX DESIGN. The *Contractor* shall submit, in writing, for approval by the *Engineer*, a mix design for the composition of each mixture to be supplied. Unless otherwise specified, the *Contractor* shall submit the mix design at least 30 *Calendar Days* prior to providing the material or product for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to transport.

Unless otherwise specified, the mix design trial batch shall be prepared no more than 365 *Calendar Days* prior to the date of the submittal. Mix designs, with the exception of slurry seal and micro-surfacing, shall be performed in an *Accredited Laboratory* and stamped and signed by a *Professional Engineer*. Individuals who perform sampling and testing required for developing the mix design shall have the appropriate NAQTC qualification. ACI Grade I Technician certification is recognized by the NAQTC for PCC testing. Mix designs for slurry seal and micro-surfacing shall be performed in a qualified laboratory approved by the *ISSA*.

337.01.02 NEW MIX DESIGN BASED ON CHANGE IN SOURCE OR SUPPLIER OR CHANGES IN MIX PROPORTIONS. Unless waived by the *Engineer*, any change in source or *Supplier* of any of the component materials will require the preparation of a new mix design.

337.01.03 NEW MIX DESIGN BASED ON UNSATISFACTORY FIELD RESULTS. The *Engineer* may require a new mix design based on unsatisfactory test results.

337.02 CEMENT TREATED CRUSHED AGGREGATE BASE.

337.02.01 COMPOSITION OF MIXTURES. Cement treated crushed aggregate base shall consist of a mixture of aggregate, cementitious materials, and water.

The mix design for cement treated crushed aggregate base shall be determined utilizing samples compacted in accordance with *ASTM D1633-07*, Method A, at the optimum moisture content for the mixture determined in accordance with *ASTM D558*. When specifications require a specific cement content, a one point design will be acceptable, provided the required strength is attained and all other parameters are satisfied. If no cement content is specified, at least three mixtures with varying cement contents shall be batched and the resulting strength versus age of specimen shall be graphically plotted for each mixture. The mix design shall conform to Table 337.02.01-I.

TABLE 337.02.01-I

| Test | Test Method | Requirements |
|--|---------------------------------|--|
| Curing of Specimens | <i>ASTM D1632-07</i> | - |
| Water Content | <i>ASTM D2216</i> | Determine at time of compressive strength test |
| Compressive Strength at 7 Days ⁽¹⁾⁽²⁾ (PSI) | <i>ASTM D1633-07</i> , Method A | As specified by <i>Engineer</i> |

1. Unless otherwise specified by the *Engineer*.
2. Average of three specimens.

337.02.02 REPORT OF MIX DESIGN. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results and a gradation summary;
- D. Dry density of test specimens;
- E. Optimum moisture content and maximum dry density for each mixture batched determined in accordance with *ASTM D1633-07*, Method A, ;
- F. Specimen identification number(s);
- G. Cross-sectional area of specimen(s);
- H. Curing and conditioning periods;
- I. Age of specimen(s);
- J. Maximum load applied to specimen(s);
- K. Compressive strength test result(s);

- L. Recommended cementitious content;
- M. *Certificates of Compliance* for cementitious materials;
- N. Date of mix design preparation;
- O. *Accredited Laboratory* name and website address of accreditation program;
- P. Personnel name(s) and website address of qualification program;
- Q. Signature of mix design preparer; and
- R. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.02.03 AGGREGATES. Aggregates shall conform to Subsection 200.01.05 – “Aggregate for Cement Treated Crushed Aggregate Base”.

337.02.04 CEMENTITIOUS AND RELATED MATERIALS. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – “Cementitious and Related Materials”.

337.02.05 WATER. Water shall conform to Section 205 – “Water”.

337.03 CEMENT TREATED RECYCLED AGGREGATE BASE.

337.03.01 COMPOSITION OF MIXTURES. Cement treated recycled aggregate base shall consist of a mixture of recycled aggregates, cementitious materials, and water.

The mix design for cement treated recycled aggregate base shall be determined utilizing samples compacted in accordance with ASTM D1633-07, Method A, at the optimum moisture content for the mixture determined in accordance with ASTM D1557, with the exception that the maximum drying temperature shall be 140° F. When specifications require a specific cement content, a one point design will be acceptable, provided the required strength is attained and all other parameters are satisfied. If no cement content is specified, at least three mixtures with varying cement contents shall be batched and the resulting strength versus age of specimen shall be graphically plotted for each mixture. The mix design shall conform to Table 337.03.01-I.

TABLE 337.03.01-I

| Test | Test Method | Requirements |
|---|-------------------------|--|
| Curing of Specimens | ASTM D1632-07 | - |
| Water Content | ASTM D2216 | Determine at time of compressive strength test |
| Compressive Strength 7 Days ⁽¹⁾⁽²⁾ (PSI) | ASTM D1633-07, Method A | As specified by <i>Engineer</i> |

1. Unless otherwise specified by the *Engineer*.
2. Average of three specimens.

337.03.02 REPORT OF MIX DESIGN. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate gradation summary;
- D. Dry density of test specimens;
- E. Optimum moisture content and maximum dry density determined in accordance with ASTM D1633-07, Method A;
- F. Specimen identification number(s);
- G. Diameter, height, and cross-sectional area of specimen(s);
- H. Curing and conditioning periods;
- I. Age of specimen(s);
- J. Maximum load applied to specimen(s);
- K. Compressive strength test result(s);
- L. Recommended cementitious content;
- M. *Certificates of Compliance* for cementitious materials;
- N. Date of mix design preparation;
- O. *Accredited Laboratory* name and website address of accreditation program;
- P. Personnel name(s) and website address of qualification program;
- Q. Signature of mix design preparer; and
- R. Stamp and Signature of the *Professional Civil Engineer* responsible for review of the mix design.

337.03.03 AGGREGATES. Aggregates shall conform to Subsection 200.01.06 "Aggregate for Cement Treated Recycled Aggregate Base".

337.03.04 CEMENTITIOUS AND RELATED MATERIALS. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – "Cementitious and Related Materials".

337.03.05 WATER. Water shall conform to Section 205 – "Water".

337.04 HMA.

337.04.01 COMPOSITION OF MIXTURES. HMA shall consist of a mixture of aggregate, including 15 percent or less of *RAP* by dry weight of the mix, asphalt cement, and additives, if required.

The aggregate gradation shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or inversely.

The mix design for *HMA* shall be performed in accordance with the Asphalt Institute MS-2 (Asphalt Mix Design Methods), utilizing the Marshall method. *RAP* shall be produced, stockpiled and tested prior to the performance of a mix design. For purposes of the mix design, the weight of any *RAP* shall be considered to contribute solely to the total weight of the aggregate.

The specimens shall be compacted with a properly correlated single mechanical or a manually-operated Marshall compaction hammer.

The mix design shall demonstrate that the *HMA* can attain a minimum dry tensile strength of at least 65 *PSI* and a tensile strength ratio of at least 70 percent determined in accordance with AASHTO T 283. The *Engineer* may elect to accept the addition of hydrated lime at a rate of at least 1-1/2 percent by dry weight of aggregate in lieu of test results.

The optimum asphalt cement content shall be determined to 0.1 percent, by total weight of mix and by dry weight of aggregate. The mix design for *HMA* shall conform to the applicable requirements of Table 337.04.01-I.

TABLE 337.04.01-I

| Test | Test Method | Requirements | | | |
|---|-------------|-----------------------|---------|-------------------|---------|
| | | 50 Blows per Side | | 75 Blows per Side | |
| Air Voids, Total Mix (%) ⁽¹⁾ | ASTM D3203 | 3 | 4 | 3 ⁽²⁾ | 4 |
| Voids in Mineral Aggregate (%) ⁽³⁾ | MS-2 | Per Table 7.3 of MS-2 | | | |
| Voids Filled with Asphalt (%) ⁽³⁾ | MS-2 | - | 65 - 78 | - | 65 - 75 |
| Marshall Stability (pounds) | ASTM D6927 | 1800 Minimum | | | |
| Marshall Flow (0.01 inch) | ASTM D6927 | 8 - 20 ⁽⁴⁾ | | | |
| | | | | | |

1. Target value.
2. Unless directed by the *Engineer*, mix designs with the target air void value of 3% shall not be used for the surface course or within the zone affected by rutting when the Design *ESAL* > 10⁴.
3. At target air void percentage.
4. Marshall Flow requirements do not apply when polymer modified binders are used.

337.04.02 REPORT OF MIX DESIGN. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by the *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results for the combined grading;
- D. Gradation summary, including percentage passing each specified sieve size for the individual materials and combined grading target values, demonstrating compliance with the gradation requirements set forth in section 200.02.03-I;
- E. Bin percentages, with each bin clearly identified;
- F. The job control grading band determined in accordance with Subsection 320.03.06.01.02.05 – "Job Control Grading Band" used during production;
- G. Asphalt cement grade and source;

- H. Specific Gravity of asphalt cement;
- I. Source and percentage by dry weight of aggregate of any mineral additive;
- J. Source and percentage based on percentage of binder of any chemical additive;
- K. Number of compaction blows per side as designated and correlated blow count if using mechanical hammer;
- L. Compaction and mixing temperatures used in producing the mix design;
- M. Summary of volumetric and mechanical mix properties for each asphalt cement content and related plots;
- N. Optimum percentage of virgin asphalt cement, contribution of the asphalt cement from the *RAP* and the optimum percentage of total asphalt cement, all to the nearest 0.1 percent based on total weight of mix and by dry weight of aggregate;
- O. Unit weight, percent air voids, stability, flow, percent voids in mineral aggregate and voids filled with asphalt at the optimum asphalt cement content;
- P. *Certificates of Compliance* for asphalt cement, including temperature/viscosity curves, and for any additives;
- Q. Date of mix design preparation
- R. *Accredited Laboratory* name and website address of accreditation program;
- S. Personnel name(s) and website address of qualification program;
- T. Signature of mix design preparer; and
- U. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.04.03 AGGREGATES. Aggregates shall conform to Subsection 200.02 – “Aggregates for Bituminous Courses”. The combined grading of the aggregate shall include the hydrated lime and/or mineral filler.

337.04.04 ASPHALT CEMENT. Asphalt cement shall conform to Subsection 201.02 – “Asphalt Cements and Additives”.

337.04.05 HYDRATED LIME. Hydrated lime shall conform to Subsection 201.08 – “Hydrated Lime for Use in HMA”.

337.04.06 MINERAL FILLER. Mineral filler shall conform to Subsection 201.09 – “Mineral Filler for HMA”.

337.05 HMA WITH GREATER THAN 15 PERCENT RAP.

337.05.01 COMPOSITION OF MIXTURES. HMA shall consist of a mixture of greater than 15 percent *RAP*, additional virgin aggregate, additive, if required, and/or additional virgin asphalt cement.

