

State of Connecticut

Department of Transportation

THE STANDARD SPECIFICATIONS

FOR

ROADS, BRIDGES AND INCIDENTAL CONSTRUCTION

FORM 816

2004

MERGED WITH

SUPPLEMENTAL SPECIFICATIONS

JANUARY 2005

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**SECTION 1.01
DEFINITION OF TERMS AND
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1.01.03—Abbreviations and Terms

1.01.01—Definitions: In these specifications, unless the context requires otherwise, words of the masculine gender include the feminine and the neuter, and, when the sense so indicates, words of the neuter gender may refer to any gender.

ADDENDUM: Contract revisions developed and incorporated into the contract after bid advertisement and before the opening of bid proposals.

AIR OPERATIONS AREA: Any paved or unpaved area of the airport used or intended to be used for the unobstructed movement of aircraft. These movements shall include landings, takeoffs, and surface maneuverings.

AWARD: The Department's acceptance in writing of the proposal of the lowest responsible bidder for the work, subject to the execution and approval by the Department of a contract therefor and the provision by the bidder of performance and payment bonds to secure the performance thereof which are acceptable to the Commissioner, and to such other conditions as may be specified by the Department or required by law.

BID ADVERTISEMENT: A public announcement soliciting bids for a contract for work to be performed or materials to be furnished.

BID MANUAL: "The State of Connecticut Department of Transportation Construction Contract Bidding and Award Manual," copies of which are available from the Department's Division of Contracts.

CALENDAR DAY: Every day shown on the calendar, Sundays and holidays included.

CERTIFICATE OF COMPLIANCE: The formal document issued at the completion of a project by the State Building Inspector's representative. The document is often referred to informally as a "Certificate of Occupancy," "C.O.C." or "C.O."

CHANNEL: A channel shall be interpreted to mean a natural or artificial watercourse having an average width at the bottom, after excavation, of 4 feet (1.2 meters) or more.

COMMISSIONER: State of Connecticut Transportation Commissioner acting directly or through a duly-authorized representative.

CONSTRUCTION ORDER: A written order signed by the Engineer for a contractor to perform work or provide supplies stipulated therein at the price or upon the basis of payment set forth therein.

CONTRACT: The agreement covering the performance of the work and the furnishing of materials required for the construction of the Project. The Contract shall be deemed to include the "Plans," "Specifications" (*i.e.*, the edition of the Department's "Standard Specifications for Roads, Bridges and Incidental Construction" which is in effect on the date of the Bid Advertisement), "Construction Orders," and such other provisions as may be incorporated into the agreement, in addition to the contents of the bound contract containing the schedule of prices, signature sheet, addenda, special provisions, required federal and state provisions, supplemental specifications, labor and wage schedules and other such material.

CONTRACTOR: When the word is capitalized, the party of the second part to the Contract, acting directly or through its agents or employees. When this word is not capitalized, it is to be taken in its more general sense.

DEPARTMENT: State of Connecticut Department of Transportation.

DESIGNER: A duly-authorized representative of the Engineer, responsible for the design of the Project.

DRAINAGE DITCH: An unpaved, artificially-constructed open depression having an average width of less than 4 feet (1.2 meters) at the bottom, after excavation, constructed for the purpose of carrying off surface water.

ENGINEER: The Commissioner or Deputy Transportation Commissioner, acting directly or through a duly-authorized representative.

EXECUTION OF CONTRACT: The date of execution of the Contract by the Department is the date on which the Department's authorized signatory signs the Contract on behalf of the Department.

EQUAL: A material, device, type of equipment, or method other than what is specified in the Contract, which is a recognized equivalent in substance and function for that specified thing, taking into account quality, workmanship, economy of operation, durability, and suitability for purposes intended, provided that the proposed equivalent would not require or constitute a change in Contract work.

FIXED COSTS: Any labor, material and equipment costs directly incurred for the item or items under consideration, which are necessary for the fulfillment of Contract requirements and which remain constant regardless of the quantity of the work done.

HIGHWAY: A general term denoting a public way used for vehicular travel. When referred to in the Contract, it signifies the whole right of way reserved for or secured by the Department for use in constructing or maintaining a roadway and its appurtenances.

INSPECTOR: A duly-authorized representative of the Engineer, assigned to make inspections of the work performed and materials furnished by the Contractor.

LABORATORY: Unless another laboratory or type of laboratory is indicated, the official testing laboratory of the Department.

MAJOR AND MINOR ITEMS: The original Contract item of greatest cost, computed at the original Contract price and quantity, and such other original Contract items next in sequence of lower cost, computed at original Contract price and quantity, necessary to equal a total cost at the original prices and quantities of not less than 60 percent of the original aggregate Contract cost shall be considered to be a major item or major items. All other original items shall be considered to be minor items.

MANAGER OF CONTRACTS: The Transportation Manager of Contracts, who is the head of the Department's Division of Contracts, and whose office is located at the headquarters of the Department at 2800 Berlin Turnpike, Newington, CT.

MATERIAL: Any substance specified in the Contract for use in the construction of the Project, including appurtenances of products that are substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the work.

PAVEMENT STRUCTURE: The combination of sub-base, base course and surface course placed on subgrade to support and distribute the traffic load.

PLANS: All drawings or reproductions of drawings supplied by the Department to the Contractor pertaining to the construction or details of the Project.

A. Standard Sheets – Standardized plans containing details approved by the Department and the FHWA, for construction of a given type on any project, included in contracts on an as-needed basis.

PROJECT: All work included under one Department contract, notwithstanding the occasional use by the Department of multiple project numbers for the work included within one contract.

PROJECT SITE: The space available to the Contractor, under the Contract, for performing construction activities. The extent of the Project site is as indicated on the plans or elsewhere in the Contract.

RECLAIMED CONCRETE AGGREGATE: Reclaimed waste consisting of crushed and graded concrete removed from pavements, structures, or buildings. Metal may be acceptable only where it is contained as reinforcement within small fragments of concrete; *e.g.*, metal projecting from concrete fragments would be unacceptable. All such material trucked from beyond the limits of the Project must be accompanied by a materials certificate and certified test report indicating that the material is environmentally acceptable and structurally sound in accordance with Section 1.06.07, unless the source of the material is a Department Project and that source is acceptable to the Engineer.

RECLAIMED MISCELLANEOUS AGGREGATE: Glass-free and clinker-free reclaimed waste, which has been crushed, graded and blended, as specified in the Contract, with natural crushed stone or gravel. Metal may be acceptable only where it is contained as reinforcement within small fragments of concrete; *e.g.*, metal projecting from concrete fragments would be unacceptable. All such material trucked from beyond the limits of the Project must be accompanied by a materials certificate and certified test report indicating that the material is environmentally acceptable and structurally sound in accordance with Section 1.06.07, unless the source of the material is a Department Project and that source is acceptable to the Engineer.

RECLAIMED WASTE: Debris from the demolition of buildings, structures, and pavements; residue from incineration and recycled glass. Acceptable material shall include concrete, bituminous concrete, glass, ceramics, brick, pavement sub-base and base courses, and clinker from resource recovery plants. Metal may be acceptable only when it is contained within large fragments of concrete. Reclaimed waste trucked from beyond the limits of the Project must be accompanied by a materials certificate and certified test report indicating that the waste is environmentally acceptable and structurally sound in accordance with Section 1.06.07, unless the source of the material is a Department Project and that source is acceptable to the Engineer.

ROADBED: The graded portion of a highway, including portions within the top and side slopes, which have been prepared as a foundation for the pavement structure and shoulders.

ROADWAY: The portion of the highway, including shoulders, which may be used for vehicular travel within the Project limits.

SHOP DRAWINGS: Drawings, including proposed details, diagrams, schedules, procedures and other supporting data, prepared by a Contractor to supplement the Contract documents, showing all information necessary for fabrication of items for which some specific design or detail appears in the Contract.

SHOULDER: The portion of the roadway adjacent to the traveled way, that can accommodate stopped vehicles for emergency use, and that provides lateral support of base and surface courses.

SPECIFICATIONS: The Department's written provisions and requirements for the performance of the Contract, contained in or incorporated by the Contract.

A. *Standard Specifications*—A book of specifications published and approved by the Department for general application and repetitive use, available from the Manager of Contracts and entitled the "Standard Specifications for Roads, Bridges and Incidental Construction."

B. *Supplemental Specifications*—Approved additions to and revisions of the Standard Specifications.

C. *Special Provisions*—Other Department specifications applicable to an individual project.

STATE: State of Connecticut.

SUBCONTRACTOR: Any individual, firm, partnership or corporation to which the Contractor sublets, with the approval of the Commissioner, any part or parts of the Project covered by the Contract.

SUBSTITUTE: A replacement for a specified material, device, type of equipment, or method, which is sufficiently different in substance and function, quality, or workmanship to constitute a change in the Contract work.

SUBSTRUCTURE: All of that part of the bridge below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, including backwalls, wingwalls and any protective railings mounted on the wingwalls.

SUB-SUBCONTRACTOR: Any individual, firm, partnership or corporation to which a subcontractor sublets, with the approval of the Commissioner, any part or parts of the Project covered by the Contract.

SUPERSTRUCTURE: The entire bridge except the substructure.

UTILITY: Any public service company and the plant of such a company or similar facilities. Such companies may consist of, but not be limited to, companies selling or controlling the sale, distribution or use of water, gas, electricity, communications systems, sewers and railroad lines. Such facilities may consist of, but not be limited to, wires, cables, ducts, pipes, manholes, transformers, poles, towers and tracks.

WORKING DRAWINGS: Drawings, calculations, procedures and other supporting data prepared by a Contractor, documenting the Contractor's proposed design, details, materials, construction methods and equipment for any construction for which no specific design or detail appears in the Contract.

1.01.02—Abbreviations, Publications and Standards: Whenever one of the following abbreviations is used in the Contract, its meaning shall be interpreted as follows:

AA—Aluminum Association, Inc. (The)

AABC—Associated Air Balance Council

AAMA—American Architectural Manufacturers Association

AAPA—American Association of Port Authorities

AASHTO—American Association of State Highway and Transportation Officials: Wherever reference is made to an AASHTO Standard Method of Test or Standard Specification, it refers by letter and number to the method or specification published by AASHTO in the "Standard Specifications for Transportation Materials and Methods of Sampling and Testing". The edition governing the work shall be in effect on the date the Contract was advertised for solicitation of bids shall govern.

ABMA—American Bearing Manufacturers Association

ACGIH—American Council of Government Industrial Hygienists

ACI—ACI International (American Concrete Institute)

ADA—Americans with Disabilities Act

ADAAG—Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities

AFPA—American Forest and Paper Association

AGA—American Gas Association

AGC—Associated General Contractors of America (The)

AHA—American Hardboard Association

AHAM—Association of Home Appliance Manufacturers

AI—Asphalt Institute

AIA—American Institute of Architects (The)
 AISC—American Institute of Steel Construction
 AISI—American Iron and Steel Institute
 AITC—American Institute of Timber Construction
 A.L.I.—Automotive Lift Institute
 ALSC—American Lumber Standards Committee, Incorporated
 AMCA—Air Movement and Control Association International, Inc.
 ANLA—American Nursery and Landscape Association
 ANSI—American National Standards Institute
 AOAC—AOAC International
 AOSA—Association of Official Seed Analysts
 APA—APA-The Engineered Wood Association
 API—American Petroleum Institute
 AREMA—American Railway Engineering and Maintenance-of-Way Association
 ARI—Air-Conditioning & Refrigeration Institute
 ARTBA—American Road and Transportation Builders Association
 ASA—Acoustical Society of America
 ASC—Adhesive and Sealant Council
 ASCE—American Society of Civil Engineers
 ASHRAE—American Society of Heating, Refrigerating and Air-Conditioning Engineers
 ASME—ASME International (The American Society of Mechanical Engineers International)
 ASSE—American Society of Sanitary Engineering
 ASTM—American Society of Testing and Materials (ASTM International): Wherever reference is made to an ASTM specification, test method, or practice, it refers by letter, number, or both to standards published by ASTM International in the "ASTM Standards Source™ Database". The edition governing the work shall be in effect on the date the Contract was advertised for solicitation of bids shall govern.
 ATSSA—American Traffic Safety Services Association
 AWI—Architectural Woodwork Institute
 AWPA—American Wood-Preservers' Association
 AWPI—American Wood Preservers Institute
 AWS—American Welding Society: Wherever reference is made to an AWS materials specification, inspection methods, or welding procedures, it refers by section number to standards of the American Welding Society published in the applicable steel, or aluminum welding code. The edition governing the work shall be in effect on the date the Contract was advertised for solicitation of bids shall govern.
 AWWA—American Water Works Association
 BHMA—Builders Hardware Manufacturers Association
 BOCA—BOCA International, Inc.
 CBM—Certified Ballast Manufacturers Association
 CCRL—Cement and Concrete Reference Laboratory
 CISCA—Ceilings and Interior Systems Construction Association
 CLFMI—Chain Link Fence Manufacturers Institute
 ConnDOT—Connecticut Department of Transportation
 CFR—Code of Federal Regulations
 CGS—Connecticut General Statutes
 CISPI—Cast Iron Soil Pipe Institute
 CRI—Carpet and Rug Institute (The)
 CRSI—Concrete Reinforcing Steel Institute
 CSI—Construction Specifications Institute (The)
 CSSB—Cedar Shake & Shingle Bureau
 CTI—Cooling Technology Institute
 DASMA—Door and Access Systems Manufacturers Association, International
 DEP—Connecticut Department of Environmental Protection
 DHI—Door and Hardware Institute
 DOD—Department of Defense Military Specifications and Standards
 DPUC—Department of Public Utility Control
 EIA—Electronic Industries Alliance