The mix design shall conform to the requirements of Subsection 337.04 – “HMA” except as modified herein.

337.05.02 REPORT OF MIX DESIGN. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by the *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results for the combined grading;
- D. Gradation summary, including percentage passing each specified sieve size for the individual materials and combined grading target values, demonstrating compliance with the gradation requirements set forth in section 200.02.03-1;
- E. Bin percentages, with each bin clearly identified;
- F. The job control grading band determined in accordance with Subsection 320.03.06.01.02.05 – “Job Control Grading Band” used during production;
- G. Virgin asphalt cement grade and source;
- H. When required, recycling agent type and source;
- I. When required, test results on reclaimed asphalt binder (combined virgin asphalt cement, reclaimed asphalt cement and recycling agent);
- J. Specific gravity of virgin asphalt cement and, when required, reclaimed asphalt cement;
- K. Source and percentage by dry weight of aggregate of any mineral additive;
- L. Source and percentage based on percentage of binder of any chemical additive;
- M. Number of compaction blows per side as designated and correlated blow count if using mechanical hammer;
- N. Compaction and mixing temperatures used on producing the mix design;
- O. Summary of volumetric and mechanical mix properties for each asphalt cement content and related plots;
- P. Optimum percentage of virgin asphalt cement, contribution of the asphalt cement from the recycled asphalt product and the optimum percentage of total asphalt cement, all to the nearest 0.1 percent based on total weight of mix and by dry weight of aggregate;

- Q. When required, optimum percentage of recycling agent, based on the percent mass of the total asphalt cement;
- R. Unit weight, percent air voids, stability, flow, percent voids in mineral aggregate and voids filled with asphalt at the optimum asphalt cement content;
- S. *Certificates of Compliance* for asphalt cement and any additives, including recycling agent;
- T. Date of mix design preparation;
- U. *Accredited Laboratory* name and website address of accreditation program;
- V. Personnel name(s) and website address of qualification program;
- W. Signature of mix design preparer; and
- X. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.05.03 AGGREGATES. Virgin aggregates shall conform to Subsection 200.02 – “Aggregates for Bituminous Courses”. The combined grading of the virgin aggregate and RAP shall include the hydrated lime and/or mineral filler and conform to Subsection 200.02.03 – “Dense Grade Plantmix and Roadmix Aggregate”.

337.05.04 ASPHALT CEMENT. Asphalt cement shall conform to Subsection 201.02 – “Asphalt Cements”.

337.05.05 RECYCLING AGENT. The recycling agent shall conform to Subsection 201.06 – “Recycling Agents”.

337.05.06 HYDRATED LIME. Hydrated lime shall conform to Subsection 201.08 – “Hydrated Lime for Use in HMA”.

337.05.07 MINERAL FILLER. Mineral filler shall conform to Subsection 201.09 - “Mineral Filler for HMA”.

337.06 CHIP SEAL.

337.06.01 COMPOSITION OF MIXTURES. Chip seal shall consist of a mixture of aggregate and asphalt cement or emulsified asphalt as specified by the *Engineer* or noted in the *Plans or Special Technical Specifications*.

337.06.02 REPORT OF MIX DESIGN. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by the *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results, including a gradation summary;
- D. Binder type and source;
- E. *Certificate of Compliance* for binder; and
- F. Signature of mix design preparer.

337.06.03 AGGREGATES. Aggregates shall conform to Subsection 200.02.05 – “Chip Seal Aggregate”.

337.06.04 BINDER. The binder shall be specified by the *Engineer* or noted in the *Plans or Special Technical Specifications*.

337.07 SLURRY SEAL AND MICRO-SURFACING.

337.07.01 COMPOSITION OF MIXTURES. Slurry seal and micro-surfacing shall consist of a mixture of aggregate and emulsified asphalt. The mixture may also include mineral filler, cementitious material, lime, and/or mortar as directed. Binder shall conform to Table 201.04-III in Section 201 for RTS with LMCQS and Micro with LMCQS.

The mix design for slurry seal shall be performed in accordance with the guidelines contained in /SSA Publication A105. The mix design for micro-surfacing shall be performed in accordance with the guidelines contained in /SSA Publication A143.

The mix design for Slurry Seal and micro-surfacing shall conform to the applicable requirements of Table 337.07.01-I.

TABLE 337.07.01-I

| Test | Test Method | Requirements | | | |
|---|--------------|--------------------------------------|-------|-----|--------------------------------------|
| | | CQS | LMCQS | RTS | MICRO |
| Wet Cohesion (kg-cm) | /ISSA TB139 | | | | |
| Set Time (30 Minutes) | | 12 kg-cm Minimum | | | |
| Traffic Time (60 Minutes) | | 20 kg-cm Minimum (or near spin) | | | |
| Excess Asphalt (g/m ²) | /ISSA TB109 | 538 Maximum | | | |
| Wet Stripping (%) | /ISSA TB114 | Pass (90 Minimum) | | | |
| Wet Track Abrasion (g/m ²) | /ISSA TB100 | | | | |
| Loss after One Hour Soak | | 528 g/m ² Maximum | | | 264 g/m ² Maximum |
| Loss after Six Day Soak | | 807 g/m ² Maximum | | | 528 g/m ² Maximum |
| Lateral Displacement (%) | /ISSA TB147A | 5 Maximum | | | 5 Maximum |
| Specific Gravity After 1000 Cycles At 56.8 kg | /ISSA TB147A | 23.10 Maximum | NA | NA | 23.10 Maximum |
| Classification Compatibility | /ISSA TB100 | (AAA,BAA) 11 grade points Minimum | NA | NA | (AAA,BAA) 11 grade points Minimum |
| Mix Time (Seconds) | /ISSA TB113 | Controllable to 120 | 120 | | |

337.07.02 REPORT OF MIX DESIGN. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by the *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results;
- D. Gradation summary, including percentage passing each specified sieve size for the individual materials used and combined grading, with the job control grading band for each specified sieve size. The report must clearly show the proportions of aggregate, mineral filler (minimum and maximum), additive(s), usage, and asphalt emulsion based on dry weight of aggregate.
- E. Emulsified asphalt type and source;
- F. Recommended mix design showing mix proportions, including additives;
- G. Results of wet cohesion, excess asphalt, wet stripping, wet-track abrasion loss, lateral displacement, classification compatibility and mix time tests, as applicable;
- H. A report of the quantitative effects of the moisture on the unit weight of aggregate (bulking effect);
- I. *Certificate of Compliance* for emulsified asphalt;
- J. Date of mix design preparation;
- K. Laboratory name; and
- L. Signature of mix design preparer.

337.07.03 AGGREGATES. Aggregates shall conform to the applicable requirements of Subsection 200.02.06 – “Slurry Seal and Micro-surfacing Aggregate”.

337.07.04 EMULSIFIED ASPHALT. Emulsified asphalt shall conform to Subsection 201.04 – “Emulsified Asphalts” for slurry seal, utilizing a minimum of 3 percent latex rubber based on weight of bitumen.

337.07.05 WATER. Water shall conform to the requirements of Section 205 – “Water”.

337.08 SLURRY BACKFILL.

337.08.01 COMPOSITION OF MIXTURES. Slurry backfill shall consist of a fluid, workable mixture of aggregate, cementitious materials, mineral and liquid admixtures, and water.

The mix design for slurry backfill shall conform to the applicable requirements of Table 337.08.01-I.

TABLE 337.08.01-I

| Test | Test Method | Requirements | |
|---------------------------------------|---------------------------|--------------------------|-----------------------------|
| | | Type A (Excavatable) | Type B (Non-Excavatable) |
| Compressive Strength at 28 Days (PSI) | ASTM D4832 ⁽¹⁾ | 50 – 200 | 200 – 1200 |
| Slump (inches) | ASTM C143 | 6 – 10 | 6 – 10 |
| Air Content (%) | ASTM C173 or ASTM C231 | 5 Minimum | 5 Minimum |
| Subsidence (%) | ASTM C940 ⁽²⁾ | 1 Maximum ⁽³⁾ | 1 Maximum ⁽³⁾ |

1. Cylinders or other test specimens shall not be rodded or tapped.
2. A 6 inch by 12 inch cylinder shall be used for measurement purposes.
3. Mixtures that require placement by use of a concrete or grout pump will be allowed a maximum subsidence of 2%.

337.08.02 REPORT OF MIX DESIGN. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate test results and a gradation summary;
- D. Recommended mix design showing all components with their associated one cubic yard batch weights and absolute volumes;
- E. Recommended design slump and air content, including the test method used;
- F. Theoretical unit weight of design mix;
- G. One cubic yard trial weights of trial batch points;
- H. Trial batch compressive strength test results;
- I. Trial batch slump test and subsidence results;
- J. Trial batch air content test results and the test method used;
- K. Trial batch unit weights;
- L. *Certificates of Compliance* for cementitious materials and admixtures;
- M. Date of mix design preparation;
- N. *Accredited Laboratory* name and website address of accreditation program;
- O. Personnel name(s) and website address of qualification program;
- P. Signature of mix design preparer; and
- Q. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.08.03 AGGREGATES. Aggregates shall conform to Subsection 200.03.07 – Slurry Backfill Aggregates".

337.08.04 CEMENTITIOUS AND RELATED MATERIALS. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – "Cementitious and Related Materials".

337.08.05 WATER. Water shall conform to Section 205 – "Water".

337.09 MASONRY.

337.09.01 MORTAR.

337.09.01.01 Composition of Materials. Mortar used in unit masonry construction shall consist of a workable mixture of aggregate, cementitious materials, mineral and liquid admixtures, and water.

The mix design for mortar used in unit masonry construction shall be performed in accordance with ASTM C270 and conform to the applicable requirements of Tables 337.09.01.01-I or 337.09.01.01-II for cement-lime or masonry cement mixtures, respectively.

TABLE 337.09.01.01-I

| Component | Proportion By Volume (Cementitious Material) | | | |
|--|--|-----------|-------------|---------------|
| | Type M | Type S | Type N | Type O |
| Portland Cement or Blended Cement | 1 | 1 | 1 | 1 |
| Hydrated Lime or Lime Putty ⁽¹⁾ | 1/4 | 1/4 - 1/2 | 1/2 - 1 1/4 | 1 1/4 - 2 1/2 |
| Aggregate ⁽²⁾ | Not less than 2 1/4 and not more than 3 times the sum of the separate volumes of cementitious material | | | |

1. When plastic cement is used in lieu of Portland cement, hydrated lime or putty may be added, but not in excess of 1/10 of the volume of cement.
2. Measured in a damp, loose condition.

TABLE 337.09.01.01-II

| Component | Proportion By Volume (Cementitious Material) | | | |
|-----------------------------------|--|--------|--------|--------|
| | Type M | Type S | Type N | Type O |
| Portland Cement or Blended Cement | 1 | 1/2 | | |
| Masonry Cement | | | | |
| Type M | | 1 | | |
| Type S | | | 1 | |
| Type N | 1 | 1 | 1 | 1 |
| Aggregate ⁽¹⁾ | Not less than 2 1/4 and not more than 3 times the sum of the separate volumes of cementitious material | | | |

1. Measured in a damp, loose condition.

337.09.01.01.01 Quantity of Water. The quantity of water to be used in the preparation of mortar shall be the minimum required to produce a mixture that is sufficiently workable for the intended use.

337.09.01.01.02 Deleterious Substances. Chloride salts or other deleterious substances shall not be used in mortar.

337.09.01.01.03 Additives and Admixtures. Air entraining substances shall not be used in mortar unless tests are conducted to determine compliance with *Engineer* requirements. Other additives and admixtures shall not be used in mortar unless approved in writing by the *Engineer*.

337.09.01.02 Report of Mix Design. The mix design report shall include the following:

- Mix *Supplier* and mix designation used by *Supplier*;
- Aggregate designation and source;
- Aggregate qualification test results, including a gradation summary ;
- Bulk specific gravity (SSD basis), absorption values and loose unit weight;
- Recommended mix design showing mix proportions;
- Trial batch compressive strength test results;
- Trial batch water retention test results;
- Trial batch air content test results;
- Certificates of Compliance* for cementitious materials and admixtures;
- Date of mix design preparation;
- Accredited Laboratory* name and website address of accreditation program;
- Personnel name(s) and website address of qualification program;
- Signature of mix design preparer; and
- Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.09.01.03 Aggregates. Aggregates shall conform to the applicable requirements of Subsection 200.04 – “Aggregate for Mortar and Grout”.

337.09.01.04 Cementitious and Related Materials. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – “Cementitious and Related Materials”.

337.09.01.05 Water. Water shall conform to Section 205 – “Water”.

337.09.02 GROUT.

337.09.02.01 Composition of Materials. Grout used in unit masonry construction shall consist of a fluid mixture of aggregate, cementitious materials, mineral and liquid admixtures, and water.

The mix design for grout used in unit masonry construction shall be determined in accordance with Subsection 337.09.02.01.01 or Subsection 337.09.02.01.02.

337.09.02.01.01 Proportions by Volume. When proportions are established by volume, grout used in masonry unit construction shall conform to the applicable requirements of Tables 337.09.02.01.01-I and 337.09.02.01.01-II.

TABLE 337.09.02.01.01-I

| Component | Proportion by Volume (Cementitious Material) | |
|-----------------------------------|---|---|
| | Fine | Coarse |
| Portland Cement or Blended Cement | 1 | |
| Hydrated Lime or Lime Putty | 0 – 1/10 | |
| Aggregate ⁽¹⁾ | | |
| Fine | 2 1/4 to 3 times the sum of the volumes of the cementitious materials | 2 1/4 to 3 times the sum of the volumes of the cementitious materials |
| Coarse | | 1 to 2 times the sum of the volumes of the cementitious materials |

1. Measured in a damp, loose condition.

TABLE 337.09.02.01.01-II

| Test | Test Method | Requirements |
|----------------|-------------|--------------|
| | | |
| Slump (inches) | ASTM C143 | 8 - 11 |

337.09.02.01.02 Proportions by Compressive Strength. When proportions are established by compressive strength, grout used in masonry unit construction shall conform to Table 337.09.02.01.02-I.

TABLE 337.09.02.01.02-I

| Test | Test Method | Requirements |
|---------------------------------------|-------------|--------------------------------------|
| | | |
| Test Specimens ⁽¹⁾ | ASTM C1019 | - |
| Compressive Strength at 28 Days (PSI) | ASTM C1019 | 2000 or As specified by the Engineer |

1. Locally available masonry test block may be used as specimen mold.

337.09.02.02 Report of Mix Design. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by the *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results, including a gradation summary ;
- D. Bulk specific gravity (SSD basis), absorption values and loose unit weight;
- E. Recommended mix design showing mix proportions;
- F. Trial batch compressive strength test results for mixes proportioned by compressive strength;
- G. Trial batch slump test results;
- H. Trial batch air content test results;
- I. *Certificates of Compliance* for cementitious materials and admixtures;
- J. Date of mix design preparation;
- K. *Accredited Laboratory* name and website address of accreditation program;
- L. Personnel name(s) and website address of qualification program;
- M. Signature of mix design preparer; and
- N. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.09.02.03 Aggregates. Aggregates shall conform to the applicable requirements of Subsection 200.04 – “Aggregate for Mortar and Grout”.

337.09.02.04 Cementitious and Related Materials. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – “Cementitious and Related Materials”.

337.09.02.05 Water. Water shall conform to Section 205 – “Water”.

337.10 PCC FLATWORK, CURBS, DITCHES AND SLOPE PAVING AND STRUCTURES.

337.10.01 COMPOSITION OF MIXTURES. PCC for flatwork, curbs, ditches and slope paving and structures shall consist of a workable mixture of aggregate, cementitious materials, admixtures, and water.

The mix design shall be performed in accordance with ACI 301, utilizing the ACI 211.1 trial batch method. Results shall be plotted on a curve showing compressive or flexural strength versus age of specimen for each water to cementitious ratio batched. When specifications require a maximum water to cementitious ratio, a one point design will be acceptable, provided the required strength is attained and all other parameters are satisfied. If no maximum water to cementitious ratio is specified, at least three mixtures with varying water to cementitious ratios shall be batched and the resulting strength versus age of specimen shall be graphically plotted for each mixture.

The cementitious content shall be met by a combination of Portland cement and SCM, including fly ash, ground blast furnace slag, and pozzolan.

337.10.01.01 SCM. SCM content shall not be less than 20 percent by weight of the cement.

337.10.01.02 Ground Blast Furnace Slag. Ground blast furnace slag may constitute up to 55 percent of the total cementitious material by weight.

337.10.01.03 Freeze-Thaw Cycles, Salt and Sulfates. All PCC exposed to freeze-thaw cycles, and/or salt and/or sulfates shall be air entrained. Unless otherwise directed by the *Engineer*, all PCC so exposed shall conform to Table 337.10.01.03-I and Table 337.10.01.03-II as shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

TABLE 337.10.01.03-I

| Test | Test Method | Requirements |
|--|------------------------|--------------|
| Test Specimens | ASTM C192 | - |
| Water to Cementitious Ratio | - | 0.45 Maximum |
| Compressive Strength at 28 Days (PSI) ⁽¹⁾ | ASTM C39 | 4000 Minimum |
| Slump (inches) | ASTM C143 | |
| Initial | | 4 Maximum |
| After Addition of <i>HRWR</i> | | 8 Maximum |
| Air Content (%) ⁽²⁾ | ASTM C173 or ASTM C231 | |
| No. 67/No. 57 Aggregate | | 6.0 |
| No. 467 Aggregate | | 5.5 |

1. Based on the average results of tests performed on three 6 x 12 Inch or five 4 x 8 Inch cylinders.
2. Target Value. The variation for the produced material shall be within plus or minus 1.5 percent of the target value.

TABLE 337.10.01.03-I

| | Severity of Potential Exposure | | | |
|--|--------------------------------|--|--|---|
| | Negligible | Moderate | Severe | Very Severe |
| Water-Soluble Soluble Sulfate (SO ₄) ⁽¹⁾⁽²⁾ (%) | 0.00 to 0.10 | >0.10 and <0.20 | >0.20 and <2.00 | >2.00 |
| Sulfate (SO ₄) ⁽¹⁾ in Water (ppm) | 0 to 150 | >150 and <1500 | >1500 and <10,000 | >10,000 |
| Type of Cement | No special requirements | II II & Fly Ash/Slag 1-P (MS) V V & Fly Ash/Slag | II & Fly Ash/Slag 1-P (MS) V V & Fly Ash/Slag | V & Fly Ash ⁽³⁾ /Slag ⁽⁴⁾ |
| Water to Cementitious Ratio | No special requirements | 0.50 Maximum | 0.45 Maximum | 0.40 Maximum |

1. Determined in accordance with ASTM C1580.
2. Sulfate expressed as SO₄ is related to sulfate expressed as SO₃, as given in reports of chemical analysis of Portland cements as follows: SO₃ % x 1.2 = SO₄ %.
3. Fly Ash proportion should be between 25 and 35 % by mass of the total cementitious material.
4. Slag proportion should be between 40 and 70 % by mass of the total cementitious material.
5. Natural pozzolans, fly ash, slag and blended cements may be qualified in accordance with ACI 201.2R and ASTM C1012.

337.10.02 REPORT OF MIX DESIGN.

The mix design report shall include the following:

- Mix *Supplier* and mix designation used by *Supplier*;
- Aggregate designation and source;
- Fine aggregate qualification test results, including a gradation summary;
- Fine aggregate bulk specific gravity (SSD basis) and absorption values;
- Coarse aggregate qualification test results, including a gradation summary;
- Coarse aggregate bulk specific gravity (SSD basis) and absorption values;
- Coarse aggregate dry rodded unit weight;
- Recommended mix design showing all components with their associated one cubic yard batch weights and absolute volumes, including water to cementitious ratio;
- Recommended design slump and air content, including the test method used;
- Theoretical unit weight of design mix;
- One cubic yard trial weights of trial batch points;

- L. Trial batch compressive and flexural strength test results;
- M. Trial batch slump test results;
- N. Trial batch air content test results and the test method used;
- O. Trial batch unit weights;
- P. *Certificates of Compliance* for cementitious materials and admixtures;
- Q. Date of mix design preparation;
- R. *Accredited Laboratory* name and website address of accreditation program;
- S. Personnel name(s) and website address of qualification program;
- T. Signature of mix design preparer; and
- U. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.10.03 AGGREGATES. Aggregates shall conform to the applicable requirements of Subsection 200.05 – “Aggregates for PCC Structures, Flatwork and Curbs”.

337.10.04 CEMENTITIOUS AND RELATED MATERIALS. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – “Cementitious and Related Materials”.

337.10.05 WATER. Water shall conform to Section 205 – Water”.

337.11 SPECIFIC USE PCC.

337.11.01 PCCP.

337.11.01.01 Composition of Mixtures. PCC for PCCP shall consist of a workable mixture of aggregate, cementitious materials, admixtures, and water.

The mix design shall be performed in accordance with ACI 301, utilizing the ACI 211.1 trial batch method. Results shall be plotted on a curve showing compressive or flexural strength versus age of specimen for each water to cementitious ratio batched. When specifications require a maximum water to cementitious ratio, a one point design will be acceptable, provided the required strength is attained and all other parameters are satisfied. If no maximum water to cementitious ratio is specified, at least three mixtures with varying water to cementitious ratios shall be batched and the resulting strength versus age of specimen shall be graphically plotted for each mixture.

The cementitious content shall be met by a combination of Portland cement and SCM, including fly ash, ground blast furnace slag, and pozzolan.