EPA—Environmental Protection Agency
FAA—Federal Aviation Administration
FCC—Federal Communications Commission
FCICA—Floor Covering Installation Contractors Association
FHWA—Federal Highway Administration
FM—Factory Mutual System
FMG—FM Global
FRA—Federal Railway Administration
FS—Wherever reference is made to FS in the contract, it refers by number, letter, or both, to the latest standard or tentative standard of the Federal Specification Unit, General Services Administration, Federal Supply Service, as to materials, specifications, or methods of testing, whichever the case may be.
FTA—Federal Transit Administration
HPVA—Hardwood Plywood & Veneer Association
GA—Gypsum Association
GANA—Glass Association of North America
GSA—General Services Administration
ICBO—International Conference of Building Officials
ICC—International Code Council
ICEA—Insulated Cable Engineers Association, Inc.
IEEE—Institute of Electrical and Electronics Engineers, Inc. (The)
IESNA—Illuminating Engineering Society of North America
IGCC—Insulating Glass Certification Council
IMSA—International Municipal Signal Association
IRI—HSB Industrial Risk Insurers
ITE—Institute of Traffic Engineers
KCMA—Kitchen Cabinet Manufacturers Association
LMA—Laminating Materials Association
LPI—Lightning Protection Institute
MBMA—Metal Building Manufacturers Association
MIL—(MILSPEC) Military Specification and Standards
MMA—Monorail Manufacturers Association
MSHA—Mine Safety and Health Administration
MSS—Manufacturers Standardization Society of The Valve and Fittings the Valve Industry, Inc.
MUTCD—Manual on Uniform Traffic Control Devices
NAAMM—National Association of Architectural Metal Manufacturers
NADCA—National Air Duct Cleaners Association
NAIMA—North American Insulation Manufacturers Association (The)
NBFU—National Board of Fire Underwriters
NCHRP—National Cooperative Highway Research Program
NCMA—National Concrete Masonry Association
NCPI—National Clay Pipe Institute
NEBB—Natural Environmental Balancing Bureau
NEC—National Electrical Code
NECA—National Electrical Contractors Association
NEMA—National Electrical Manufacturers Association
NEPCOAT—North East Protective Coatings Committee
NESC—National Electrical Safety Code
NETA—InterNational Testing Association
NFPA—National Fire Protection Association
NHLA—National Hardwood Lumber Association
NICET—National Institute for Certification in Engineering Technologies
NIOSH—National Institute of Occupational Safety and Health
NIST—National Institute of Standards and Technology
NLGA—National Lumber Grades Authority
NOAA—National Oceanic and Atmospheric Administration

NRCA—National Roofing Contractors Association
NSF—NSF International
NTMA—National Terrazzo and Mosaic Association, Inc.
NWWDA—National Wood Window and Door Association
OEO—Office of Equal Opportunity
OSHA—Occupational Safety and Health Administration
PCA—Portland Cement Association
PCI—Precast/Prestressed Concrete Institute
PTI—Post-Tensioning Institute
RMA—Rubber Manufacturers Association
SAE—SAE International
SDI—Steel Deck Institute
S.D.I.—Steel Door Institute
SFPA—Southern Forest Products Association
SJI—Steel Joist Institute
SMACNA—Sheet Metal and Air Conditioning Contractors' National Association
SPIB—Southern Pine Inspection Bureau (The)
SSPC—Where reference is made to SSPC in the Contract, it refers by number, letter, or both, to the latest standard or tentative standard specification of The Society for Protective Coatings, Formerly the Steel Structures Painting Council, as to materials specifications, methods of testing, systems, procedures, inspection or other specification pertaining to any or all phases of cleaning or painting, whichever may apply.
TCA—Tile Council of America, Inc.
TIA—Telecommunications Industry Association
TPI—Truss Plate Institute, Inc.
UL—Underwriters Laboratories Inc.
USDA—United States Department of Agriculture
USGBC—U.S. Green Building Council
WCLIB—West Coast Lumber Inspection Bureau
WCSC—Window Covering Safety Council
WWPA—Western Wood Products Association

1.01.03—Abbreviations and Terms: Abbreviations and terms used in the Contract are in lieu of and are to be construed in the same way as are the respective expressions represented. Some of these abbreviations and terms, but not necessarily all, are:

ABS—acrylonitrile butadiene styrene
AC—alternating current
ACCM Pipe or ACCMP—Asphalt-Coated Corrugated Metal Pipe
AOEC—Area of Environmental Concern
AWG—American Wire Gauge
B & B—balled and burlapped
bbl—barrel
BCPC—Bituminous Concrete Park Curbing
Bit.—bituminous
Bit. Conc.—bituminous concrete
CB—catch basin
CCM Pipe or CCMP—coated corrugated metal pipe
CICU—controller interface communications unit
CLLCU—closed loop local coordination unit
CLMU—closed loop master unit
Conc.—concrete
CPE Pipe or CPEP—corrugated plastic or polyethylene pipe
CPS—centipoise second
cwt—hundredweight or 100 pounds
DC—direct current
dist.—distillation
EW—endwall

exc—excavation
fi—jacking tension
f c—specified minimum compressive strength at a specified age
f' ci—required strength at time of transfer
g—gram
ga—gauge or gage
HASP—Health and Safety Plan
HMA—hot mix asphalt or bituminous concrete
JMF—job mix formula
kip—1000 pounds
ksf—kips per square foot
LED—light-emitting diode
L.S.—lump sum
mbf—1000-foot board measure
MBR—metal beam rail
Mgal—1000 gallons
MH—manhole
MPT—Maintenance and Protection of Traffic
Pavt.—pavement
PCBC—precast concrete barrier curb
PCC—Portland Cement Concrete
PE—polyethylene
Perf. ACCM Pipe or Perf. ACCMP—Perforated Asphalt-Coated Corrugated Metal Pipe
Perf. CCM Pipe or Perf. CCMP—Perforated Coated Corrugated Metal Pipe
Perf. CPE Pipe or Perf. CPEP—Perforated Corrugated Plastic or Polyethylene Pipe
pfmd.—preformed
PROM—programmable read only memory
psf—pounds per square foot
psi—pounds per square inch
p/s—prestressed
PVC—polyvinyl chloride
RAP—reclaimed asphalt pavement
RC—Reinforced Concrete
RCCE—Reinforced Concrete Culvert End
RC Pipe or RCP—Reinforced Concrete Pipe
SD—system detector
sec.—second
sol.—soluble
sp. gr.—specific gravity
sp. visc.—specific viscosity
std.—standard
surf.—surface
THHN—Heat resistant thermoplastic, insulated nylon jacket, 90 degrees Centigrade, 600 volt building wire
THWN—Moisture and heat resistant thermoplastic, insulated nylon jacket, 75 degrees Centigrade, 600 volt building wire
tsf—tons per square foot
U'drain—Underdrain
UTCS—urban traffic control system
UV—ultra-violet or ultra violet light
VOC—Volatile Organic Compound
VT—vitrified tile
W—watt
WSA—Temporary Waste Stockpile Area

**SECTION 1.02
PROPOSAL REQUIREMENTS AND CONDITIONS**

- 1.02.01—Contract Bidding and Award**
- 1.02.02—Competence of Bidder**
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- 1.02.04—Examination of Plans, Specifications, Special Provisions and Site of Work**
- 1.02.05—Preparation of Proposals**
- 1.02.06—Rejection of Non-responsive Proposals**
- 1.02.07—Proposal Guaranty**
- 1.02.08—Delivery of Proposal**
- 1.02.09—Withdrawal of Proposals**
- 1.02.10—Public Opening of Proposals**
- 1.02.11—Miscellaneous Grounds for Rejection of Proposals**
- 1.02.12—Vacant**
- 1.02.13—Knowledge of Applicable Laws**
- 1.02.14—Sworn Statement by Bidder**
- 1.02.15—Required Certifications of Eligibility to Bid**

1.02.01—Contract Bidding and Award: For information about the bidding and award of Department construction contracts, consult the “State of Connecticut Department of Transportation Construction Contract Bidding and Award Manual,” available from the Division of Contracts. In order to be eligible for award of a Department construction contract, a bidder must follow the requirements of this Bid Manual, and all bidding and award matters regarding Department construction contracts shall be governed by the terms of the Bid Manual, unless treated otherwise in the Contract, including these Specifications.

1.02.02—Competence of Bidder: See Article 1.02.01.

1.02.03—Interpretation of Estimate: The quantities shown on the proposal form are approximate only and are given as a basis for the pricing upon which the award of the Contract will be made. The Department does not warrant that these quantities shall remain unchanged in the actual construction, and the Contractor may not plead misunderstanding or deception because of any variation between estimated and final quantities. The Engineer reserves the right to increase or decrease any or all of the quantities shown on the proposal form as may be necessary to properly complete the Project.

The Department will pay for the actual quantity of authorized and accepted work done or material furnished under each of the items.

1.02.04—Examination of Plans, Specifications, Special Provisions and Site of Work: The bidder is required to examine carefully the site of the Contract work and the proposal form, plans, special provisions, specifications, supplemental specifications, Contract form and other Contract documents for the work contemplated, as well as any permits or permit applications that are likely to affect the Contract work. The bidder must judge for itself and satisfy itself as to the conditions to be encountered; the character, quality and quantities of the work to be performed; the materials to be furnished; and the requirements of the above documents, particularly the requirements under each Contract item, under the general cost of the work, or under other applicable, but more general, provisions, of the Contract.

The subsurface information furnished in the Contract is based on the interpretation, by the Department, of investigations made only at the specific locations indicated; and the Department gives no assurance that the conditions discovered are typical of the conditions at other Project site locations or that those conditions will have remained unchanged since the field data were obtained. The Department also gives no assurance that the presence or absence of subsurface water at the time and locations of these explorations will be representative of actual conditions at the time of construction. Such subsurface information as was obtained by the Department for its use in the design of the Project will be available for inspection by bidders through the Division of Contracts. Also, bidders may arrange through the Division of Contracts an opportunity to examine, in advance of bidding, at a location to be specified by the Department, any available samples of the materials encountered in the Department’s subsurface explorations. The Contractor shall be solely responsible for all assumptions, deductions, or conclusions it may make or derive from its examination of any Department subsurface information, document or sample. In furnishing or making available such information, the Department makes no warranty or representation as to the actual conditions that may be encountered or actual quantities or distribution of quantities of work that will be

required in the course of the Project.

The Department does not intend or warrant that plan sheets furnished to the State by utility companies whose facilities may be affected by the proposed construction will show all proposed utility work that will be done by utility companies or municipal authorities or both before, during, or after the life of this Contract. In addition to the work indicated on such plan sheets, the utility companies and authorities may make adjustments to or remove certain of their installations other than those indicated on the plans, or may install facilities not so indicated.

Bidders must inform the Department in writing, at the earliest opportunity, of any and all omissions, errors, and/or discrepancies that the bidder discovers within or among the plans, specifications, and bidding documents. Information and inquiries concerning such matters, and any other information or inquiry concerning the conditions of bidding or award or the interpretation of contract documents, must be transmitted in writing to the Manager of Contracts, Connecticut Department of Transportation, P. O. Box 317546, Newington, Connecticut 06131-7546. The Department cannot ensure a response to inquiries received later than ten (10) days prior to the scheduled opening of the related bid. When the Department deems it warranted, responses to such inquiries that relate to changes in or interpretations of the Project documents (plans and specifications) will be issued to all bidders in the form of addenda and made a part of the Contract. Bidders are responsible for ensuring that they are aware of all addenda. Failure by the Department or postal or other courier services to deliver addenda or other information regarding a Contract being bid does not release the bidder from any obligations under said addenda or the conditions of the bid.

1.02.05—Preparation of Proposals: See Article 1.02.01.

1.02.06—Rejection of Non-responsive Proposals: See Article 1.02.01.

1.02.07—Proposal Guaranty: See Article 1.02.01.

1.02.08—Delivery of Proposal: See Article 1.02.01.

1.02.09—Withdrawal of Proposals: See Article 1.02.01.

1.02.10—Public Opening of Proposals: See Article 1.02.01.

1.02.11—Miscellaneous Grounds for Rejection of Proposals: See Article 1.02.01.

1.02.12—Vacant

1.02.13—Knowledge of Applicable Laws: Bidders shall be deemed to know and understand all federal, state and local laws, ordinances and regulations and municipal bylaws which in any manner apply to projects for which they bid; such legal requirements shall include, but not necessarily be limited to, those which apply to the conduct of the Contract work, the equipment and materials to be used on the Project, or the treatment of individuals or classes of individuals in relationship to their involvement with the Project. A Contractor's ignorance of such requirements shall not, in any internal Department proceeding or in any claims or other legal proceeding, constitute justification for the Contractor's failure to consider such requirements in formulating a bid proposal, or for the Contractor's failure to ensure that such legal requirements are met with regard to any Department project in which that Contractor participates.

The Contractor agrees that if it should be awarded the contract for any project supported at least in part by federal funding, the Contractor will not knowingly enter into any lower-tier transaction on that project with a person (including entities) who, by virtue of federal law or regulation, or by voluntary agreement, is currently ineligible to participate in such a project, unless after disclosure of such ineligibility, such participation is authorized by appropriate federal and State authorities.

The Department expects the Contractor to obey municipal laws and regulations and cooperate with municipal officials. In some instances, however, municipal laws or regulations, or the orders of municipal officials, may conflict with necessary Project activities. In most such cases, the municipality does not have the legal power to enforce its laws and regulations upon the State or upon a State project. This is because the State is protected by its sovereign immunity. If local police or other authorities should attempt to stop the Contractor from carrying out activities that are necessary in order for the Contractor to comply with Contract requirements, the Contractor should politely inform the municipal authorities that they probably do not have jurisdiction over the State's project, and the Contractor should immediately inform the Engineer of the attempted interference with Project activities. If the municipal authorities continue to insist upon preventing the Contractor from carrying out Project activities, the Contractor should not defy the authorities, but, to the extent possible, should await directions from the Engineer.