337.11.01.02 SCM. SCM content shall not be less than 20 percent by weight of the cement.

337.11.01.03 Ground Blast Furnace Slag. Ground blast furnace slag may constitute up to 55 percent of the total cementitious material by weight.

A minimum of three specimens shall be cast and tested for flexural and compressive strengths at 3 days, 5 days, 7 days, 14 days, and 28 days. The mix design shall establish the relationship between flexural and compressive strength. The compressive strength of the PCC referred to in this Subsection will be based on the average results of tests performed on three 6 x 12 Inch cylinders. The flexural strength of the PCC referred to in this Subsection will be based on the average results of tests performed on three flexural beams. The mix design shall establish the relationship between flexural and compressive strength.

Unless otherwise directed or approved by the *Engineer*, all PCC used for PCCP shall conform to Table 337.11.01.03-I.

TABLE 337.11.01.03-I

| Test | Test Method | Requirements |
|---------------------------------------|------------------------|--------------------------|
| Test Specimens | ASTM C192 | - |
| Water to Cementitious Ratio | - | 0.45 Maximum |
| Compressive Strength at 28 Days (PSI) | ASTM C39 | - |
| Flexural Strength at 28 Days (PSI) | ASTM C78 | 650 Minimum |
| Slump (inches) | ASTM C143 | |
| Initial | | 2 Maximum ⁽¹⁾ |
| After Addition of HRWR | | 4 Maximum |
| Air Content (%) ⁽²⁾ | ASTM C173 or ASTM C231 | |
| | | |
| No. 467 Aggregate | | 5.5 |
| | | |

1. Sideform Paving, for Slipform Paving, a 1" maximum slump is recommended for constructability.
2. Target Value. The variation for the produced material shall be within plus or minus 1.5 percent of the target value.

337.11.01.03.01 PCC Exposed to Soils Containing Water-Soluble Sulfates. Unless otherwise directed by the *Engineer*, all PCC exposed to soils containing soluble sulfates shall conform to the applicable requirements of Table 337.11.01.03-I, based on the percentage of the soluble sulfate contained in the soil.

337.11.01.04 Report of Mix Design. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by *Supplier*;
- B. Aggregate designation and source;
- C. Fine aggregate qualification test results, including a gradation summary ;
- D. Fine aggregate bulk specific gravity (SSD basis) and absorption values;
- E. Coarse aggregate qualification test results, including a gradation summary;
- F. Coarse aggregate bulk specific gravity (SSD basis) and absorption values;
- G. Coarse aggregate dry rodded unit weight;
- H. Recommended mix design showing all components with their associated one cubic yard batch weights and absolute volumes, including water to cementitious ratio;
- I. Recommended design slump and air content, including the test method used;
- J. Theoretical unit weight of design mix;
- K. One cubic yard trial weights of trial batch points;
- L. Trial batch compressive and flexural strength test results and the relationship between the two;
- M. Trial batch slump test results;
- N. Trial batch air content test results and the test method used;
- O. Trial batch unit weights;
- P. Type, brand, and source of cementitious materials and admixtures;
- Q. Certificates of Compliance for cementitious materials and admixtures;
- R. Date of mix design preparation;
- S. Accredited Laboratory name and website address of accreditation program;
- T. Personnel name(s) and website address of qualification program;
- U. Signature of mix design preparer; and
- V. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.11.01.05 Aggregates. Aggregates shall conform to the applicable requirements of Subsection 200.06.01 – “Aggregates for PCCP”.

337.11.01.06 Cementitious and Related Materials. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – “Cementitious and Related Materials”.

337.11.01.07 Water. Water shall conform to Section 205 – “Water”.

337.11.02 AIR PLACED CONCRETE.

337.11.02.01 Gunite.

337.11.02.01.01 Composition of Materials. Gunite shall consist of a mixture of aggregate, cementitious materials, and water, which is mixed at the nozzle immediately prior to placement.

Unless otherwise directed by the *Engineer*, the mix design for gunite shall be proportioned in accordance with Table 337.11.02.01.01-I.

TABLE 337.11.02.01.01-I

| Component | Proportion by Dry, Loose Volume |
|-----------------------------------|---------------------------------|
| Portland Cement or Blended Cement | 1 |
| Aggregate ⁽¹⁾ | 4-1/2 |

1. The aggregate shall contain not less than 3 percent nor more than 6 percent moisture by dry weight when determined in accordance with *ASTM C70*.

337.11.02.01.02 Quantity of Water. The quantity of water to be used in the preparation of gunite shall be the minimum required to for proper hydration of the mix.

337.11.02.01.03 Report of Mix Design. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results, including a gradation summary ;
- D. Bulk specific gravity (SSD basis), absorption values and loose unit weight;
- E. Recommended mix design showing mix proportions;
- F. *Certificates of Compliance* for cementitious materials;
- G. Date of mix design preparation;
- H. *Accredited Laboratory* name and website address of accreditation program;
- I. Personnel name(s) and website address of qualification program;
- J. Signature of mix design preparer; and
- K. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.11.02.01.04 Aggregates. Aggregates shall conform to Subsection 200.06.02 – “Aggregates for Gunite”.

337.11.02.01.05 Cementitious and Related Materials. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – “Cementitious and Related Materials”.

337.11.02.01.06 Water. Water shall conform to Section 205 – “Water”.

337.11.02.02 Shotcrete.

337.11.02.02.01 Composition of Materials. Shotcrete shall consist of a mechanically mixed fluid mixture of aggregate, cementitious materials, and water.

The compressive strength of the shotcrete referred to in this Subsection will be based specimens prepared and obtained in accordance with the procedures outlined in *ACI 506*, Chapter 6, Section 6.4. The specimens shall be obtained one *Day* prior to compressive strength testing.

Unless otherwise directed by the *Engineer*, the mix design for shotcrete shall conform to Table 337.11.02.02.01-I.

TABLE 337.11.02.02.01-I

| Test | Test Method | Requirements |
|--|------------------------|------------------------------------|
| Maximum Aggregate Size | ASTM C136 | As specified by <i>Engineer</i> |
| Water to Cementitious Ratio | - | |
| Compressive Strength at 28 Days (PSI) ⁽¹⁾ | ASTM C42 | |
| Slump (inches) | ASTM C143 | |
| Air Content (%) | ASTM C138 or ASTM C231 | |

1. Tested in the as received condition after curing in accordance with ASTM C42.

337.11.02.02.02 Report of Mix Design. The mix design report shall include the following:

- A. Mix *Supplier* and mix designation used by *Supplier*;
- B. Aggregate designation and source;
- C. Aggregate qualification test results, including a gradation summary ;
- D. Bulk specific gravity (SSD basis), absorption values and loose unit weight;
- E. Cement type;
- F. Recommended mix design showing mix proportions, including water to cementitious ratio;
- G. Compressive strength test results;
- H. Slump test results
- I. Air content test results;
- J. *Certificates of Compliance* for cementitious materials;
- K. Date of mix design preparation;
- L. *Accredited Laboratory* name and website address of accreditation program;
- M. Personnel name(s) and website address of qualification program;
- N. Signature of mix design preparer; and
- O. Stamp and Signature of the *Professional Engineer* responsible for review of the mix design.

337.11.02.02.03 Aggregates. Aggregates shall conform to Subsection 200.06.03 – “Aggregates for Shotcrete”.

337.11.02.02.04 Cementitious and Related Materials. Cementitious and related materials, including mineral and liquid admixtures, shall conform to Section 202 – “Cementitious and Related Materials”.

337.11.02.02.05 Water. Water shall conform to Section 205 – “Water”.

338.01 MAINTENANCE OF TRAFFIC**338.01.01 TRAFFIC CONTROL PLANS**

All traffic control shall conform to the *MUTCD* and *NDOT* Standard Plans for Road and Bridge Construction, specifically, Plans T-35.1.1 through T-35.1.7, and as directed by the Project Manager for the owner, hereinafter designated as "Agency", or Design Engineer.

It shall be the Contractor's responsibility to prepare traffic control plans. The proposed traffic control plans shall be prepared and signed by a *PTOE* or a *TCS*.

After the execution of the contract, but prior to the preparation of traffic control plans, a pre plan meeting between the Contractor, the Construction *TCS*, representatives from the Engineer, the Design Engineer, and the Agency Project Manager, will be held at a mutually acceptable time and place.

The contractor's traffic control plans shall include, but not be limited to, the following:

- A. Proposed construction zone and existing speed limits;
- B. All construction signing;
- C. Message Board locations;
- D. Location of flaggers;
- E. Types and location of traffic control devices;
- F. Temporary lane striping;
- G. Construction phasing (including phasing of intersection construction and detours, if any);
- H. Lane crossovers between construction phases;
- I. Method for maintaining traffic signal functions;
- J. Intersection Control Strategy;
- K. Special events scheduling;
- L. Detours;
- M. 8 1/2" x 11" individual access plans for multi-access properties;
- N. Draft notification letters (7-day notice type);
- O. Draft notification letters (2-day notice type);
- P. Draft driveway closure notice (18-24 hour notice type);
- Q. Accommodations for pedestrian, bicycle, and transit facilities;
- R. Lighting System Plans where night operations are permitted or for work accomplished one half hour after sunset to one half hour before sunrise; and
- S. Letter of conformance stating that all Category 1 and 2 traffic control devices used on the project meet the evaluation criteria of National Cooperative Highway Research Program (NCHRP) Report 350. Note that a sign together with its portable support is considered as a system, which together must meet the NCHRP Report 350 Requirements.

The Contractor's traffic control plans shall indicate the intersection control strategy to be used throughout the project. Intersection closures shall be approved by the AGENCY Project Manager and the appropriate jurisdiction. Full detour plans shall be included for any intersection closures.

It shall be the Contractor's responsibility to coordinate traffic control with other projects in the area.

The Contractor shall submit an electronic version of proposed traffic control plans, to the *Engineer* for review and comments at least seven (7) calendar days prior to the Preconstruction Conference. Intersection closure and detour plans shall also be electronically submitted at least seven (7) calendar days prior to the preconstruction meeting for review and approval by the AGENCY Project Manager.

The AGENCY Project Manager will review the submittal with the Design Engineer and Engineer staff and provide, if any, written comments and/or corrections to the Traffic Control Plans. If necessary, the Contractor and AGENCY Project Manager will meet to consider the comments and/or corrections to the plan prior to the Preconstruction Conference to resolve any issue relative to the traffic control plans. Upon resolution of all issues or acceptance of the traffic control plans as submitted, the AGENCY Project Manager shall accept the plans in writing.

Acceptance by the AGENCY Project Manager of the submitted traffic control plans shall in no way relieve the Contractor of the responsibility for safety requirements. Acceptance of the traffic control plans by the AGENCY Project Manager indicates that the plans generally appear to conform to the contract requirements. Such acceptance shall in no way be construed as confirmation of the technical accuracy or adequacy of the contents of the plans and shall not relieve the Contractor of the obligation to institute traffic control measures in full compliance with contract requirements, and which function safely and correctly, and are in conformance with applicable statutes, ordinances, and regulations.