1.02.14—Sworn Statement by Bidder: See Article 1.02.01.

1.02.15—Required Certifications of Eligibility to Bid: See Article 1.02.01.

SECTION 1.03
AWARD AND EXECUTION OF CONTRACT

1.03.01—Consideration of Bids

1.03.02—Award and Execution of Contract

1.03.03—Return of Proposal Guaranty

1.03.04—Requirements of Performance Contract Bond and Payment Bond

1.03.05—Vacant

1.03.06—Failure to Execute Contract

1.03.07—Insurance

1.03.08—Notice to Proceed and Commencement of Work

1.03.01—Consideration of Bids: See Article 1.02.01.

1.03.02—Award and Execution of Contract: Except as otherwise authorized by the Commissioner, all contracts will be awarded and executed in accordance with the order of the Commissioner. The award, if made, will be made within 60 days after the opening of the proposals unless otherwise agreed upon by the Commissioner, the successful bidder, and the surety. The successful bidder, upon receipt of notice from the Department that the contract is ready for execution, shall, at the time and place designated in said notice, be present in person or be represented by an official legally authorized to sign the Contract, and shall there and then sign the necessary Project contract with the State. No proposal shall be considered binding upon the State until the proper execution of the Contract by both parties.

1.03.03—Return of Proposal Guaranty: All proposal guaranties will be returned within 3 calendar days following the award of the Contract. Ten calendar days after the opening of the proposals, all guaranties, except those of the 3 lowest bidders, will be returned. Should no award be made within 60 calendar days after the opening of proposals, the Commissioner may reject all proposals and return the proposal guaranties, except that with the approval of the lowest bidder and its surety, the Commissioner may extend the time for the award and may retain the proposal and proposal guaranty of the lowest bidder for said extended time, or for any other period of time agreed upon by the Commissioner, bidder and surety.

1.03.04—Requirements of Performance Contract Bond and Payment Bond: See Article 1.02.01.

In conformance with Section 49-41a of the Connecticut General Statutes, as revised, the Contractor (1) shall, within 30 days after any given Contract payment to the Contractor by the State, pay any amounts due any subcontractor, whether for labor performed or materials furnished, when charges for such labor or materials have been included in a payment estimate paid by the State; (2) and shall include in each of its subcontracts a provision requiring each subcontractor to pay any amounts due any of its subcontractors on the Project, whether for labor performed or materials furnished, within 30 days after such subcontractor receives a payment from the Contractor which encompasses labor or materials furnished by such subcontractor for the Project.

If the Contractor believes that it has a valid reason for withholding payment for particular work or materials from a subcontractor or supplier, then the Contractor, within 30 days of receiving payment from the State for that work or materials, shall notify the subcontractor or supplier and the Department of its reasons for withholding payment.

1.03.05—Vacant

1.03.06—Failure to Execute Contract: See Article 1.02.01.

1.03.07—Insurance: Before the Contract is executed, the Contractor must file with the Commissioner a certificate of insurance, executed by an insurance company satisfactory to the Commissioner, on the form provided by the Department, stating that with respect to the Contract, the Contractor carries insurance at least in accordance with the requirements and stipulations listed below. State of Connecticut, Department of Transportation, Form Number CON-32 entitled "CERTIFICATE OF INSURANCE" shall be the only acceptable form to be used by the Contractor as evidence of required insurance coverage. Continuance of the required insurance during the entire term of the Contract shall be the responsibility of the Contractor and is a condition of the Contract.

The Contractor and its insurer may not assert the defense of sovereign immunity in the adjustment of claims or in the defense of any claim or suit brought against the Contractor or the State, unless the State, in writing, requests it to do so or consents to its doing so. The Contractor shall assume and pay all costs and billings for premiums and audit charges earned and payable under the required insurance.

The State must be named as an additional insured party for the insurance required under paragraphs 2, 3, and 6 stipulated below. In the event that the Contractor secures Excess/Umbrella Liability Insurance to

meet the minimum requirements specified in paragraph 2, 3, or 6 below, the State shall be named as an additional insured.

1. Worker's Compensation Insurance: With respect to all operations the Contractor performs and all those performed for it by subcontractors, the Contractor and each such subcontractor shall carry Workers' Compensation Insurance in accordance with the requirements of State law. Each such contractor's Workers' Compensation policy shall contain the U.S. Longshoreman's and Harbor Workers' Act endorsement when work is to be performed over or adjacent to a navigable water.

2. Commercial General Liability Insurance: With respect to the operations it performs and also those performed for it by subcontractors, the Contractor shall carry commercial general liability insurance, including Contractual Liability Insurance, which shall provide coverage of at least \$1,000,000 for each accident or occurrence resulting in damages from (1) bodily injury to or death of persons and/or (2) injury to or destruction of property. Subject to that limit per accident or occurrence, the policy shall provide a total or aggregate coverage of at least \$2,000,000 for all pertinent damages arising during the policy period.

3. Automobile Liability Insurance: The Contractor shall obtain automobile liability insurance covering the operation of all motor vehicles, including those hired or borrowed, that are used in connection with the Project; said insurance shall provide coverage of at least \$1,000,000 for each accident or occurrence resulting in damages from (1) bodily injury to or death of persons and/or (2) injury to or destruction of property. If an insurance policy shows an aggregate limit as part of the automobile liability coverage, the aggregate limit must be at least \$2,000,000.

4. Owner's and Contractor's Protective Liability Insurance for and in the Name of the State: With respect to the Contractor's Project operations and also those of its subcontractors, the Contractor shall carry, for and on behalf of the State, insurance which shall provide coverage of at least \$2,000,000 for each accident or occurrence resulting in damages from (1) bodily injury to or death of persons and/or (2) injury to or destruction of property. Subject to that limit per accident or occurrence, the policy shall provide an aggregate coverage of at least \$2,000,000 for all pertinent damages arising during the policy period.

5. Railroad Protective Liability Insurance: When the Contract involves work on, over or under the right-of-way of any railroad company, the Contractor shall carry, with respect to its Project operations and also those of its subcontractors, Railroad Protective Liability Insurance for, and on behalf of, the railroad company as named insured and the State as additional insured, providing coverage of at least \$2,000,000 for each accident or occurrence resulting in damages from (1) bodily injury to or death of all persons and/or (2) injury to or destruction of property. Subject to that limit per accident or occurrence, the policy shall provide an aggregate coverage of at least \$6,000,000 for all damages during the policy period.

6. Blasting: When explosives are to be used for the Project, the insurance required under paragraphs 2, 4 and 5 above shall also contain provisions for protection, in the amounts stated, against damage claims regarding such use of explosives.

7. Termination or Change of Insurance: Each insurance policy required by this Article must be endorsed to provide that the insurance company shall notify the Department by certified mail at least 30 days in advance of the termination or any alteration of the terms of the policy. No such change shall be made without the prior written approval of the Commissioner.

The Contractor shall keep all the required insurance in continuous effect until the date that the Department designates for the termination of the Contractor's responsibility, as determined under Article 1.08.13.

8. Claims: Each insurance policy required by this Article must state that the insurance company shall agree to investigate and defend the insured parties, at the insurer's expense, against all claims for damages, even if groundless.

9. Compensation: There shall be no direct compensation allowed the Contractor on account of any premium or other charge necessary to obtain and keep in effect any insurance or bonds in connection with the Project, but the cost thereof shall be considered included in the general cost of the Project work.

10. Protection and Indemnity Insurance for Marine Construction Operations in Navigable Waters: If a vessel of any kind will be involved in Project work, the Contractor shall obtain the following additional insurance coverage:

- A. Protection and Indemnity Coverage of at least \$300,000 per vessel or equal to at least the value of hull and machinery, whichever is greater.
- B. If there is any limitation or exclusion with regard to crew and employees under the protection and indemnity form, the Contractor must obtain and keep in effect throughout the Project a workers' compensation policy, including coverage for operations under admiralty jurisdiction, with a limit of liability of at least \$300,000 per accident or a limit equal to at least the value of the hull and

machinery, whichever is greater, or for any amount otherwise required by statute.

1.03.08—Notice to Proceed and Commencement of Work: The Contractor shall commence and proceed with the Contract work on the date specified in a written Notice to Proceed issued by the Engineer to the Contractor. The date specified will be no later than 45 calendar days after the date of the execution of the Contract by the Department, except that if the expiration of said 45 calendar days occurs during the period between November 30 and April 1 of the following year, the Engineer may specify that the April 1 following said expiration shall be the date for the Contractor to proceed with the work.

If the Engineer does not issue a Notice to Proceed to the Contractor within the said 45 calendar days, the Contractor shall have the option of canceling the Contract and its payment and performance bonds for the Project. Any failure by the Department to issue a notice to proceed, or to issue one on a timely basis, shall not, however, constitute a breach of the Contract. Neither the Contractor nor any other party may use such a failure as a basis for any claim against the Department for damages.

The Contractor shall not begin physical Project construction prior to the date specified for same by the Engineer in the Notice to Proceed, except as may be otherwise authorized by the Engineer in writing.

**SECTION 1.04
SCOPE OF WORK**

1.04.01—Intent of Contract

1.04.02—Increased or Decreased Quantities of Minor Items, and Elimination of Minor Items

1.04.03—Changes in Quantities and Significant Changes in the Character of Work

1.04.04—Differing Site Conditions

1.04.05—Extra Work

1.04.06—Removal and Disposal of Structures on the Work Site

1.04.07—Rights in and Use of Materials Found on the Work Site

1.04.01—Intent of Contract: The intent of the Contract is to prescribe a complete work or improvement that the Contractor undertakes and is required to do in full compliance with the specifications, plans, special provisions, proposal, and other Contract documents. The Contractor shall perform all Project work in conformity with the lines, grades, typical cross-sections, dimensions, and other data shown on the plans and other Contract documents, as they may be modified by written orders from the Engineer subsequent to the date of the Contract. Said work includes the furnishing of all materials, implements, machinery, equipment, tools, supplies, transportation, labor, and all other things necessary for the satisfactory prosecution and completion of the Project.

1.04.02—Increased or Decreased Quantities of Minor Items, and Elimination of Minor Items: An increase or decrease in the quantity of a Contract item shall be deemed to have occurred for the purposes of these specifications when the total pay quantity of that item (i.e., the total number of units of that item for which payment is due to the Contractor as of the time when the work under that item has been completed) is either more or less than the estimated quantity of that item which was given in the bid proposal form or in the Contract as bid upon (referred to below in this section as the “estimated quantity” of the given item). This article shall apply only to minor Contract items, and not to major items in the original Contract. Any quantity increase or decrease from an estimated quantity, if that increase or decrease results from a significant change in the character of the work as defined in Subsection 1.04.03(4)(a), shall be treated in accordance with the provisions of Article 1.04.03, and shall not be governed by or treated in accordance with the provisions of this article. Any such increase or decrease that occurs as the result of a differing site condition as defined in Article 1.04.04 shall be treated in accordance with the provisions of this article only to the extent that those provisions do not directly conflict with Article 1.04.04. If the total pay quantity of any minor item varies from the estimated quantity by 25% or less, payment for that item will be made at the original Contract unit price therefor, unless said price is eligible for adjustment under Article 1.04.03. If the total pay quantity of any minor item varies from the estimated quantity by more than 25%, the compensation payable to the Contractor for that item will be determined in accordance with the provisions of this article. If, however, the Engineer and Contractor have executed a construction order specifying the payment to be made for the item, then payment will be made in accordance with the terms of said order. As an alternative to any and all bases for payment described in this article, the Department may, in any circumstance described in this article, make any price or payment adjustment agreed upon in writing by the Department and the Contractor.

(a) Increases of More Than 25 Percent: If the total pay quantity of a minor item exceeds the estimated quantity by more than 25%, the quantity of work in excess of 125% of the estimated quantity shall be paid for (i) by adjusting the Contract unit price for the quantity exceeding 125% (and only for that "excess" quantity) in the manner described in this Article; (ii) at the option of the Engineer, on a cost-plus basis as provided in Article 1.09.04; or (iii) on any basis agreed upon in writing by the Engineer and the Contractor.

If the Engineer does not elect to pay for said excess units on a cost-plus basis or according to such a written agreement, the price or payment adjustment shall be made according to the following principles: The increase or decrease in the unit price for the excess units of the subject item shall be the difference between the original Contract unit price and the actual unit cost, said difference to be calculated in the manner described hereafter, as of the time when work under the item was completed. If the costs of work under such item include fixed costs, all such fixed costs shall be deemed to have been recovered by the Contractor as part of the payments made by the Department for the first 125% of the estimated quantity. Such fixed costs shall therefore be excluded from any computation used to adjust the price or payment for the excess units of the given item. Subject to the above provisions, the actual unit cost of the item to be adjusted shall be determined by the Engineer in the same way that it would be determined if the work were to be paid for on a cost-plus basis as provided in Article 1.09.04.

If, however, the aggregate payment for the excess number of units, if they were paid for at the original, unadjusted Contract price, would be less than \$25,000, the Engineer shall not adjust the Contract unit price.

(b) Decreases of More Than 25%: If the total pay quantity of any minor item is less than 75% of the estimated quantity, the original Contract unit price for the item will not be adjusted unless the Contractor gives a written request for such an adjustment to the Engineer. If the Contractor so requests, the quantity of said item performed or provided shall be paid for by (i) adjusting the Contract unit price as hereinafter provided; (ii) at the option of the Engineer, on a cost-plus basis as provided in Article 1.09.04, except that in this kind of instance, the Contractor's fixed cost shall be included in the calculation; or (iii) on any basis agreed upon in writing by the Engineer and the Contractor.

The unit price paid for the decreased number of units shall not, in any case, be less than the unit price in the original Contract. On the other hand, the aggregate payment for a decreased total pay quantity of a minor item may not exceed the aggregate payment which would be made for the performance of 75% of the estimated quantity at the original Contract unit price for that item.

If the Engineer does not elect to pay for the decreased quantity of units on a cost-plus basis or on a basis established by written agreement, the price or payment adjustment shall be made according to the following principles:

The amount of the adjustment of the original Contract unit price shall be the difference between that unit price and the actual unit cost (including fixed costs), to be calculated as of the time all work under the item has been completed. The Engineer shall determine such actual unit costs in the same way that they would be determined if payment were to be made on a cost-plus basis under Article 1.09.04.

(c) Eliminated Items: If an item is entirely eliminated from the Contract, the Department will pay the Contractor only for costs which it incurred in connection with the eliminated item prior to the date upon which the Engineer provided the Contractor with written notice of said elimination. If the Contractor had ordered Project materials (that conformed to all pertinent Contract requirements) prior to the aforesaid date of notification, and if the orders for said materials could not have been canceled within 2 business days after the date of notification, the Department shall pay the Contractor for said materials at their actual cost to the Contractor. In such a case, the materials shall become property of the State and the actual cost of any further handling necessary to deliver them to the Department shall be assumed by the State. If the materials are returnable to their vendor and if the Engineer so directs, the Contractor shall return the materials to the vendor and the State shall reimburse the Contractor (i) for any reasonable charges made to the Contractor by the vendor for the return of the materials, and (ii) for the actual costs to the Contractor of its handling the materials in returning them to the vendor. Such charges or actual costs to be paid by the Department shall be computed as though the work was being paid for on a cost-plus basis under Articles 1.04.02(b)(ii) and 1.09.04.

1.04.03—Changes in Quantities and Significant Changes in the Character of Work:

- (1) The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the Contractor agrees to perform the work as altered.
- (2) If the alterations or changes in quantities significantly change the character of the work under the contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.
- (3) If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.
- (4) The term "significant change" shall be construed to apply only to the following circumstances:
 - (a) When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction or
 - (b) When a major item of work, as defined elsewhere in the Contract, is increased in excess of 125% or decreased below 75% of the original Contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125% of original contract item quantity, or in case of a decrease below 75%, to the actual amount of work performed

1.04.04—Differing Site Conditions:

- (1) During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the Contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.
- (2) Upon written notification, the Engineer will investigate the conditions, and if he/she determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the Contract, an adjustment, excluding loss of anticipated profits, will be made and the Contract modified in writing accordingly. The Engineer will notify the Contractor of his/her determination whether or not an adjustment of the Contract is warranted.
- (3) No Contract adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.
- (4) No Contract adjustment will be allowed under this clause for any effects caused on unchanged work.

1.04.05—Extra Work: Unforeseen work made necessary by the Engineer's changes of the Contract plans or specifications, or work that is necessary for completion of the Project, but for which no price is provided in the Contract, shall be done in accordance with the requirements of the specifications and as directed by the Engineer. The Engineer shall notify the Contractor of the necessity for such extra work, stipulating its character and extent, and shall notify the Contractor as to whether the Engineer wants the Contractor to propose a unit price or, instead, a lump sum, for the extra work. Within 5 days of receipt of such notification, the Contractor shall advise the Engineer, in writing, of the compensation (as a unit price or lump sum, whichever has been requested by the Engineer) that the Contractor requests as compensation for the required extra work. The Contractor's request shall be itemized and reasonably detailed, and shall include all known or anticipated direct and indirect costs of the work, including but not limited to, the costs of all safety and other equipment, small tools, labor, subcontractor quotes, consumables, field office overhead, home office overhead, insurance, bonding, and profit. The character and extent of the extra work, together with the basis of compensation, shall be communicated to the Contractor by means of a construction order which, when signed by the Engineer, shall become a part of the Contract. If a Contractor objects to any portion of a construction order submitted to it by the Engineer for signing, and if the Contractor is not willing to sign that order or some portion of that order, the Contractor must, within 15 days of its receipt of said order, return the order with a letter to the Department's Assistant District Engineer administering the Contract, describing specifically what portions of the order the Contractor finds objectionable, the nature of its objections, and the bases for its objections. If the Contractor does not do so, it shall be deemed to have accepted the terms of the construction order. If the Engineer changes the scope of Contract work, the Contractor shall submit a proposed revised schedule and a cost revision proposal, which takes all such changes into account, if the Contractor believes that such revisions are warranted. If the schedule is to be revised, it will be revised in accordance with Article 1.08.08.

1.04.06—Removal and Disposal of Structures on the Work Site: All structures on the Project site which are not to remain on the Project site after completion of the Project shall be removed from said site and disposed of by the Contractor once it is no longer needed for the Project, and any such structure shall then become the property of the Contractor, except as otherwise required or provided by Article 1.10.07.

1.04.07—Rights in and Use of Materials Found on the Work Site: Upon written request of the Contractor and with the written approval of the Engineer, subject to limitations which may be set forth within such approval, any stone, gravel, sand, topsoil or any material from existing bridge substructures, buildings, or other structures, found within the limits of the Project may be excavated or removed and used by the Contractor on the Project, provided that said materials meet the requirements of the specification for such materials. Any materials excavated or removed shall not be taken off the Project site unless the Engineer in writing specifically authorizes such action. The following conditions shall govern these matters:

1. Excavation or removal of materials that would necessarily be excavated or removed in making the improvement will be paid for at the applicable Contract unit prices; and, in addition, the item for which this material is used will also be paid for at its Contract unit price. The Contractor will not be charged for such materials. The Contractor shall, without compensation, place in the embankment or elsewhere, as appropriate, sufficient suitable material to fill the space that the excavated materials would have occupied, unless otherwise directed by the Engineer.

2. The excavation or removal of materials that are not required to be excavated or removed in connection with the Contract work will not be paid for; and the Contractor will be charged for such materials at a negotiated unit price. The item for which this material is used will be paid for at its Contract unit price. The Contractor shall, without compensation, backfill with accepted material the space that the excavated materials had occupied, to the satisfaction of the Engineer, unless otherwise directed by the Engineer.

Surplus material shall be removed from the Project only with the Engineer's written permission. The Engineer may determine that such material is not surplus, and may order that it be incorporated into the Project.

**SECTION 1.05
CONTROL OF THE WORK**

1.05.01—Authority of Engineer

1.05.02—Plans, Working Drawings and Shop Drawings

1.05.03—Conformity with Plans and Specifications

1.05.04—Coordination of Special Provisions, Plans, Supplemental Specifications and Standard Specifications and Other Contract Requirements

1.05.05—Cooperation by Contractor

1.05.06—Cooperation with Utilities (Including Railroads):

1.05.07—Coordination with Work by Other Parties

1.05.08—Vacant

1.05.09—Authority of Inspectors

1.05.10—Inspection

1.05.11—Removal of Defective or Unauthorized Work

1.05.12—Payrolls

1.05.13—Examining and Copying Contractor's Records

1.05.14—Termination Clause

1.05.15—Markings for Underground Facilities

1.05.16—Dimensions and Measurements

1.05.01—Authority of Engineer: All work shall be subject to the review of the Engineer. He shall decide all questions as to interpretation of the plans and specifications, and questions of mutual or respective rights of the Contractor and other Department contractors. The Engineer shall decide on an acceptable rate of progress, on the manner of performance, and on what shall be deemed acceptable fulfillment of the Contract. The Engineer shall have the right to determine the points at which the Contractor may begin work and the order in which the work shall be prosecuted in the best interests of the State within the intent of the terms in the Contract.

If a Project-related dispute arises between the Contractor and Department personnel assigned to the Project, and if those parties prove unable to resolve it, the Contractor may submit a detailed written description of the dispute to the Department's Assistant District Engineer administering the Contract.

It must be understood, though, that at no time may the Contractor, because of its disagreement with the Engineer, either disregard the orders of the Engineer or halt Project construction. If the Contractor cannot resolve a Project work or pricing dispute with the Engineer, the Contractor's proper remedy is a claim under CGS Section 4-61. A Contractor that disregards the orders of the Engineer with regard to the prosecution of Project work, or who refuses to continue Project work because of a disagreement with the Engineer, may be subject to termination of its Contract, to a subsequent finding that it is nonresponsible as an apparent low bidder for a Department contract, to the assessment of liquidated damages, and to other adverse legal or administrative action by the Department.

1.05.02—Plans, Working Drawings and Shop Drawings:

1. Plans: The plans prepared by the Department show the details necessary to give a comprehensive idea of the construction contemplated under the Contract. The plans will generally show location, character, dimensions, and details necessary to complete the Project. If the plans do not show complete details, they will show the necessary dimensions and details, which when used along with the other Contract documents, will enable the Contractor to prepare working drawings or shop drawings necessary to complete the Project.

2. Working Drawings: When required by the Contract or when ordered to do so by the Engineer, the Contractor shall prepare and submit 9 copies of the working drawings to the Engineer for review.

These drawings shall be submitted sufficiently (at least 30 calendar days) in advance of the proposed use, to allow for their review, and any necessary revisions, without delay of the Project. No work covered by these working drawings shall be done until the drawings have been submitted to the Engineer for review and the Engineer's comments have been appropriately taken into account and implemented. The furnishing of the working drawings shall not serve to relieve the Contractor of any part of its responsibility for the safety or the successful completion of the Project construction.

Any comments or suggestions by the Engineer concerning working drawings prepared by the Contractor shall not relieve the Contractor of any of its responsibility for claims by the State or by third parties, as per

Article 1.07.10.

There will be no direct payment for furnishing any working drawings, procedures or supporting calculations, but the cost thereof shall be considered as included in the general cost of the work.

The working drawings shall be signed, sealed and dated by a qualified Professional Engineer licensed to practice in the State of Connecticut.

- a. Working Drawings for Permanent Construction: Drawings shall be submitted on 22-inch x 34-inch (559-millimeter x 864-millimeter) sheets with a border and title block similar to the Department standard. Calculations, procedures and other supporting data may be submitted in an 8-1/2-inch x 11-inch (216-millimeter x 279-millimeter) format. The Contractor will be required to furnish the Engineer with a complete set of reproducible mylar drawings of all the 22-inch x 34-inch (559-millimeter x 864-millimeter) sheets after all the comments made by the Engineer are resolved. The Contractor's designer who prepares the working drawings, shall secure and maintain at no direct cost to the State a Professional Liability Insurance Policy for errors and omissions in the minimum amount of \$1,000,000. The Contractor's designer may, at his election, obtain a policy containing a maximum \$250,000 deductible clause, but if the Contractor's designer should obtain a policy containing such a clause, he shall be liable to the extent of at least the deductible amount. The Contractor's designer shall obtain the appropriate and proper endorsement of its Professional Liability Policy to cover the indemnification clause in this Contract, as the same relates to negligent acts, errors or omissions in the Project work performed by him. The Contractor's designer shall continue this liability insurance coverage for a period (1) of 3 years from the date of acceptance of the Project by the Commissioner, as evidenced by a State of Connecticut, Department of Transportation Form Number CON-13, entitled "Certificate of Acceptance of Work and Acceptance of Project," issued to the Contractor, or (2) for 3 years after the termination of the Contract, whichever is earlier, subject to the continued commercial availability of such insurance.

The Contractor shall supply to the Engineer a certificate of insurance in accordance with Article 1.03.07 at the time that he submits the working drawings for the Project.

- b. Working Drawings for Temporary Construction: The Contractor may submit to the Engineer drawings, calculations, procedures and other supporting data in any format acceptable to the Engineer.

3. Shop Drawings: When required by the Contract or when ordered to do so by the Engineer, the Contractor shall prepare and submit 9 copies of the shop drawings to the Engineer for review and approval before fabrication. In the case of a structure carrying a railroad, an additional copy of the superstructure shop drawings shall be submitted to the Engineer. When requested to do so by the Engineer, the Contractor shall also furnish the Engineer with a complete set of reproducible mylar drawings of same.

Drawings shall be submitted on 22-inch x 34-inch (559-millimeter x 864-millimeter) sheets with an appropriate border and with a title block in the lower right-hand corner of each sheet. Procedures and other supporting data may be submitted on 8½-inch x 11-inch (216-millimeter x 279-millimeter) sheets.

After review of such drawings, the Engineer will stamp each drawing as "Approved," "Approved as Noted," or "Revise and Resubmit." Three copies of each drawing stamped as "Approved" or "Approved as Noted" will be returned to the Contractor for its use. No additional copies of a drawing stamped "Approved as Noted" need be resubmitted, but the Engineer's notes must be appropriately taken into account and implemented by the Contractor. In the case of a drawing that is reviewed and stamped "Revise and Resubmit," two copies of the drawing will be returned to the Contractor, which shall take into account and implement all comments; the Contractor shall then resubmit the required number of copies of the revised drawings for review and approval.

If the Contractor proposes a revision of a previously-submitted shop drawing that has been stamped "Approved" or "Approved as Noted," the Contractor shall submit 9 copies of the revised drawing for the Engineer's review. Any such resubmitted shop drawing shall clearly indicate, in a revision block, the date and precise nature of the revision, as well as its location on the revised drawing.

When any shop drawing is stamped "Approved" or "Approved as Noted" by the Engineer, such approval shall not relieve the Contractor from responsibility for omissions, or for errors in dimensions, shop fits, field connections, etc.; or for providing the proper quantity of materials; or for compliance with the Contract; or for the successful completion of the Project. Any approval, comments or suggestions by the Engineer concerning shop drawings prepared by the Contractor shall not relieve the Contractor of any of the Contractor's responsibility for claims by the State or by third parties, as per Article 1.07.10.

The Contractor shall submit any drawings to the Engineer at least 30 calendar days in advance of their proposed use in order to allow for their review by the Engineer, as well as for any necessary revision and

approval of the drawing, without undue delay of the Project construction.

No work covered by shop drawings shall be done until the drawings have been submitted to the Engineer for review and approved by the Engineer. There will be no direct payment for furnishing any shop drawings, but the cost thereof shall be considered as included in the general Project costs.