The Contractor shall not proceed with traffic control set-up until traffic control plans have been accepted by the AGENCY, Design Engineer, and the Engineer. Any days lost due to lack of traffic control plans, will be charged against the Contractor's allowable working days.

Should the Contractor choose to accomplish work by methods or phasing which require modification to any part of the approved traffic control plans, the Contractor shall submit for approval modified traffic control plans at least five (5) working days prior to implementation of such work or phasing. Any request by the Contractor to change the traffic control plans shall be submitted in writing and accompanied with drawings, prepared and signed by the PTOE/TCS, showing the appropriate aspects of the traffic control plans. Such requests must be approved in writing by the AGENCY Project Manager prior to implementation. Any days lost due to modification of the approved traffic control plans, will be charged against the Contractor's allowable working days.

Where night operations are permitted or for work accomplished one half (1/2) hour after sunset to one half (1/2) hour before sunrise, the Contractor shall submit a night lighting system plan for approval. The plan shall include the light types, locations, and the manner in which the lights will be moved. Floodlights shall be used to illuminate the work area, flagger stations, equipment crossings, and other areas. Floodlights shall not produce a disabling glare condition for approaching road users. Vehicle headlights or incandescent lights shall not be used. The Night Lighting System Plan shall be prepared and signed by the PTOE/TCS and submitted to the AGENCY at least seven (7) calendar days before use.

The Contractor shall not proceed with night operations until night lighting system plan has been accepted by the AGENCY, Design Engineer, and the Engineer. Any days lost due to lack of night lighting system plans, will be charged against the Contractor's allowable working days.

338.01.02 TRAFFIC CONTROL — GENERAL REQUIREMENTS

The Contractor shall maintain public traffic throughout the project in accordance with the approved traffic control plans and perform work in a manner that assures the safety and convenience of the public and protects the residents and property adjacent to the project.

During the course of construction, the Contractor shall be prepared to provide access through the construction zone for police, fire or emergency vehicles as necessary to reach their destination with a minimum delay.

Regardless of the number of work zones, public traffic shall not be stopped for more than a thirty (30) minute duration and shall not be delayed for more than thirty (30) minutes total through the project. Should these delay restrictions be exceeded, work shall be immediately suspended. The Contractor shall be required to submit written revised traffic control plans that address the delay problem. Upon approval from the AGENCY Project Manager, construction operations may resume. Working days will continue to be assessed during the suspension period.

The Contractor shall not proceed with any construction until proper traffic control has been provided to the satisfaction of the AGENCY Project Manager and the Design Engineer. If at any time it is determined that traffic controls have been modified or are not functioning as intended, the AGENCY Project Manager or Design Engineer's representative may request the Contractor's PTOE/TCS to evaluate the traffic controls installed by the Contractor. Additionally, if during construction, revisions to the accepted plans are necessary for safety or accommodation to traffic, the AGENCY Project Manager or Design Engineer may require such revisions. Any days lost due to improper traffic control will be charged against the Contractor's allowable working days.

Should the Contractor neglect to prosecute the traffic control requirements properly or fail to perform any provision of the traffic control requirements, the AGENCY Project Manager, after twenty-four (24) hours written notice to the Contractor may without prejudice to any other remedy it may have, make good such deficiencies and deduct the cost thereof from the payment then or thereafter due the Contractor.

Unless otherwise directed or approved by the AGENCY Project Manager and the Engineer, the Contractor shall maintain a minimum of one (1) paved travel lane in each direction during all construction activities with the exception of the placement of the top lift of bituminous plantmix. Paved travel lanes shall be at least ten (10) feet wide.

The Contractor shall place temporary HOT-patch for all lowered utilities that fall within all open travel lanes. If curb and gutter removal results in patch areas that fall within any parking or travel lane, areas shall be patched with HOT-mix. Temporary patches shall be maintained until bottom lift paving is complete. Temporary patches shall be hot-mix asphalt a minimum of 2-inches in depth. Cold mix is not acceptable. The finished surface of the temporary hot-mix patches shall be free from ruts, humps, depressions or irregularities.

During the roadway removal process, the Contractor shall safety slope all longitudinal drop-offs. Safety slopes shall be placed flush with the existing pavement, tapered and compacted at the end of each day's operation. The Contractor shall submit details for the proposed safety slope construction to the AGENCY Project Manager

at least five (5) working days prior to implementation. The proposed details shall be approved by the Design Engineer prior to use. The Contractor may submit an alternate method in lieu of using safety slopes. If the Design Engineer does not approve the alternate method, or if it does not function as intended, safety slopes will be required. All driveways shall be opened and accessible at the end of shift.

All longitudinal drop-offs must be acceptably delineated and signed. Approved four horizontal to one vertical (4:1) aggregate/grindings base safety slopes (with hot/cold mix safety slopes at driveway/intersection access points to prevent scattering of safety slope when constructing within paved areas) and/or other safety measures approved by AGENCY Project Manager shall be constructed and maintained where public traffic is exposed to longitudinal drop-offs greater than four (4) inches during non-working hours.

Temporary ramps shall be placed and maintained flush with the higher elevated grade at driveways, crossings, or any other grade drop-offs within travel lanes open to the public where pavement grades do not match. Said ramps shall be sufficiently sloped to eliminate conditions that are hazardous to the motoring public. Under no circumstances shall the ramps be steeper than five percent (5%) in travel lanes. Temporary driveway ramps may be steeper, but must not cause vehicle bumpers or underside to hit the ground. Unless otherwise directed or approved by the AGENCY Project Manager, ramps shall be constructed with hot/cold mix if either approach to the ramp is paved. If neither approach at the ramp is paved, then the ramp may be constructed with base/grindings. Where temporary hot/cold mix ramps are installed, the Contractor shall completely remove the ramp and prepare the edge prior to placing new pavement. "Bump" signs are to be installed on both approaches to all grade transitions in the travel lanes to warn motorists.

If steel plates are approved by the AGENCY Project Manager for use in bridging utility adjustments, all plates shall have a 4:1 cold mix ramp constructed along the face of all perimeter edges, and "bump" signs shall be placed at all locations where a vehicle may encounter the plates. Additionally, if steel plates that are subject to non-working hour vehicular traffic are approved for use in bridging an open excavation, the contractor shall provide an acceptable method to prevent the plates from sliding or moving, in addition to the cold mix ramps.

The Contractor shall coordinate with and secure approval from Kurt Dietrich, P.E., with the City of Reno [phone: (775) 334-3334] or Jim Herman, with the City of Sparks Traffic Engineering Division [phone: (775) 353-2404], as appropriate for any use of or changes to operation of existing traffic signal equipment in the traffic control plans operation. The Contractor shall comply with jurisdictional requirements without additional cost to the AGENCY.

The flaggers must not control the intersection with the signal in full operation, since flaggers' directions to motorists may conflict with signal operation and thereby create an unsafe condition. If flaggers enter the intersection to control traffic, they shall be equipped with proper attire and control devices. The number of flaggers and equipment/attire shall comply with applicable MUTCD, State, and local requirements.

If existing traffic control signs are removed, the Contractor shall install temporary signs of the same designation as close as possible to the original location. It shall be the Contractor's responsibility to provide safe storage and protection of all signs which are removed, but are not designated for replacement. The Contractor shall notify the Design Engineer's representative prior to removal of any existing signs, which, in the Contractor's opinion, are not suitable for reinstallation. The Design Engineer's representative will make a determination of the condition of the sign.

All "ROAD WORK AHEAD" signs shall have associated placards, minimum letter size 6D, which designate the roadway where the work is being performed.

The Contractor shall provide and maintain temporary and permanent pavement markings in accordance with the MUTCD Part VI. Unless otherwise directed or approved by the AGENCY Project Manager, temporary painted and/ or other pavement markings which conflict with the permanent pavement markings will be prohibited. Conflicting pavement markings shall be obliterated using methods that result in minimum pavement scar and completely remove marking materials. Obliterated markings shall be unidentifiable as pavement markings under day or night, wet or dry conditions. Temporary traffic paint shall not be applied to the final pavement surface.

Type I or Type II barricades will not be permitted for use to prevent vehicle traffic from entering a closed portion of roadway. Only Type III barricades will be used in all such instances. Type III-B barricades used for this purpose will be placed a maximum four (4) feet apart. Yellow warning lights may be necessary for some barricade or drum applications.

Traffic control devices shall be removed as soon as they no longer apply to the current construction activities.

338.01.03 TRAFFIC CONTROL SUPERVISOR REQUIREMENTS AND RESPONSIBILITIES

The Contractor shall designate a Construction TCS who shall be responsible for initiating, installing and maintaining all traffic control devices as shown on the traffic control plans, as specified in the MUTCD, the NDOT Standard Plans for Road and Bridge Construction, specifically, Plans T-35.1.1 through T-35.1.7 and these specifications. The Construction TCS shall be under the direct supervision of the Superintendent. The designated Construction TCS shall be available to be contacted by the AGENCY Project Manager twenty-four (24) hours a day, seven (7) days a week for the life of this contract. The designated traffic control supervisor shall be available to be on the work site within forty-five (45) minutes after notification by the AGENCY Project Manager. The Contractor shall submit the designated Construction TCS's name, ATSSA certification number, and qualifications for AGENCY approval at the preconstruction conference. The Construction TCS shall:

- Have at least one (1) year of field experience directly related to work site traffic control set up in a supervisory or responsible capacity and be certified by ATSSA as a worksite Traffic Control Supervisor;
- Understand the Contract requirements;
- Understand the MUTCD requirements;
- During a work day, make at least three (3) inspections of the condition and position of all traffic control devices in use each day before beginning work, at mid-shift, and one half (1/2) hour after the end of the shift;
- During a non-work day, make at least one (1) inspection of the condition and position of all traffic control devices;
- Correct all traffic control deficiencies;
- Coordinate maintenance of traffic operations with the PTOE/TCS who prepared the traffic control plans, if a different person;
- Report all corrective actions to maintain and protect traffic through the project;
- Review work areas, equipment operation and storage, and material and handling and storage relative to traffic safety; and
- Furnish weekly written certification to the AGENCY Project Manager that inspections and reviews were conducted and that traffic control devices met or exceeded the contract requirements. Weekly certification shall include daily records of traffic control activities and reviews.

The Contractor shall not proceed with any construction until the Construction TCS has been approved by the AGENCY Project Manager and the Design Engineer. Any days lost due to the lack of Construction TCS will be charged against the Contractor's allowable working days.