1.05.03—Conformity with Plans and Specifications: All work performed and all materials furnished by the Contractor must be, in the opinion of the Engineer, in conformity with the lines, grades, cross-sections, dimensions and material requirements, including tolerances, shown on the plans or indicated in the Contract specifications.

If the Engineer believes that the materials or the finished product in which the materials were used are not in conformity with the plans and specifications, but believes nonetheless that the finished product is acceptable, he will then determine whether or not the work will be accepted and remain in place. If the Engineer believes that the work should be accepted, he will issue a construction order confirming his determination, and may provide therein for any equitable adjustment in the basis of payment which he deems appropriate.

If, in the opinion of the Engineer, any material provided by the Contractor, any finished product in which the materials were used, or any work performed does not conform to the plans and specifications and has resulted in an unacceptable product, the Contractor shall, at its own expense, either cure or remove and replace the unaccepted work and material, as the Engineer directs.

1.05.04—Coordination of Special Provisions, Plans, Supplemental Specifications and Standard Specifications and Other Contract Requirements: All requirements indicated on the plans or in the Standard Specifications, the Supplemental Specifications, Special Provisions or other Contract provisions shall be equally binding on the Contractor, unless there is a conflict between or among any of those requirements. In the case of such a conflict, the order of governance among those requirements, in order of descending authority, shall be as follows:

1. Environmental Permits
2. Environmental Permit Applications
3. Special Provisions
4. Plans other than Standard Sheets (enlarged details on plans, used to clarify construction, shall take precedence over smaller details of the same area; and information contained in schedules or tables, titled as such, shall take precedence over other data on plans)
5. Standard Sheets
6. Supplemental Specifications
7. Standard Specifications and other Contract requirements

Numerical designations of dimensions shall take precedence over dimensions calculated by applying a scale to graphic representations. Neither party to the Contract may take advantage of any obvious error or omission in the Contract. Should either party to the Contract discover such an error or omission, that party shall notify the other party of same immediately in writing. The Engineer will make such corrections and interpretations of the Contract as are necessary, in his judgment, to fulfill the purposes of the Contract that are evident from examining the Contract as a whole.

If the Contract includes an item that does not have a corresponding specification for either performance or payment purposes, the Contractor shall notify the Engineer of that fact in writing at least 2 weeks prior to ordering materials for or commencing work on the item. If the Department's documents do not contain such a specification, the Engineer shall, if possible, derive an appropriate specification from applicable AASHTO Specifications or, if necessary, ASTM Specifications. If neither of those sources provides a suitable specification, the Contractor shall seek guidance from the Engineer with regard to the item, and the Engineer will formulate a reasonable specification for the item. When compliance with 2 or more standards is specified, and the standards may establish different or conflicting requirements for minimum quantities or quality levels, the Contractor shall refer such issues to the Engineer for a decision before proceeding with the pertinent work.

1.05.05—Cooperation by Contractor: The Contractor will be supplied by the Department with copies of the plans, and the Contractor shall have available on the Project site at all times during the prosecution of the Project, a copy of the Contract plans and specifications. The Contractor shall give the Project constant attention to facilitate the progress thereof, shall cooperate with the Department, and shall promptly comply with all orders and directions of the Engineer.

The Contractor shall at all times during Project construction have on the Project site one of its employees who is thoroughly experienced in the type of work being performed, to supervise the work and accept

directions from the Engineer. The Contractor shall always notify the Engineer of the identity of said employee representative in advance of the employee's assignment to that position. The Contractor's representative must have full authority to promptly execute and carry out the orders and directions of the Engineer within the terms of the Contract, and to supply such materials, equipment, tools, labor and incidentals as may be required by the Contract or by the Engineer.

1.05.06—Cooperation with Utilities (Including Railroads): The Engineer may anticipate that a Project construction activity will require the removal, repair, replacement or relocation of a utility appurtenance. In such an instance, the Engineer, in advance of the commencement of such activity, will notify the affected utilities, either directly or through the local government, of the anticipated nature and timing of said activity. The Engineer will endeavor to have all necessary adjustments of public or private utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of Project construction made as soon as practicable, when such changes are required by the State or local government.

Whenever the Engineer determines that the relocation or adjustment of poles or the overhead plant of public or private utilities or railroad facilities is dependent upon the completion of certain required Contract activities, the Contractor shall complete those activities within a reasonable length of time.

Temporary and permanent changes required by the State or local government in water lines, gas lines, sewer lines, wire lines, service connections, water or gas meter boxes, water or gas valve boxes, light standards, cableways, signals and all other utility (including railroad) appurtenances within the site of the proposed Project construction are to be made by others at no expense to the Contractor, except as otherwise provided for in the Special Provisions or as noted on the plans.

When the Contractor is required by the Engineer to relocate utility appurtenances, such work will be paid for as extra work unless specific bid items for such work appear in the Contract.

If the Contractor, for its convenience or for any other reason, desires a change in the location of a water line, gas line, sewer line, wire line, service connection, water or gas meter box, valve box, light standard, cableway, signal or any other utility (including railroad) appurtenances, the Contractor shall satisfy the Department that the proposed relocation will not interfere with the Contractor's or other contractors' Project operations or their fulfillment of the requirements of the plans, and that said change will not create an obstruction or hazard to traffic. If the requested change of location is acceptable to the Engineer, the Contractor shall make its own request for such relocation work to the utility companies, pipe owners or other parties likely to be affected by said work. Such relocation work shall be done at the Contractor's sole expense.

The Contractor shall schedule its operations in such a manner as to minimize interference with the operations of the utility companies or local governments in effecting the installation of new facilities, as shown on the plans, or the relocation of their existing facilities. The Contractor shall consider in its bid all permanent and temporary utility appurtenances in their present or relocated positions and any installation of new facilities required for the Project. The Department will not make any additional compensation to the Contractor for delays, inconvenience or damage sustained by the Contractor due to (i) interference with Project construction caused by the location, condition or operation of utility (including railroad) appurtenances or (ii) the installation, removal, or relocation of such appurtenances; and the Contractor may not make a claim for any such compensation.

1.05.07—Coordination with Work by Other Parties: The Contractor shall make every effort to perform its work so as not to interfere with other work for the State or other parties. In the case of a dispute with another contractor working for the Department regarding their work for the State, or in the case of a conflict between their planned operations or the needs of their projects, the Contractor shall bring that dispute or conflict to the Engineer's attention, and the Engineer shall decide how it shall be resolved. The Engineer's decision shall be binding upon all of the contractors working for the Department who are involved in the matter.

The Contractor shall, as far as possible, schedule and otherwise plan and arrange its work, and place and dispose of its Project materials, so as not to interfere with the operations of other contractors working for the State. The Contractor shall, as necessary to accomplish this goal, endeavor to coordinate and schedule its work in the way which will interfere least with the work of other parties.

If the Contractor's work or activities under the Contract come into conflict with other activities or work for the State, any financial or other liability arising from such conflicts shall be the Contractor's; and the Contractor shall protect and save harmless the State from any and all damages or claims, and the costs of defending same, which may arise because of inconvenience, delay, financial hardship, or injuries caused to the Contractor or to other contractors as a result of such conflicts, unless:

- (a) The Contractor notifies the Engineer of such conflicts as soon as the likelihood of such a conflict becomes apparent; or, if such likelihood could not have been foreseen earlier, then as soon as the conflict becomes apparent.
- (b) The Contractor waits for direction from the Engineer as to how the conflict should be avoided or resolved, and the Contractor does not proceed with the work involved in the conflict until the Engineer has provided the Contractor with such direction.
- (c) The Contractor follows the directions given by the Engineer for avoiding, resolving, or minimizing the conflict.

The Contractor shall be responsible for the completion of its Contract work, regardless of any interference with, or delay of, that work which may be caused by the presence or activities of other contractors working for the State.

1.05.08—Vacant

1.05.09—Authority of Inspectors: Inspectors employed by the Department are authorized to inspect all work done and all materials furnished for Project construction. Such inspection may extend to any part of the Project work, and to the preparation or manufacture of the materials to be used for same. In case of any dispute arising between the Contractor and the inspector as to materials furnished or the manner of performing work, the inspector has the authority to reject material or stop the work until the question at issue can be referred to and decided by the Engineer. The inspector is not authorized to revoke, alter, enlarge, relax, or release any requirements of the Contract, nor to approve or accept any portion of the Contract work, nor to issue instructions contrary to the Contract. The inspector shall in no case act as a foreman, or fulfill other duties for the Contractor. Any advice that the inspector may give to the Contractor shall not be construed as binding the Department in any way, nor as releasing the Contractor from its obligation to fulfill the terms of the Contract.

The conducting, failure to conduct, sufficiency, or accuracy of any inspection does not relieve the Contractor of its responsibility to perform the Project work properly, to monitor its work and the work of its subcontractors, and to institute and maintain quality control procedures appropriate for the proper execution of Project work.

1.05.10—Inspection: All materials and each part or detail of the Project work shall be subject at all times to inspection by the Engineer. Such inspection may include mill, plant, shop or other types of inspection; and any material furnished under the Contract is subject to such inspection. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as the Engineer deems necessary to make complete, detailed and timely inspections.

The Contractor shall always notify the Engineer of its intention to perform work on the Project, including the nature of the particular work it intends to perform, at least 48 hours before the Contractor commences that work. If, after receiving such notice, the Engineer decides that he needs more than 48 hours to arrange for and conduct inspection related to that work, he shall so notify the Contractor, and the Contractor shall refrain from commencing the work until the Engineer has arranged for such inspection. The Contractor may not commence any portion of its work without prior related inspection by the Engineer unless the Engineer agrees otherwise. In the absence of such advance agreement by the Engineer, any work done or material used without inspection by a Department representative may be ordered exposed for examination and testing, and then corrected or restored, all at the Contractor's expense.

If, at any time before the Department's acceptance of the Project, the Engineer requests the Contractor to remove or uncover any portion of the Project work for inspection by the Engineer, the Contractor shall do so. After such inspection is completed, the Contractor shall restore such portions of the work to the condition required by the Contract as construed by the Engineer. If the work or material exposed and inspected under this provision proves acceptable to the Engineer, the Department shall pay the Contractor for any removal, uncovering or restoration of its previous Contract work. The Department shall pay the Contractor for such removal, uncovering, and restoration of the prior work as extra work. If the work or material exposed and inspected proves, in the opinion of the Engineer, not to conform with Contract requirements, the Contractor shall be responsible for the costs of the removal, uncovering, correction and restoration of the work and material in accordance with the Contract or as the Engineer requires.

1.05.11—Removal of Defective or Unauthorized Work: Work that does not conform to the requirements of the Contract shall be remedied in a manner acceptable to the Engineer or removed and replaced at the Contractor's expense in a manner acceptable to the Engineer.

No work shall be done without appropriate lines and grades having been established in the field. Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, or extra

work done without the Engineer's prior written direction to perform it will be considered as unauthorized and the Department will not pay for it. Work so done may be ordered removed or replaced at the Contractor's expense.

If the Contractor fails to comply with any order of the Engineer made under the provisions of this Article, the Engineer has the authority to cause unacceptable or unauthorized work to be remedied or removed and replaced by a party or parties other than the Contractor, and to deduct the costs of such activities from any monies due or to become due to the Contractor from the Department or any other agency of the State.

1.05.12—Payrolls: The Contractor shall furnish to the Engineer certified copies of payrolls showing the names of its employees working on the Project, the specific days and hours and number of hours that each of them has spent in doing so, and the amount paid to each person for said work. If the Engineer so directs, such payrolls shall also include the rental rates paid for rented trucks or other equipment used for Project work. This requirement shall also apply to the work of any subcontractor having a subcontract for any part of the Project work.

Every Contractor or subcontractor performing Project work is required to post the relevant prevailing wage rates as determined by the State Labor Commissioner and, on federal aid projects, those determined by the United States Secretary of Labor. The wage rate determinations shall be posted in prominent and easily accessible places at the work site.

1.05.13—Examining and Copying Contractor's Records: The Contractor shall permit the Department and its duly-authorized representatives to examine and copy all documents and other records of the Contractor that are relevant to charges for extra work, alleged breaches of Contract, or any formal or informal claim for additional compensation or for damages in connection with the Project.

With the exception noted below, the Contractor shall also permit the Department to examine and copy such of its documents and other records pertaining to the Project as the Department may deem necessary in order to determine whether or not the Contractor has complied with all laws, regulations and other governmental mandates, e.g., those relating to labor compliance, affirmative action programs, and equal employment opportunity. Documents and other records relating to the Project, if they were created prior to the opening of bids for the Contract, and if they are sought by the Department only for the purpose of confirming such compliance with legal requirements, shall, however, not be subject to examination by the Department pursuant to this Article without the consent of the Contractor.

The Contractor further agrees that it shall keep all documents and other records relating to the Project at least until the expiration of 3 years after the date of acceptance of the Project by the Department, as designated in a "Certificate of Acceptance of Work and Acceptance of Project" (CON-13), issued by the Department. If any claims are brought by the Department or the Contractor prior to that expiration, however, the Contractor shall keep all such records until the Department has given the Contractor a full and final release from all pending and potential claims regarding the Project. If the Contractor does not so keep any such records, it may not assert any formal or informal claim for compensation or damages that could have been substantiated or disproven with such records.

The Contractor shall ensure that the requirements of this provision are made applicable to its subcontractors and suppliers, for the State's benefit, by including the operative language of this Article in its Project subcontracts and purchase agreements.

1.05.14—Termination for Convenience Clause: The State may terminate the Contract whenever the Engineer determines that such termination is in the best interests of the State. Any such termination shall be effected by delivery to the Contractor of a written Notice of Termination specifying the extent to which performance of work under the Contract is terminated and the date upon which said termination shall be effective.

In the case of such a termination, the Department will pay the Contractor at the Contract unit prices for the actual number of units or items of Contract work completed prior to the effective date of termination, or as may be agreed by the parties for such items of work partially completed. No claim for loss of overhead or anticipated profits shall be allowed.

When the volume of work completed is too small to compensate the Contractor under Contract unit prices for its related expenses, the Department may consider reimbursing the Contractor for such expenses.

Materials obtained by the Contractor for the Project, if they have been inspected, tested as required, and accepted by the Engineer, but have not been incorporated into the Project construction, shall, if the Engineer and the Contractor so agree, be purchased by the Department from the Contractor at their actual cost as shown by receipted bills. To this cost shall be added all actual costs for delivery at such points of delivery as may be designated by the Engineer, as shown by actual cost records. If the Engineer does not

agree to purchase such materials, the Department shall reimburse the Contractor for any reasonable restocking fees and handling costs incurred by the Contractor in returning said materials to the vendor.

Termination of the Contract shall not relieve the Contractor of its responsibilities for the completed Project, nor shall it relieve the Contractor's surety of its obligation concerning any claims arising out of the work performed, until the requirements of Article 1.08.13 and 1.08.14 have been met.

1.05.15—Markings for Underground Facilities: In conformance with Section 16-345 of the Regulations of the DPUC, the Contractor is responsible for notifying “Call Before You Dig” prior to commencing any excavation, including milling, reclamation or trenching; and the Contractor shall install a warning tape located a minimum of 12 inches (300 millimeters) above all conduits, wires, cables, utility pipes, drainage pipes, underdrains, or other facility, unless the excavation’s depth, other underground facilities, or other engineering considerations make this minimum separation unfeasible. The warning tape shall be of durable impervious material, designed to withstand extended underground exposure without material deterioration or fading of color. The tape shall be of the color assigned to the type of facility for surface markings and shall be durably imprinted with an appropriate warning message. The tape shall also comply with the specific requirements of the utility that owns the facility.

All tapes, unless otherwise directed by the specific utility, shall be detectable to a depth of at least 3 feet with a commercial radio-type metal locator.

Assigned colors are:

Green—Storm and sanitary sewers and drainage systems, including force mains and other non-hazardous materials

Blue—Water

Orange—Communication lines or cables, including, but not limited to, those used in, or in connection with, telephone, telegraph, fire signals, cable television, civil defense, data systems, electronic controls and other instrumentation

Red—Electrical power lines, electrical power conduits and other electrical power facilities, traffic signals and appurtenances and illumination facilities

Yellow—Gas, oil petroleum products, steam, compressed air, compressed gases and all other hazardous material except water

Brown—Other

Purple—Radioactive materials

Payment for warning tapes shall be included in the bid price for the pay item of the specific facility for which the tape is used.

1.05.16—Dimensions and Measurements: The Contractor or one of its subcontractors shall verify each dimension that is needed in order to ensure that its work complies with the Contract, and must do so before ordering any material or doing any work for which such dimension is needed. Such dimensions include, but are not limited to, dimensions given on the plans, as well as dimensions of structures in place prior to Project construction or installed in the course of construction. The Contractor or any subcontractor that finds a discrepancy or error in dimensions must report it promptly to the Engineer and may proceed with affected work only after receiving clarification and direction from the Engineer regarding the matter. Any costs for delays, changes, cutting or repairs that are incurred due to the Contractor's failure to observe the above requirements shall be borne by the Contractor.

**SECTION 1.06
CONTROL OF MATERIALS**

- 1.06.01—Source of Supply and Quality**
- 1.06.02—Samples and Test**
- 1.06.03—Storage**
- 1.06.04—Defective Materials**
- 1.06.05—Shipping Material**
- 1.06.06—Vacant**
- 1.06.07—Certified Test Reports and Materials Certificates**
- 1.06.08—Warranties, Guarantees and Instruction Sheets**

1.06.01—Source of Supply and Quality: The Contractor must obtain the Engineer's approval of the source of supply for each of the materials specified in the Contract before beginning delivery of such materials to the Project site. If, at any time, the Department discovers that a source of supply that had been approved does not furnish uniform materials, or if the material from any source proves unacceptable to the Engineer, the Engineer will so notify the Contractor. Thereafter, the Contractor shall furnish only approved materials from other approved sources for the Project, and shall use such approved materials to replace any previously-furnished materials that have been rejected by the Engineer. Only materials conforming to the requirements of these specifications and approved by the Engineer shall be used for the Project. No material that, after approval, has in any way become unfit for use shall be used for the Project.

All permanently incorporated steel and iron used in the construction of the Project must have been produced and fabricated in the United States. It is the express intent of this specification to require that all manufacturing processes for all steel and iron materials and products to be used for the Project, including the coating of steel and iron, occur within the United States, with the following exceptions:

The Contractor may request, in accordance with Section 635.410(b)(4) of Title 23 CFR, approval to include a minimal amount of foreign steel in the Project construction. This amount is defined as 1/10 of 1% of the total Contract price or \$2,500.00, whichever is greater. The cost of the foreign steel or iron is defined as its Contract value when delivered to the Project site.

Additionally, the FHWA has granted a nationwide waiver of the requirements of 23 CFR 635.410, Buy America requirements, for the production of pig iron and processed, pelletized, and reduced iron ore. Items not specifically included in the waiver remain subject to the Buy America requirements. The Contractor may request the Engineer to seek from the FHWA a further waiver of said requirements, but it shall be at the sole discretion of the Engineer whether or not to seek such a waiver.

When the Contractor proposes to use materials from a source not currently approved by the Engineer, the Contractor shall submit as a prerequisite to consideration for source approval such evidence as the Engineer may request, showing that the materials from the proposed source meet the Contract requirements and will be available to the Contractor in sufficient quantity to assure continuous and satisfactory progress of the Project.

Should it become necessary after award of the Contract for the Contractor to obtain material from sources other than those indicated in the statement on materials sources that is furnished by the Department prior to award, the Contractor shall furnish a supplementary statement and required samples of said proposed materials to the Engineer not less than 10 calendar days prior to placing an order for any such material.

For any material that requires more than one month for delivery, the Contractor shall provide the Engineer with documentary proof that said material has been ordered in sufficient time to complete the Project as planned. Failure to produce such documentary proof will result in a denial of any claim for a time extension based on late delivery of such material.

When one manufacturer's product is specified in the Contract, it shall be understood that this represents the standard required, but that a comparable product of another manufacturer may be considered as an equal and may be approved, unless the plans or special provisions indicate that no equal shall be allowed. Should a Contractor desire to use a product that he considers equal or superior to the one material specified, the Contractor shall submit to the Engineer a complete description of the proposed product, together with 7 copies of shop drawings, cuts and other descriptive literature, so as to inform the Department completely of the nature of such product before the Engineer decides whether or not to approve its use. Such approval shall not change any Contract requirement for a related Certified Test Report and Materials Certificate.

1.06.02—Samples and Test: The Contractor must obtain the Engineer's approval of any materials to be incorporated into the Project before beginning to use them for the Project. Approval of materials may be

by certification accepted by the Engineer, written permission of the Engineer, or prior approval after documented test or inspection by the Department. Any Project work in which materials are used without (1) approved certification accepted by the Engineer, (2) prior approval after documented test or inspection by the Department, or (3) written permission of the Engineer, may be considered unauthorized by the Engineer, and therefore not to be paid for. Materials tests or inspection, when required, will be made by and at the expense of the Department, unless otherwise noted in these specifications.

Department certification will be used as the basis for approval of such materials, as the Contract documents may specify or as the Engineer may require. With regard to such materials, the Contractor shall furnish the Engineer a Certified Test Report and Materials Certificate, conforming to Article 1.06.07, as may be required for each type of material. The Contractor shall bear any costs involved in furnishing the Test Report and Certificate.

If the Contractor has purchased materials for use on a previous Department project, and if they comply with the requirements of this Contract, then those materials, with the approval of the Engineer, may be used for the Project, provided that the Contractor, acting as the materials supplier, submits a related Materials Certificate conforming to Article 1.06.07. This Materials Certificate shall further identify the project for which the material was originally purchased and shall be accompanied by a copy of the original Certificate.

The Department will also maintain a current list of approved materials and approved suppliers of those materials. Samplings made by the Department will be as shown in the latest edition of the "Schedule of Minimum Requirements for Sampling Materials for Test," and tests will be made in accordance with the latest revision of the standard method of AASHTO or ASTM, or in accordance with other standards accepted by the Department which are in effect at the time of bidding, unless otherwise specified on the plans or in the special provisions. Any items not covered in the "Schedule of Minimum Requirements for Sampling Materials for Test," special provisions, or plans shall be sampled and tested or certified, as directed by the Engineer.

The Contractor shall submit to the Engineer representative preliminary samples of any materials proposed for Project use, without charge by the Contractor or the producer of the materials. Samples submitted shall be taken by a representative of the Department or a commercial laboratory approved by the Engineer. All such materials shall be subject to inspection, testing or re-testing at the Engineer's direction at any time during their manufacturing, fabrication or use.

The Contractor shall furnish all required samples without charge, and provide secure facilities for their storage. The Contractor shall provide means for, and shall assist in the verification of, all scales, measures and other devices that it operates or uses in connection with the Project.

Materials will be rejected by the Engineer whenever, in his judgment, they fail to meet Contract requirements. The Engineer may accept material or combination of materials and thereby waive noncomplying test results, provided that the following conditions are met:

1. The Engineer finds results of prior and subsequent series of tests of the material or materials from the same source or sources to be satisfactory.
2. The incidence and degree of nonconformance with the Contract requirements are, in the Engineer's judgment, within reasonable limits.
3. The Contractor, in the Engineer's judgment, had diligently exercised material controls consistent with good practices.
4. No adverse effect on the value or serviceability of the completed work could result from said degree of nonconformance.

The Engineer may, in his discretion, waive testing of minor quantities of a particular material if said material was obtained from sources that have furnished supplies of the material that have consistently met Department testing standards.

1.06.03—Storage: The Contractor shall store all materials for the Project in a way that ensures that their quality and fitness for the Project will be preserved, and that the Engineer will have easy and prompt access to them for inspection purposes. Materials shall be kept on wooden platforms or on other hard, clean surfaces and not on the ground. When so directed by the Engineer, the Contractor shall store materials in a weatherproof building.

The Contractor shall not store materials in any way that would lead to a violation of Section 1.10 of these specifications. Stored materials, even if they have been approved by the Engineer prior to their storage, must be inspected by the Engineer and meet all pertinent Contract requirements immediately prior to use of those materials for the Project.

1.06.04—Defective Materials: Unless otherwise permitted by the Engineer, all materials not conforming

to Contract requirements shall be considered defective, shall be rejected, and shall be removed immediately from the Project site.

If deemed necessary by the Engineer, the Engineer may require the retesting of materials previously tested, approved and incorporated into the Project. If, after such retesting, the materials are found not to conform to the Contract, the Engineer may, however, allow the Contractor to leave the materials in place, provided that an equitable reduction of the payment for the materials shall be made. No rejected material, the defects of which have been subsequently corrected, shall be used until approval for such use has been given by the Engineer. Should the Contractor fail to comply with any order of the Engineer made under the provisions of this article, the Engineer shall have authority to remove and replace defective material, and to deduct the cost of such removal and replacement from any money due or to become due to the Contractor.

When a material is fabricated or treated with another material, or when any combination of materials is assembled to form a product, any or all of which are covered by the Contract specifications, the failure of any components of the product to comply with the specifications may be sufficient cause for the rejection of the whole combination or product.

Materials that have been shipped from approved deposits or sources of supply, but which are found to be defective upon their delivery to the Department, to the Project site, or to any testing or storage site approved by the Engineer, shall not be used for the Project.

1.06.05—Shipping Material: Any conveyance used for transporting materials must be clean when used, be in proper working condition, have a strong and substantial body that will prevent the loss of materials during transportation, and be approved by the Engineer.

1.06.06—Vacant

1.06.07—Certified Test Reports and Materials Certificates: The Contractor shall furnish the Engineer with any Certified Test Report and Materials Certificate required by the Contract or the Engineer.

The Contractor shall forward the Certified Test Report and Materials Certificate to the Engineer, and, in addition, shall deliver a copy of same to the Department's inspector at the Project site. Materials for which such documentation is required may be conditionally incorporated into the Project prior to receipt by the inspector of a Certified Test Report and a Materials Certificate; however, payment for such incorporated material will not be made prior to receipt of a Certified Test Report and Materials Certificate indicating that the materials meets the Contract requirements.

The Certified Test Report is a document containing a list of the dimensional, chemical, metallurgical, electrical and physical results obtained from a physical test of the materials involved, and shall certify that the materials meet the requirements of the Contract. Such Report shall also include the following information:

- (1) Item number and description of materials
- (2) Date of manufacture
- (3) Date of testing
- (4) Name of organization to which the material has been consigned
- (5) Quantity of material represented, such as batch, lot, group, etc.
- (6) Means of identifying the consignment, such as label, marking, lot number, etc.
- (7) Date and method of shipment
- (8) Name of organization performing tests

The Certified Test Report shall be signed by a duly-authorized and responsible agent for the organization manufacturing the materials, and the signature must be notarized.

A Materials Certificate is a document certifying that the materials, components and equipment furnished conform to all requirements of the Contract plans and specifications. Such Certificate shall also include the following information:

- (1) Project for which the material has been consigned
- (2) Name of Contractor to which material is supplied
- (3) Item number and description of material
- (4) Quantity of material represented by the certificate
- (5) Means of identifying the consignment, such as label, marking, lot numbers, etc.
- (6) Date and method of shipment

The Materials Certificate shall be signed by a duly-authorized and responsible agent for the organization supplying the material, and the signature must be notarized.

The Contractor shall be responsible for any testing, Materials Certificates, and inspections required under individual sections of the Special Provisions.