Immediately after set up of new or modified traffic control plans, the Contractor shall have the TCS inspect the controls installed in the field to determine if all required controls have been installed and are operating as intended. The TCS shall submit to the AGENCY Project Manager a written inspection report on the traffic controls conformance with the approved traffic control plans and contract requirements. If the TCS determines that the traffic controls are not in conformance with the approved traffic control plans, contract requirements, or determines that the traffic controls are not functioning as intended, the report shall address such deficiencies and make recommendations for changes. The AGENCY Project Manager may require the Contractor's PTOE/TCS to revise the traffic control plans accordingly.

338.01.04 TRAFFIC CONTROL NOTIFICATION

Upon approval of the traffic control plans, and at least two (2) working days prior to beginning construction, the Contractor shall notify and submit a copy of the approved traffic control plans to the Engineer, RTC Ride, refuse collection agencies, the Washoe County School District, RTC Ride and appropriate police and fire departments, REMSA, and any other emergency service as directed by the AGENCY Project Manager.

The Contractor shall also prepare and deliver general project information notices to all residences and businesses adjacent to the project to ensure that residences/businesses receive the notices at least seven (7) calendar days prior to beginning any construction. The initial notice (see Exhibit "A" at the end of the Special Provisions section for sample notice format) shall include:

- 8½" x 11" individual access plans for multi-access properties (the 8.5" x 11" individual access plans for multi-access properties and notification letters need not be prepared and signed by the PTOE/TCS);
- General scope of project (description of project and limits, hours and days of operation, phasing information, lane closure, parking restrictions, etc.);
- Contractor contact and telephone number; and
- Other appropriate information requested by the AGENCY Project Manager

In addition to the general project information notices, the Contractor must prepare written notification of commencement of any new phase or sub-phase of construction (see Exhibit "B" at the end of the Special Provisions section for sample notice format). The Contractor shall distribute these notices to adjacent residences/businesses within the new phase or sub-phase at least two (2) working days prior to commencing

work in the new street segment. A draft of the notice shall be submitted to the AGENCY Project Manager for acceptance prior to distribution.

When temporary driveway closures are necessary, written notification shall be delivered by the Contractor to the impacted businesses and residences twenty-four (24) hours prior to each driveway closure event (see Exhibit "C" at the end of the Special Provisions section for sample notice format). In the event the 24 hour advance notice falls on a weekend, holiday, or after business hours, the Contractor's notice shall be distributed no later than noon the last non-holiday weekday prior to scheduled work.

When full-street or intersection closures are necessary or access is restricted to side streets, written notification shall be delivered by the Contractor to the impacted businesses and residences at least two (2) working days prior to the closure. The Contractor shall also notify and submit a copy of the approved traffic control and detour plan to the Engineer, RTC Ride, refuse collection agencies, the Washoe County School District, appropriate police and fire departments, REMSA, and any other emergency service as directed by the AGENCY Project Manager.

Draft of all notifications to residences and businesses shall be submitted to the AGENCY Project Manager for review and approval before the Contractor distributes the notifications. The Contractor shall submit a final copy to the AGENCY Project Manager of all notifications that the Contractor is required to distribute.

The public notification process is anticipated to involve in excess of # (^) hand deliveries and # (^) mailings.

#(^) Mobile changeable message boards shall be used at various locations, a minimum of seven (7) calendar days prior to start of any construction. The size and locations of the message boards shall be finalized at the Preconstruction meeting. The locations of the message boards may be moved at the direction of the AGENCY Project Manager or Design Engineer's representative.

The mobile changeable message boards shall operate twenty-four (24) hours a day for the entire duration of the Contract. The wording at each of the changeable messages shall be in accordance with the direction received from the AGENCY Project Manager or Design Engineer's representative.

In the event the Contractor fails to comply with notification or message board requirements, the AGENCY Project Manager may secure the services of a public notification agent to provide notification services and/or obtain message boards, and deduct from payments to the Contractor all expenses related to this effort.

338.01.05 TRUCK ROUTE/STORAGE AREA REQUIREMENTS

The construction limits of this project are adjacent to residential areas. Truck route and storage area locations shall be identified and a plan shall be submitted seven (7) calendar days prior to the preconstruction meeting, for review and approval by the AGENCY Project Manager.

The Contractor's truck route plan shall include, but not be limited to, the following:

- Proposed construction zone;
- Proposed storage areas;
- Location of flaggers (to control truck access, where applicable);
- Construction phasing (including phasing of intersection construction and detours, if any); and proposed truck route (including the location of other construction projects which impact, or may be impacted by, the proposed haul route).

Storage of construction materials, supplies, and equipment within the public streets and alleys during night and weekend periods is prohibited, except where approved by AGENCY Project Manager. At no time shall materials, supplies, or equipment be stored or stockpiled within twelve (12) feet of a travel lane unless separated by a method approved by the AGENCY Project Manager.

The use of private driveways, adjacent side streets, alleys, easements, and parking areas for storage of construction materials, supplies, and equipment, including temporary parking of vehicles owned by the Contractor or employees of the Contractor, is strictly prohibited at all times, unless written approval is obtained from the property owner. The Contractor and employees of the Contractor shall give special consideration to maintaining curbside parking on **INSERT STREET NAME(S)** and the adjacent side streets for the use of adjacent businesses and residences at all time.

The Contractor shall not proceed with any construction until the truck haul plans have been approved to the satisfaction of the Design Engineer and the AGENCY Project Manager. Any days lost due to the lack of an approved truck haul plan will be charged against the Contractor's allowable work days.

340.01 GENERAL.

340.01.01 DESCRIPTION. This Section covers *HMA* pavement preservation methods.

Any Subsection designations which are omitted within this Section shall be interpreted to be intentionally left blank.

340.01.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

340.01.01.01.02 Terms.

Cape Seal. Cape seal shall be defined as the placement of a chip seal followed by the placement of a slurry seal or micro-surfacing.

Chip Seal. Chip seal shall be defined as the placement of a layer of liquid asphalt cement followed by the placement of a layer of uniformly sized aggregate.

Crack, Major. Major crack shall be defined as a crack with a width of 1 inch or greater.

Crack, Minor. Minor crack shall be defined as a crack with a width greater than $\frac{1}{4}$ inch but less than 1 inch.

Fog Seal. Fog seal shall be defined as a light application of an asphalt emulsion.

Micro-surface. Microsurface shall be defined as a type of slurry seal.

Scratch Course. Scratch course shall be defined as a thin lift of bituminous mixture placed to smooth and level the existing pavement surface prior to placing the next lift.

Scrub Seal, Aggregate. Aggregate scrub seal shall be defined as process in which a layer of aggregate is pressed or scrubbed into modified asphalt cement on an existing pavement surface.

Scrub Seal, Bituminous. Bituminous scrub seal shall be defined as process in which a layer of modified asphalt cement is pressed or scrubbed into the pavement surface.

Slurry Seal. Slurry seal shall be defined as the placement of a mixture of aggregate and emulsion.

340.01.01.02 Design. This Subsection does not address the complete design requirements that must be taken into account by the *Engineer* in order to achieve the expected performance of the resulting composite roadway section. The *Engineer* shall show specific design requirements on the *Plans* or specify these requirements in the *Special Provisions* and/or *Special Technical Specifications*.

340.01.01.03 Safety. The *Contractor* shall be responsible for safety in accordance with Subsection 100.25.01 – “Safety”.

340.01.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to transport.

340.01.02.01 Inspection of Materials. The *Contractor* shall accommodate inspection and sampling of the materials in accordance with Subsections 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

340.01.02.02 Care of Materials.

340.01.02.02.01 Material Storage. Materials shall be stored in accordance with Subsection 100.31.03 – “Material Storage.” except as modified herein.

340.01.02.02.01.01 Aggregates. Sufficient storage space shall be provided for the aggregate required. The storage yard shall be maintained neatly and orderly and separate aggregate stockpiles shall be readily accessible for sampling.

340.01.02.03 Use of Other Materials. The *Contractor* shall not use other materials and/or methods except as provided in Subsection 100.31.02 – “Use of Other Materials”, except as modified herein.

340.01.03 CONSTRUCTION.

340.01.03.01 Submittals.

340.01.03.01.01 Certificate of Compliance. The *Contractor* shall provide a certificate of compliance for each material in accordance with Subsection 100.31.01 – “Certificate of Compliance”, except as modified herein:

340.01.03.01.01.01 Asphalts and Additives. The date of each test performed shall be no more than 30 *Calendar Days* prior to the date of shipment to the hot plant.

340.01.03.02 Composition of Materials. The *Contractor* shall submit, in writing, the mix design at least 14 *Calendar Days* prior to placement, for acceptance by the *Engineer*. Written comments regarding the submittal shall be provided to the *Contractor* within 7 *Calendar Days* of the submittal. The *Contractor* shall ensure that the mix design has been reviewed and accepted by the *Engineer* prior to providing the *HMA*.

340.01.03.03 Inspection and Testing. Inspection and testing shall be performed in accordance with Subsection 100.30 – “Inspection and Testing” and the applicable Subsections of Section 336 – “Inspection and Testing”.

340.01.03.04 Limit of Work. The limit of work shall be in accordance with Subsection 100.40 – “Location of Work”.

340.01.03.05 Scheduling of Work. The *Contractor* shall prepare and provide to the *Engineer*, for review, a baseline schedule, weekly work agenda and monthly updates in accordance with Subsection 100.17 – “Scheduling of Work”.

340.01.03.06 Existing Improvements and Systems. Removal of existing improvements and systems shall be performed in accordance with Section 300 – “Site Preparation”. The *Contractor* shall protect items not removed in accordance with Section 301 – “Protection and Restoration”, except as modified herein.

340.01.03.07 Construction Equipment. The *Contractor* shall provide all equipment, tools, and machinery in accordance with Subsection 100.33 – “Workers; Methods and Equipment”, except as modified herein.

340.01.03.08 Construction Loads. The *Contractor*’s operations shall not produce a surcharge which would impact stability of adjacent improvements.

340.01.03.09 Subgrade Preparation. Subgrade preparation shall be performed in accordance with Section 302 – “Subgrade Preparation”.

340.01.03.10 Excavation. Excavation shall be performed in accordance with Section 303 - “Excavation”.

340.01.03.11 Maintenance of Traffic. Maintenance of traffic shall be performed in accordance with Section 338 – “Maintenance of Traffic”.

340.01.03.12 Protection of Work and Cleaning Up. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up”.

340.02 PERMANENT PATCHING.

340.02.01 DESCRIPTION. This Section covers permanent patching utilizing *HMA*.

340.02.01.01.01 Composition of Mixtures. A mix design shall be submitted to the *Engineer* in accordance with Subsection 337.01 - "Mix Design". The blows per side, target air voids, aggregate gradation and type and grade of asphalt shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

340.02.02 MATERIALS. Materials shall conform to Section 320 – "HMA" except as modified herein.

340.02.02.01 Aggregates. Unless otherwise directed or approved by the *Engineer*, aggregate for *HMA* used in patching shall conform to Subsection 202.02.03 – "Plantmix and Roadmix Aggregate", Type 3.

340.02.03 CONSTRUCTION. Construction shall conform to Section 320 – "HMA" except as modified herein.

340.02.03.01 Preparation of Existing Surface. Contact surface of existing curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of asphalt emulsion prior to the *HMA* being placed against them in accordance with Section 321 – "Prime and Tack Coat."

340.02.03.02 Subgrade Preparation. *Subgrade* preparation shall be performed in accordance with Section 302 – "Subgrade Preparation".

340.02.03.03 Placing Of Materials. Placing of materials shall conform to Subsection 320.03.10.01 – "Spreading and Compacting".

340.02.03.04 Weather Limitations. Weather limitations shall conform to Subsection 320.03.11 – "Weather Limitations".

340.03 CRACK SEALING AND FILLING.

340.03.01 DESCRIPTION. This Section covers sealing minor cracks and filling major cracks in *HMA* pavement.

340.03.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to transport.

340.03.02.01.01 Minor Crack.

340.03.02.01.01.01 Hot-Applied Crack Filler. Hot-applied crack filler shall conform to Subsection 201.07 – "Hot-Applied Crack Filler".

340.03.02.01.02 Major Crack.

340.03.02.01.02.01 HMA. *HMA* shall conform to Subsection 320.02 "Materials", except as modified herein.

340.03.02.01.02.01.01 Aggregates. Type 3 aggregate conforming to Subsection 200.02.03 - "Dense Grade Plantmix and Roadmix Aggregate" shall be used.

340.03.03 CONSTRUCTION.**340.03.03.01 Preparation of Existing Surface.**

340.03.03.01.01.01 Minor Crack. Minor cracks shall be routed to create a uniform width, and blown clean of loose materials with a high-pressure air nozzle, (90 *PSI* or greater) to the satisfaction of the *Engineer*.

340.03.03.01.01.02 Major Crack. Major cracks shall be sawcut to create a uniform width of at least 16 inches for the full depth and length of the crack to be filled. Existing pavement and loose materials shall be removed to the satisfaction of the *Engineer*.

340.03.03.02 Construction Equipment.

340.03.03.02.01 Minor Crack. The *Contractor* shall use a squeegee or similar equipment to drag excess material flush to existing grade to provide a flush finish.

340.03.03.02.02 Major Crack. Construction equipment shall conform to Subsection 320.03.06 – "Construction Equipment".

340.03.03.03 Placing Of Materials.

340.03.03.03.01 Minor Crack. The *Contractor* shall seal minor cracks from the bottom up. Sealant material shall be applied so it is flush with the pavement surface. Sealant material shall not be higher than the adjacent surface.

Traffic shall not be allowed on the material until it has cured or until it has been sanded to prevent tracking and damage to vehicles. Pavement shall not be placed for at least 24 hours after crack sealing.

340.03.03.03.02 Major Crack. Placing of materials shall conform to Subsection 320.03.10 – "Placing of Materials" except as modified herein.

320.03.03.02.01.01 Pavement Surface. HMA shall be applied so it is flush with the pavement surface and shall not be higher than the adjacent surface. The *Contractor* shall provide a flush finish.

340.03.03.04 Weather Limitations.

340.03.03.04.01 Major Crack. The *Contractor* shall adhere to the weather limitations contained in Subsection 320.03.11 – "Weather Limitations".

340.04 FOG SEAL.

340.04.01 DESCRIPTION. This Section covers the application of fog seal.

340.04.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to transport.

340.04.02.01 Emulsified Asphalt. Unless otherwise directed or approved by the *Engineer* fog seal shall conform to Section 201.04 – "Emulsified Asphalts."

340.04.03 CONSTRUCTION.

340.04.03.01 Preparation of Existing Surface. Immediately before applying the bituminous material, the surface to be sealed shall be thoroughly cleaned of dirt and loose material by sweeping with vacuum power brooms or mechanical power brooms as accepted by the *Engineer* and supplemented by hand brooms if necessary. The process of cleaning shall continue until dirt and loose material is removed from the entire width of the surfacing.

340.04.03.02 Construction Equipment.

340.04.03.02.01 Distributors. The distributor shall conform to Subsection 318.03.06.01 – "Distributors".

340.04.03.03 Placing of Materials. Bituminous material shall not be spread later in the day than will permit the stopping of traffic control prior to darkness. Bituminous material shall be applied to only one designated lane at a time and the entire width of the lane shall be covered in one operation.

Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated. If the texture of the surface is such that bituminous material penetrates too rapidly, a preliminary application of form 0.05 to 0.10 gallons per square yard may be necessary.

The distributor when not spreading shall be parked so the spray bar or mechanism will not drip bituminous materials on the surface of the traveled way.

340.04.03.03.01 Application Rate. The bituminous material shall be uniformly applied at the rate specified in Table 340.04.03.03.01-I.

TABLE 340.04.03.03.01-I

| Application Rate (Gallons per square yard) |
|--|
| |
| 0.07 – 0.12 (Diluted Emulsion) |
| |

340.04.03.03.02 Application Temperatures. The temperature of the bituminous material shall conform to the applicable requirements of Table 340.04.03.03.01-II.

TABLE 340.04.03.03.01-II

| Emulsion Type | Distributor Spraying Temperature °F | | Pugmill Mixing Temperature ⁽¹⁾ °F of Emulsion and Aggregates | |
|----------------|-------------------------------------|---------|---|---------------------|
| | Minimum | Maximum | Minimum | Maximum |
| RS-1, CRS-1 | 100 | 140 | | Not used for Mixing |
| RS-2, CRS-2 | 110 | 160 | | Not used for Mixing |
| SS-1, CSS-1 | 100 | 130 | 50 | 130 |
| SS-1h, CSS-1h | 100 | 130 | 50 | 130 |
| CMS-2s | 100 | 160 | 60 | 140 |
| LMCRS-2h, PMPS | 125 | 165 | | Not used for Mixing |

1. The maximum spraying temperature may be used if the aggregate is heated

340.04.03.04 Weather Limitations. Bituminous material shall not be spread when weather conditions are unsuitable or when the atmospheric temperature is below 50 °F.

340.05 SAND SEAL, CHIP SEAL AND AGGREGATE SCRUB SEAL.

340.05.01 DESCRIPTION. This Section covers seals which consist of an application of bituminous material on an existing pavement surface followed by an application of aggregate.

340.05.01.01 Abbreviations and Terms. Abbreviations and terms shall be in accordance with Subsection 100.01 – “Abbreviations and Terms”, except as modified herein.

340.05.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to transport.

340.05.02.01 Aggregates.

340.05.02.01.01 Sand Seal. Aggregates shall conform to Section 200.02.07 – “Sand Seal and Sand Blotter”.

340.05.02.01.02 Chip Seal and Aggregate Scrub Seal. Aggregates shall conform to Section 200.02.05 – “Chip Seal”.

340.05.02.05 Emulsified Asphalt. Emulsified asphalts shall conform to Section 201.04 – “Emulsified Asphalts”.

340.05.03 CONSTRUCTION.

340.05.03.01 Preparation of Existing Surface. Immediately before applying the bituminous material, the surface to be sealed shall be thoroughly cleaned of dirt and loose material by sweeping with vacuum power brooms or mechanical power brooms as approved by the Engineer or Contract documents and supplemented by hand brooms if necessary. The process of cleaning shall continue until dirt and loose material is removed from the entire width of the surfacing.

340.05.03.02 Construction Equipment.

340.05.03.02.01 Distributors. Distributors shall conform to Subsection 318.03.06.01 – “Distributors”.

340.05.03.02.02 Aggregate Spreader. The aggregate spreader shall be self-propelled and supported by at least four wheels with pneumatic tires on two axles. The aggregate spreader shall be equipped with positive control so that the required amount of material will be uniformly deposited over the full width of the asphalt emulsion.

340.05.03.02.03 Rollers.

340.05.03.03.01.01 Pneumatic Rollers. Pneumatic rollers shall conform to Subsection 320.03.06.04.02 - “Pneumatic Rollers”.

340.05.03.03.01.01.01 Steel Wheel Rollers for Chip Seal and Aggregate Scrub Seal. Steel wheel rollers shall not weigh more than 6 tons.

340.05.03.02.03 Brooms. Broom attachment for scrub seals shall be a wholly portable device that attaches to the distributor for clean application of bituminous material.

340.05.03.03 Placing of Materials. The Contractor shall operate in a minimum of two pneumatic rollers for each aggregate spreader. A steel wheel roller shall be used as directed or approved by the *Engineer*.

Aggregate shall be spread immediately following the application of the bituminous material. Bituminous material and aggregate shall not be spread over a greater distance than can be rolled and swept within one day's operation.

340.05.03.03.01 Application Rate.

340.05.03.03.01.01 Asphalt Emulsion. Asphalt emulsion shall be applied in accordance with Table 340.05.03.03.01-I.

TABLE 340.05.03.03.01-I

| | Application Rate (Gallons per Square Yard) |
|-------------------------|---|
| Sand Seal | 0.15 – 0.20 |
| Chip Seal or Scrub Seal | 0.25 – 0.45 |

340.05.03.03.01.02 Aggregate. Aggregate shall be spread at the rate conforming to Table 340.05.03.03.01.02-I.

TABLE 340.05.03.03.01.02-I

| Application Rate (Pounds per Square Yard) | |
|---|---------|
| | |
| Sand Seal | 10 – 15 |
| Chip Seal | 15 – 30 |
| Scrub Seal | 10 – 25 |
| | |

In order to avoid building a longitudinal joint when spreading aggregate on the first width of bituminous material, no aggregate shall be applied within 6 of the inches of the edge adjacent to the next application of bituminous material.

In order to eliminate dust film, aggregate shall be moistened with water before being applied. In spreading the screenings, the equipment shall be so operated that the fresh bituminous material will be covered before the equipment wheels come upon it.

Asphalt emulsion applied to the road surface shall be covered with aggregate before breaking or setting occurs.

After the aggregates have been spread upon the bituminous material, any piles, ridges, or uneven distribution shall be carefully removed with flat bottom shovels, or other approved methods, to insure against permanent ridges or bumps in the completed surface. Additional aggregate shall be spread by hand in whatever quantities that are required to prevent picking up at the rollers or traffic.

After the application of the aggregate, the surface shall be lightly broomed or otherwise maintained as directed for a period of 4 days or as directed. Maintenance of the surface shall include the distribution of screenings over the surface to absorb any free bituminous material and cover any area deficient in screenings. The maintenance shall be conducted so as not to displace embedded material. Excess material shall be swept away at the time determined by the Engineer.

All sand seals, chip seals, and scrub seals shall be placed in the presence of the Agency or Engineer or their representative. The Contractor shall notify the Agency or Engineer 24 hours prior to construction of sand seal, chip seal, or scrub seal. The Contractor shall supply the on-site inspector with an asphalt sample taken directly from the distributor truck and provide asphalt certification before proceeding.