1.06.08—Warranties, Guarantees and Instruction Sheets: Manufacturers' warranties and guarantees furnished for materials used for the Project, as well as instruction sheets and parts lists supplied with Project materials, shall be delivered to the Engineer prior to acceptance of the Project. Each warranty or guaranty so furnished shall indicate its commencement and expiration dates.

**SECTION 1.07
LEGAL RELATIONS AND RESPONSIBILITIES**

- 1.07.01—Laws to Be Observed**
- 1.07.02—Permits and Licenses**
- 1.07.03—Proprietary Devices, Materials and Processes**
- 1.07.04—Restoration of Surfaces Opened Pursuant to Permit or Contract**
- 1.07.05—Load Restrictions**
- 1.07.06—Sanitary Provisions**
- 1.07.07—Public Convenience and Safety**
- 1.07.08—Use of Explosives**
- 1.07.09—Protection and Restoration of Property**
- 1.07.10—Contractor's Duty to Indemnify the State against Claims for Injury or Damage**
- 1.07.11—Opening of Section of Project to Traffic or Occupancy**
- 1.07.12—Contractor's Responsibility for Work**
- 1.07.13—Contractor's Responsibility for Adjacent Property, Facilities and Services**
- 1.07.14—Personal Liability of Representatives of the State**
- 1.07.15—No Waiver of Legal Rights**
- 1.07.16—Unauthorized Use of Area(s) within the Project Site**
- 1.07.17—Vacant**
- 1.07.18—Use of State Property**

1.07.01—Laws to Be Observed: The Contractor at all times shall observe and comply with all laws, ordinances, government bylaws, permits, regulations, orders and decrees which in any manner affect the conduct of the Contract work. The Contractor shall indemnify and save harmless the State and all of its officers, employees and agents against any claim, fine, or other liability arising from or based on the violation of any such law, bylaw, permit, ordinance, regulation, order or decree, whether by the Contractor, its subcontractors or any of their officers, employees or agents. See the last paragraph in Article 1.02.13, however, regarding conflicts between municipal law or authorities and the requirements of Project construction.

1.07.02—Permits and Licenses: Except as may be provided otherwise in a specific Contract provision or a written direction from the Engineer, the Contractor shall procure all permits and licenses, pay all charges and fees, and give all notices required by government authorities in connection with the due prosecution of the Project.

Under Connecticut law, a commercial vehicle used by a contractor or vendor in connection with the Project may be subject to Connecticut registration requirements. The CGS require such registration for any vehicle that most often is garaged in this State, or that most often leaves from and returns to one or more points within this State in the normal course of its operation. In addition, a vehicle must be registered in Connecticut if it continuously receives and discharges cargo within this State. Reciprocal registrations as allowed under CGS are acceptable for meeting the registration requirements.

Residence or domicile of the owner, lessor or lessee of the motor vehicle, or the place where the owner, lessor or lessee is incorporated or organized, shall not be a factor in determining whether or not the vehicle must be registered in this State. Failure to register a vehicle, if the law requires it, may result in issuance of a citation for such an infraction, and also may result in administrative action by the Commissioner of Motor Vehicles.

The registration requirement applies not only to the Contractor, but also to its subcontractors, suppliers, and other agents and representatives. It is the Contractor's responsibility to ensure that such entities and individuals comply with this requirement as well. The Contractor shall maintain, on the Project site, records that document compliance with this requirement in connection with all vehicles used for the Project.

1.07.03—Proprietary Devices, Materials and Processes: If the Contractor is required or desires to use any design, device, material or process covered by another party's license, patent, copyright or trademark, the Contractor shall provide for such use by suitable legal agreement with the license, patent, copyright or trademark holder.

The Contractor shall provide a copy of any and all such agreements to the Engineer.

If the Contractor is allowed, but not specifically required by the Engineer, to use any particular proprietor's design, device, material or process covered by license, patent, copyright or trademark, the

Contractor and its surety shall indemnify and save harmless the State from any and all claims that may be brought against the State, and any and all costs, expenses, and damages that the State may be obligated to pay by reason of any infringement or alleged infringement relating to the use of such licensed, patented, copyrighted or trademarked design, device, material or process at any time during the prosecution or after the completion of the Project.

1.07.04—Restoration of Surfaces Opened Pursuant to Permit or Contract: The Contractor shall not make, and shall not allow any person to make, an opening in a highway unless written and duly-authorized permission to do so has been obtained from the Department. If at any time prior to the completion of the Project, the Contractor should make such an opening without such permission, the Contractor shall perform all restoration necessary to close said opening, at its own expense, if the Engineer directs it to do so.

1.07.05—Load Restrictions: The Contractor shall comply with all legal load restrictions as to truck size, the gross weight of vehicles, and the axle weight of vehicles while hauling materials.

This provision shall apply to travel both on existing pavements and pavements under construction. Vehicles of the Contractor, either loaded or unloaded, will not be allowed to travel across any bridge or on any highway when such vehicle exceeds the statutory limit or posted limit of such bridge or highway unless the Contractor receives and complies with the requirements of a permit from the Department for such travel, as provided in the CGS. Such permit will not excuse the Contractor from liability for damage to the highway caused by its equipment.

The Contractor is subject to fines, assessments and other penalties that may be levied as a result of violations by its employees or agents of the legal restrictions as to vehicle size and weight.

1.07.06—Sanitary Provisions: The Contractor shall provide and maintain in a neat and sanitary condition such accommodations for the use of its employees as may be necessary to comply with the regulations and other requirements of the State Department of Public Health or of other bodies or tribunals having jurisdiction over such matters.

1.07.07—Public Convenience and Safety: The Contractor shall conduct the Project work at all times in such a manner as to ensure the least possible obstruction to traffic. In a manner acceptable to the Engineer, the Contractor shall provide for the convenience and interests of the general public; the traveling public; parties residing along or adjacent to the highway or Project site; and parties owning, occupying or using property adjacent to the Project site, such as commuters, workers, tenants, lessors and operating agencies.

Notwithstanding any other Contract provision, the Contractor shall not close to normal pedestrian or vehicular traffic any section of road, access drive, parking lot, sidewalk, station platform, railroad track, bus stop, runway, taxiway, occupied space within a site, or occupied space within a building, except with the written permission of the Engineer.

All equipment, materials, equipment or material storage areas, and work areas must be placed, located, and used in ways that do not create a hazard to people or property, especially in areas open to public pedestrian or vehicular traffic. All equipment and materials shall be placed or stored in such a way and in such locations as will not create a hazard to the traveling public. In an area unprotected by barriers or other means, equipment and materials must not be stored within 30 feet (9.15 meters) of any traveled way.

The Contractor must always erect barriers and warning signs between any of its work or storage areas and any area open to public, pedestrian, or vehicular traffic. Such barriers and signs must comply with all laws and regulations, including any applicable codes.

The Contractor must arrange for temporary lighting, snow and ice removal, security against vandalism and theft, and protection against excessive precipitation runoff within its Project work and storage areas, and within other areas specifically designated in the Contract.

In addition to meeting the requirements of Article 9.71, the Contractor shall take all precautions necessary and reasonable for the protection of all persons, including, but not limited to, employees of the Contractor or the Department, and for the protection of property, until the Engineer notifies the Contractor in writing that the Project or the pertinent portion of the Project has been completed to the Engineer's satisfaction. The Contractor shall comply with the safety provisions of applicable laws, including building and construction codes and the latest edition of the CFR. The Contractor must make available for reference in its field office, throughout the duration of the Project, a copy of the latest edition and all supplements of the CFR pertaining to OSHA.

The Contractor shall furnish to the Engineer's representative supervising the Project a report on any accident that occurs on the Project site with regard to which the Contractor is required to report under OSHA or any other legal requirement. The Contractor shall also furnish to the Engineer a report regarding any other accident involving public liability or property damage in connection with the Project. The form

and detail of such reports must be acceptable to the Engineer.

The Contractor shall designate a competent representative with authority to act in cooperation with the Department in the enforcement of safety provisions and promotion of safe practices on and related to the Project throughout the duration of the Project.

Under Article 1.08.06, the Engineer may suspend the work of the Contractor if and when the latter does not take the safety precautions referenced in this article. Nothing herein shall be construed, however, to relieve the Contractor from responsibility for the prosecution of the Project.

1.07.08—Use of Explosives: To the extent possible, the Contractor shall avoid using explosives in proximity to existing structures. When the use of explosives is necessary for the prosecution of the Project, the Contractor shall take the utmost care not to endanger life or property.

The Contractor shall take adequate protective measures when engaging in blasting operations, and shall be responsible for any damage resulting from such operations.

The Contractor shall notify each utility with facilities in proximity to the site of such blasting operations, and any other individuals and entities that may be affected thereby, of the Contractor's intention to use explosives; and such notice shall be given sufficiently in advance of any blasting to enable such affected parties to take steps to prevent such blasting from injuring persons or property. Such notice shall not relieve the Contractor of responsibility for damage resulting from its blasting operations.

1.07.09—Protection and Restoration of Property: The Contractor shall not enter upon private property for any purpose without having obtained written permission to do so from the owner of such property and having provided the Engineer with a copy of same. The Contractor shall use every reasonable precaution to avoid disturbing or damaging public or private property, including, but not limited to, trees and monuments. The Contractor shall use suitable precautions to avoid disturbing or damaging underground or overhead structures or facilities, whether or not they are shown on the plans.

If the Project requires the moving or removal of a land monument or property marker, the Contractor shall not disturb it until a duly-authorized agent of the public or private property's owner has witnessed or recorded the monument or marker's location. The Contractor shall not move or remove such property until and unless directed to do so by the Engineer.

The Contractor shall not remove, cut, injure or destroy trees or shrubs without the Engineer's prior approval.

The Contractor shall be responsible for all damage to property resulting from any act, omission, neglect or misconduct in the Contractor's manner or method of executing its work, or due to its defective work or materials. When or where any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Project work, the Contractor shall restore, at its own expense, such property to a condition as close as possible to that which existed before such damage was done, by repairing, rebuilding or otherwise restoring the property, as may be directed by the Engineer; or the Contractor shall make good such damage in another manner acceptable to the Engineer. If the Contractor fails to restore such property or make good such damage in a way acceptable to the Engineer, the Engineer may, upon 48 hours' notice, proceed to have such property repaired, rebuilt or restored as he may deem necessary; and the cost thereof will be deducted from any monies due or which may become due the Contractor under the Contract or under any other contract(s) that the Contractor may have with the State.

The Engineer shall mark the locations of underground facilities belonging to the State when given seventy-two (72) hours' (excluding Saturdays, Sundays, and State holidays) notice by the Contractor that it will be excavating or driving material into the ground near such facilities as a part of necessary Contract work. After the Engineer marks the location of such facilities, it will be the Contractor's responsibility to maintain the location markers until no longer needed. Repairs of State facilities located further than 1 foot (300 millimeters) from the line delineated by such markers shall be paid for by the State.

1.07.10—Contractor's Duty to Indemnify the State against Claims for Injury or Damage: The Contractor shall indemnify and save harmless the State, the Department and all of its officers, employees and agents from all suits, actions or claims of any character, name or description brought for or on account of any injury or damage caused to any person or property as a result of, in connection with, or pursuant to the performance of the Contract, including all costs incurred by the State in defending itself against such claims or actions, in proportion to the extent that the Contractor is held liable for same by an arbiter of competent jurisdiction. As much of any money that may be due the Contractor under the Contract as the Commissioner considers necessary for the purpose of such indemnification or holding the State harmless may be retained for such use by the State; and the Contractor's surety bonds may be held until such suit or

suits, action or actions, claim or claims, as aforesaid, shall have been settled and until the Contractor has furnished to the Commissioner suitable evidence to that effect. Such indemnity shall not be limited by reason of any insurance coverage required under the Contract.

1.07.11—Opening of Section of Project to Traffic or Occupancy: Whenever, in the opinion of the Engineer, any portion of the Project has been substantially completed, it may be opened to traffic or occupancy as directed by the Engineer. The Engineer's approval of any such opening shall not be held to be in any way an acceptance of such completed portion of the Project, or as a waiver of any of the provisions of these Specifications, or of any state or federal statutes, applicable building codes, or other Contract provisions. Such approval shall not constitute a basis for claims for damages due to interruptions to, or interference with, the Contractor's operations.

If repair or replacement of any portion of the Project construction becomes necessary because the Engineer has directed that said portion be opened to travel or occupancy prior to completion of the Contract work, the Contractor shall perform that repair or replacement. The Contractor shall perform such work at its own expense, unless the Department or an arbiter of competent jurisdiction shall determine definitely that the damage necessitating the repair or replacement was caused by equipment operated by a State employee while controlling snow or ice, or by routine State maintenance operations. In the latter cases, the State shall reimburse the Contractor for the cost of the repair or replacement. If the damage was caused by a traffic accident involving only a vehicle or vehicles that were not owned by the State and were not operated by an agent of the State, the Contractor may seek recovery from the responsible parties, but not from the State.

1.07.12—Contractor's Responsibility for Work: From the date for commencement of construction given in the "Notice to Proceed" until the date when the Engineer relieves the Contractor of responsibility for the Project, the Project construction and site shall be under the charge and care of the Contractor; and the Contractor shall take every necessary precaution against damage to the same or any part thereof by the action of the elements or from any other cause, including either execution or non-execution of Project work. The Contractor shall rebuild, repair, restore or otherwise make good, at its own expense, all damage to, or impairment of, any portion or purpose of the Project which results from any of the above causes prior to completion of the Project, except as provided in Article 1.07.11.