340.05.03.03.02 Rolling of Aggregate. Rollers shall always include pneumatic rollers. In addition a steel drum roller shall be utilized on the second course of a double chip seal and shall be operational on a single chip seal. Rolling shall follow immediately behind spreading to properly imbed the screenings in the soft bituminous material, and rolling shall commence at the outer edges and proceed toward the inner edges of each spread of bituminous material and screenings, and shall be continued until the aggregates are thoroughly set. Roller speed shall be less than 5 miles per hour and shall not displace aggregate.

340.05.03.03.03 Sweeping Operations and Aggregate Cleanup. The Contractor shall broom excess aggregate from the roadway within 4 hours of application or reference Contract documents before opening roadway to any full speed traffic. Excess aggregate shall be removed from the project site. Contractor shall provide a minimum of three self-propelled kick brooms or mechanical pick-up brooms or any combination thereof unless directed otherwise by the Contract documents.

340.05.03.04 Weather Limitations. Placement operations shall not proceed unless the both the ambient and surface temperatures conform to Table 340.05.03.04.01-I.

Table 340.05.03.04.01-1

| | Ambient Temperature ° F | Surface Temperature ⁽¹⁾ ° F |
|-----------------------------------|----------------------------|---|
| Sand Seal | 50 Minimum | - |
| Chip Seal or Aggregate Scrub Seal | 65 Minimum | 80 Minimum |

1. Shall be measured on surface that is to be paved.

340.05.03.05 Protection of Work and Cleaning Up. Protection of work and cleaning up shall be in accordance with Section 100.44 – “Protection of Work and Cleaning Up” except as modified herein.

340.05.03.05.01 Clean Up of Aggregate. The *Contractor* shall broom excess aggregate from the roadway within 24 to 72 hours of application and before opening to any full speed traffic. Excess aggregate shall be removed from the project site.

340.06 SLURRY SEAL.

340.06.01 DESCRIPTION. This Section covers the preparation for placement, mixing and application of emulsified asphalt slurry seal.

340.06.01.01.01 Composition of Mixtures. A mix design shall be submitted to the *Engineer* in accordance with Subsection 337.01 - “Mix Design”. The aggregate gradation and type and type of asphalt emulsion shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*. Binder shall conform to Table 201.04-III in Section 201 for RTS with LMCQS and Micro with LMCQS.

340.06.02 MATERIALS. The materials used shall be accepted by the *Engineer*. The *Contractor* shall ensure that the materials have been accepted by the *Engineer* prior to transport.

340.06.02.01 Aggregates. Aggregates shall conform to Subsection 200.02.06 – “Slurry Seal and Micro-Surfacing Aggregate”.

340.06.02.02 Emulsified Asphalt. Emulsified asphalts shall conform to Subsection 201.04 – “Emulsified Asphalts”.

340.06.02.03 Mineral Filler. Mineral filler shall conform to Subsection 201.09 – “Mineral Filler for HMA”.

340.06.02.04 Cementitious Materials. Cementitious materials shall conform to Subsection 202.02 – “Cementitious Materials”.

340.06.03 CONSTRUCTION.

340.06.03.01 Preparation of Existing Surface. Immediately prior to applying the slurry seal, the surface shall be cleared of all loose material, silt spots, vegetation, oil spots, and other objectionable material. Any standard cleaning method will be accepted. If water is used, cracks shall be allowed to dry thoroughly before slurry sealing. Manholes, valve boxes, drop inlets, and other service entrances shall be protected from the slurry seal by a suitable method. The *Engineer* shall accept the surface preparation prior to sealing.

340.06.03.01.01 Tack Coat. When shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications* the *Contractor* shall apply a tack coat consisting of one part asphalt emulsion and three parts water. Tack coats are necessary only on very smooth surfaces or on concrete. The same asphalt emulsion to be used in the slurry seal shall be used.

340.06.03.02 Construction Equipment.

340.06.03.02.01 Tack Coat. The equipment used to apply the tack coat shall be capable of applying the dilution at a rate of 0.05 to 0.10 gallons per square yard.

340.06.03.02.02 Mixing. The slurry seal mixing equipment shall be a continuous flow mixing unit, either an individual unit that returns to the stockpile for reloading or a continuous run unit that is resupplied on the job.

All units must have suitable means of accurately metering each individual material being fed into the mixer. All feeding mechanisms must be continuous feed and proportioning must remain constant at all times.

The units shall be equipped with approved devices so that the machine can be accurately calibrated, and the quantities of materials used during any one period can be estimated. In the event these metering devices stop working, the slurry unit(s) will stop the application process until they are mixed.

The mixer shall thoroughly blend all materials to form a homogeneous mass before leaving the mixer.

340.06.03.02.03 Spreading. The spreader box shall be equipped to prevent loss of slurry seal from all sides and with a flexible rear strike-off. It shall be capable of producing a uniform surface its full width. It shall have suitable means for side tracking to compensate for deviations in pavement geometry.

Any type drag used shall be accepted by the *Engineer* and kept in a completely flexible condition at all times. The box shall be kept clean, and build-up of asphalt and aggregate shall not be permitted. Augered and/or double strike offs shall be required with RTS or Micro applications.

340.06.03.02.03.01 Machine Calibration and Verification.

340.06.03.02.03.01.01 Calibration. Each slurry mixing unit to be used in performance of the work shall be calibrated in the presence of the *Engineer* or Agency prior to construction. Previous calibration documentation covering the exact materials to be used may be accepted provided they were made during the calendar year. The documentation shall include an individual calibration of each material at various settings, which can be related to the machine's meeting device(s). No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

340.06.03.02.03.01.02 Verification. Test strips will be made by each machine after calibration and prior to construction. Test strips shall be a portion of the project. Samples of the slurry seal will be taken and verification made as to mix consistency and proportioning. Verification of rate of application will also be made. Upon failure of any of the tests, additional test strips, at no cost to the Owner or Agency, will be required until each unit is authorized to work. Any unit failing to pass the tests after the third trial will not be permitted to work on the project. Test strips must be accepted or rejected within 24 hours after application.

340.06.03.02.04 Auxiliary Equipment. Suitable crack and surface cleaning equipment, barricading equipment, hand tools, and any support equipment should be provided as necessary to perform the work.

340.06.03.03 Placing of Materials.**340.06.03.04 Application.**

340.06.03.04.01 General. The surface should be pre-wetted by fogging ahead of the slurry box when required by local conditions. Water used in pre-wetting the surface shall be applied such that the entire surface is damp with no apparent flowing water in front of the slurry box. The rate of application of the fog spray shall be adjusted during the day to suit temperatures, surface texture, humidity, and dryness of the pavement surface.

The slurry mixture shall be of the desired consistency upon leaving the mixture and no additional materials shall be added. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that a complete coverage is obtained. Overloading of the spreader shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted.

No streaks, such as those caused by oversized aggregate, will be left in the finished surface. If excess oversize develops, the job will be stopped until the Contractor proves to the Engineer or Agency that the situation has been corrected.

340.06.03.04.02 Rate of Application. The slurry seal mixture shall be of proper consistency at all times so as to provide the amount of mixture required by the surface condition. The mixture shall be applied in accordance with Table 340.06.03.04.02-I.

TABLE 340.06.03.04.02-I

| Aggregate Gradation | Application Rate (Pounds per Square Yard) | | |
|---------------------|---|---------|-----------|
| | Standard Slurry (1) | RTS (1) | Micro (1) |
| Type 1 | 6 – 10 | - | - |
| Type 2 | 10 – 15 | 12 – 18 | 14 – 20 |
| Type 3 | 15 – 25 | 18 – 24 | 20 – 30 |
| Type 4 | - | - | 25 – 35 |

(1) Dry Aggregate Weight

340.06.03.04.03 Joints. No excessive buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. An excessive overlap will not be permitted on longitudinal joints. The Contractor shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. Half passes and odd width passes will be used only in minimum amounts. If half passes are used, they shall not be the last pass of any paved area.

340.06.03.04.04 Mix Stability. The slurry mixture shall possess sufficient stability so that premature breaking of the slurry seal in the spreader box does not occur. The mixture shall be homogeneous during and following 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.

340.06.03.04.05 Hand Work. Areas which cannot be reached with the slurry seal machine shall be surfaced using hand squeegees to provide complete and uniform slurry seal coverage. The area to be handworked shall be lightly dampened prior to mix placement and the slurry worked immediately. Care shall be exercised to leave no unsightly appearance from handwork. The same type finish as applied by the spreader box shall be required. Handwork shall be completed during the machine applying process.

340.06.03.04.06 Lines. Care shall be taken to insure straight lines along curbs and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide a good appearance.

340.06.03.05 Weather Limitations. The slurry seal shall not be placed unless both the ambient and surface temperatures conform to Table 340.06.03.05-I.

Table 340.06.03.05-I

| Ambient Temperature °F | Surface Temperature ⁽¹⁾ °F |
|---------------------------|--|
| 55 and Rising | 55 Minimum |

1. Shall be measured on surface that is to be paved.

Slurry seal shall be applied when there is danger that the finished product will freeze before 24 hours. The mixture shall not be applied when weather conditions prolong opening to traffic beyond a reasonable time.

340.06.04 ACCEPTANCE.

340.06.04.01 Tolerances. Tolerances for individual materials as well as the slurry seal mixture are as follows:

- After the designed residual asphalt content is determined, a plus or minus 1 percentage point variation will be permitted.
- The percent of aggregate passing each sieve shall not vary more than \pm 4.0 percent from the mix design.
- The percent of aggregate passing shall not go from the high end to the low end of the specified range of any two successive sieves.
- The slurry consistency shall not vary more than \pm 05 cm from the mix design after field adjustments.
- Dry Aggregate weights shall meet the requirements of Table 340.06.03.10.02-I.

340.07 OVERLAY.

340.07.01 DESCRIPTION. This Section covers the placement of *HMA* on an existing pavement surface.

340.07.01.01 Composition of Mixtures. A mix design shall be submitted to the *Engineer* in accordance with Subsection 337.01 - "Mix Design". The blows per side, target air voids, aggregate gradation and type and grade of asphalt shall be shown on the *Plans* or specified in the *Special Provisions* and/or *Special Technical Specifications*.

340.07.02 MATERIALS. Materials shall conform to Section 320 – "HMA".

340.07.03 CONSTRUCTION. Construction shall conform to Section 320 – "HMA" except as modified herein.

340.07.03.01.01 Preparation of Existing Surface. The contact surface of existing curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of asphalt emulsion prior to the *HMA* being placed against them in accordance with Section 321 – "Prime and Tack Coat."

340.07.04 ACCEPTANCE. Acceptance shall conform to Section 320 – "HMA".