1.07.13—Contractor's Responsibility for Adjacent Property, Facilities and Services: The Project work shall not commence until the Contractor has made all arrangements necessary to protect all property and facilities adjacent to the Project site, including, but not limited to, those of utilities, from damaging or disruptive effects of Project operations. The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication of such utilities work may be kept to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

In the event of interruption of water or utility services as a result of accidental breakage of facilities, or as a result of related facilities being exposed or unsupported, the Contractor shall promptly notify the proper utility and law enforcement authorities and the Engineer of same. The Contractor shall cooperate with said authorities in the restoration of such services as promptly as possible. In no case shall the Contractor leave the site until the interrupted service has been restored. Fire hydrants shall be kept accessible at all times, and no materials shall be left within 15 feet (5 meters) of any fire hydrant.

1.07.14—Personal Liability of Representatives of the State: In carrying out any of the provisions of these Specifications, or in exercising any power or authority granted by the Contract, or by law or regulation, the Commissioner, Engineer, and their authorized representatives, including consultant engineering firms and their employees, shall be subject to no liability, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

1.07.15—No Waiver of Legal Rights: The Commissioner reserves the right, should the Department discover an error in the estimate, or conclusive proof of defective work done or material used by or on behalf of the Contractor, either before or after the acceptance of the Contract, or even after the final payment has been made to the Contractor, to retain and apply monies owed to the Contractor under any State contract, or to claim and recover by process of law such sums, in order to correct any error or make good any defects in the Project work or materials.

1.07.16—Unauthorized Use of Area(s) Within the Project Site: The use of any area within the Project site for any purpose other than the construction of the Project, without prior written authorization to do so from the Commissioner, is prohibited.

Any request by the Contractor for authorization of such special use must include details describing the

proposed use. If the proposed special use would involve the Contractor's making any lease or any profits in connection with the proposed use, the Contractor must enter into an agreement with the State for an equitable sharing of any profits with the State before such use may be authorized.

1.07.17—Vacant

1.07.18—Use of State Property: The Contractor may not use State property for any purpose or activity other than carrying out the construction activities required by the Contract, except with the prior written consent of the Engineer.

Such other activities, which require the Engineer's advance consent, include, but are not limited to, the establishment of staging areas, storage areas, asphalt plants, concrete plants, or gravel/borrow pits; or the conduct of screening, crushing, manufacturing, or mining operations.

Any permitted use of the Project site or other State property for such other purposes or activities must be for the performance of the specific Contract only, and must be at no cost to the State. In addition, the Contractor may not assert or bring any claim or formal proceeding for damages or additional compensation based on either the approval or denial of a request to make such use of the Project site or other State property.

Under no circumstances shall the bulk storage of fuel or lubricants by the Contractor or its agents be permitted on State property. Nor shall the Contractor store any hazardous materials on State property other than those that are integral to the Contractor's performance of the Contract, as allowed by the Contract or in a writing from the Engineer. The Contractor shall have the responsibility and duty to ensure the proper storage, handling, management and disposal of any such hazardous materials. The Contractor shall be liable to the Department for all remedial or punitive costs, damages or penalties incurred by the Department as a result of the Contractor's failure to fulfill this duty.

The Engineer may require environmental testing of the affected site at the Contractor's expense both prior to and upon completion of the Contractor's permitted use of the site or of other related State property. The Contractor shall be responsible for ensuring that such a site is restored to the condition required by the Engineer and that all contaminants deposited on the site by the Contractor or its agents are removed and properly disposed of. All such restoration and removal activities must be carried out at the Contractor's expense, and must be carried out in accordance with the provisions of the Department's Best Management Practices, any applicable environmental permits, and all other applicable State or Federal laws or regulations.

The Contractor must submit any request to use State property for a staging or storage area to the District Engineer at the District Construction Office. The following information, at a minimum, must accompany such written request:

- (a) A detailed description of the proposed operation or use of State property.
 - (b) A site plan detailing the proposed location of any operations, materials, or facilities related to the requested use, including any appropriate sedimentation or erosion controls.
 - (c) An area plan detailing anticipated ingress to and egress from the site of the proposed activity or the Project site, as appropriate, and indicating the location of and proximity to residential or occupied buildings in the vicinity.
 - (d) Copies of any related, required or affected environmental permits.
 - (e) A detailed listing or description of the anticipated dates and hours of the proposed operations or activities.
 - (f) Photo documentation (a minimum of twelve 8x10-in. color photographs) (i) of the preconstruction condition of each site of the proposed activities and (ii) of adjacent property at the boundaries of those areas. If the site to be used or affected is State property that lies outside of any Department right-of-way, the Contractor must also obtain from other State agencies all necessary or appropriate authorizations for the proposed use(s) of State property.
- Any request by the Contractor relating to a proposed use of State property for activities other than the establishment of a construction staging or storage area must also be submitted to the District Engineer at the District Construction Office, and must include the same information required by (a) through (f) of the preceding paragraph. In addition, in connection with such other requests, the Contractor must submit to the District Engineer
- (g) written confirmation from the municipality or municipalities in which each affected site is located that each such municipality has no objection to the proposed use or activity; and
 - (h) a license agreement with the Department, executed by the Contractor, on terms acceptable to the Department, defining the nature and scope of the proposed use or activity.

For any request to establish or operate an asphalt batching or continuous mix facility, the Contractor must also provide to the District Engineer at the District Construction Office a map detailing the outermost perimeter of the proposed facilities and operations, showing all related and potentially-affected structures, land uses, watercourses, wetlands, and other areas of environmental concern within one-third of a mile (.50 km) of the facility or operation perimeter. No such facility will be permitted on State property where any hospital, nursing home, school, area of environmental concern, watercourse, or residential housing exists within one-third of a mile (.50 km) of the perimeter of the facility or operation (as per Public Act 98-216).

**SECTION 1.08
PROSECUTION AND PROGRESS**

- 1.08.01--Transfer of Work or Contract**
- 1.08.02--Establishment of Construction Field Office**
- 1.08.03--Prosecution of Work**
- 1.08.04--Limitation of Operations**
- 1.08.05--Personnel and Equipment**
- 1.08.06--Suspensions of Work Ordered by the Engineer**
- 1.08.07--Determination of Contract Time**
- 1.08.08--Extension of Time**
- 1.08.09--Failure to Complete Work on Time**
- 1.08.10--Annulment of Contract**
- 1.08.11--Final Cleaning Up**
- 1.08.12--Final Inspection**
- 1.08.13--Termination of the Contractor's Responsibility**
- 1.08.14--Acceptance of Project**

1.08.01--Transfer of Work or Contract: The Contractor shall perform with its own organization Contract work with a value under the Contract of at least 50% of the original total Contract value. If the Contractor sublets, sells, transfers, or otherwise disposes of any part of the Contract work without the Commissioner's prior written consent, the Contractor will not be relieved of any Contractual or other legal responsibility in connection therewith. Such an unauthorized act by the Contractor shall constitute a material breach of the Contract, and the Commissioner may, in such a case, terminate the Contract without further compensation to the Contractor.

The Contractor shall include the following alternative dispute resolution clause in all of its Project subcontracts:

"For any dispute arising out of the agreement between the Contractor and a subcontractor, including claims of late payment or non-payment, which cannot be settled within 60 days of the subcontractor submitting a written claim to the Contractor, either party may bring the dispute before an alternative dispute resolution entity for resolution. If the parties do not agree upon a particular dispute resolution entity for that purpose, the dispute shall be resolved under the auspices and construction arbitration rules of the American Arbitration Association, or under the rules of any other alternative dispute resolution entity approved by the Department either generally or for the specific dispute. The Department may not be made a party to formal arbitration regarding such a dispute. These rights and restrictions may not be waived, and if these provisions are not included in the Contractor's subcontracts for the Project, these provisions shall nonetheless be read into them."

The Contractor shall not knowingly enter into any lower-tier transaction on a Department project with any person or entity which, under any federal or state law or regulation, or by voluntary agreement, is currently debarred or disqualified from bidding for construction contracts or participating in construction projects in any jurisdiction within the United States, unless after disclosure of such ineligibility, such participation is authorized by appropriate federal and State authorities, including the Commissioner.

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the Contract or any portion thereof, or of the work provided for therein, or of its right, title, or interest therein, to any individual or entity without the prior written consent of the Commissioner. No payment will be made for any part of the work sublet, sold, transferred, assigned, or otherwise disposed of by the Contractor, prior to the authorization date given in the written consent of the Commissioner. Such an unauthorized act by the Contractor shall constitute a material breach of the Contract, and the Commissioner may, in such a case, terminate the Contract without further compensation to the Contractor.

1.08.02--Establishment of Construction Field Office: Prior to the start of Project construction, and within 10 calendar days after the signing of the Contract by the parties, the Contractor shall propose in writing to the Engineer a field office location. The proposal shall include the office telephone number to be used, the nearest utility pole number, and the distance from that pole to the proposed field office. The office shall be made acceptable to the Engineer and available for use, including all utility hookups, local permits and inspections, within 30 days of the Engineer's order to establish the office. Such order shall not be deemed the "Notice to Proceed."

1.08.03--Prosecution of Work: The Contractor shall commence construction operations with that part of the Project designated for such commencement in the progress schedule which it has submitted to the Department, unless the Engineer directs the Contractor to commence with a different part of the Project. The work shall be conducted in such manner and with sufficient materials, equipment and labor as are necessary to ensure completion of the Project in accordance with the Contract within the time set forth in the Contract. The Contractor shall notify the Engineer of its intention to commence or recommence any Project operation at least 48 hours in advance of doing so. The Contractor shall also give the Engineer such advance notice of any intent to discontinue any Project operation, unless emergency conditions make it impracticable to give such notice so far in advance. The Engineer retains the right to disallow such commencement, recommencement or discontinuance of operations.

1.08.04--Limitation of Operations: The Contractor shall plan and perform the Project work in such a manner and in such sequence as will cause as little interference as is practicable with vehicular, railroad, aircraft, pedestrian or other traffic. The Contractor shall cooperate with any utilities involved in or affected by the Project operations, and shall schedule its operations in accordance with Article 1.05.06.

The Contractor shall give the Engineer 7 days' advance written notice of any proposed changes in Project activities that will alter vehicular traffic patterns, causing lane shifts, detours, temporary closure of a lane, permanent closure of a lane or lane reductions, or any other alteration of railroad, aircraft, pedestrian or other traffic patterns affecting usage of such a transportation facility by the traveling public. This advance notification will allow the Department to publish news releases and provide public radio announcements to inform the public of revised traffic patterns or possible traffic delays. Failure of the Contractor to provide such timely notice will subject the Contractor to stop work orders until such time as the 7 days of required notice have run from either the Contractor's giving of the relevant notice or the Department's discovery of the pertinent alteration of traffic conditions.

1.08.05--Personnel and Equipment: The Contractor shall assign to the Project only personnel who are careful and competent. The Engineer may demand the removal of any person employed by the Contractor on the Project who is, in the opinion of the Engineer, guilty of misconduct on a Department project or incompetent or negligent in the performance of his duties on a Department project or any portion thereof, or who neglects or refuses to comply with directions given by the Engineer in connection with the Project. Following such a demand for his removal, such person shall not work again on the Project without the prior written consent of the Engineer. Should the Contractor, following such a demand for removal, continue to employ or again employ such person on any Department project without the required consent of the Engineer, the Commissioner may withhold all estimated payments that are or may become due to the Contractor for the Project, or the Engineer may shut down the Project until the Contractor has complied with the Engineer's orders concerning that person. The use of convict labor on projects funded in whole or in part by the federal government is prohibited.

The Contractor shall furnish whatever equipment is necessary for the Project to be performed in a manner and at a rate of progress that is acceptable to the Engineer. Equipment used on any portion of the Project shall not be used in any way that may cause injury to the roadway, adjacent property, or other property on or adjacent to the Project site, unless such damage is allowed by the Engineer for the performance of the Project.

The Contractor may submit to the Engineer a request to use equipment or methods other than those specified in the Contract. If the Engineer so directs, there shall be a trial of such equipment or methods. If the results of the trial are satisfactory to the Engineer, the Contractor may begin using the proposed equipment or method on the Project. Failure of the equipment or method to meet the specified Contract performance standards in the course of the specified trial, or, in the absence of such standards, a failure to perform to the satisfaction of the Engineer, shall be cause for rejection of any such method or equipment, and any work performed with either. Such rejected equipment or work shall be removed immediately from the Project site.

1.08.06--Suspensions of Work Ordered by the Engineer: The Engineer may suspend the Project wholly or in part, for such period or periods as he considers to be in the best interests of the State, including, but not limited to, the interests of public necessity, convenience, or safety.

During such periods of suspension, and subject to any related directions from the Engineer, the Contractor shall store all materials and equipment in a way that will keep them from obstructing or impeding the traveling public unnecessarily, and that will keep the materials from being damaged; shall take all reasonable measures to prevent damage to the work performed; shall provide suitable drainage of the roadway and Project site by opening ditches, shoulder drains, etc., as appropriate; and shall erect temporary

structures to prevent damage to the Project or to other property, and to protect the public, where and when necessary.

The Contractor shall maintain the Project site and all roadways and buildings thereon in a condition safe for travel or occupancy, and shall maintain all required barricades, signs, and lights during the period of suspension:

- (1) If the Engineer orders in writing that performance of all or any portion of the Project shall be suspended, or that it shall be delayed for an unreasonable period of time (not customary, within the scope of possibilities that an experienced contractor should know might occur on a construction project, or inherent in the nature of construction activities), and if the Contractor believes that additional compensation or Contract time is due to it as a result of such suspension or delay, the Contractor shall submit to the Engineer in writing a request for a related Contract adjustment within 7 calendar days of the Contractor's receipt of a direction from the Engineer to resume work. The request shall set forth the specific reasons and support for the requested adjustment.
- (2) Upon his receipt of the Contractor's request, the Engineer will evaluate the request. If the Engineer agrees that the expenditures or time required for the Contractor's performance of the Contract have increased as a result of such suspension or delay, and if the suspension or delay was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and was not caused by weather, the Engineer will make an appropriate adjustment (excluding any profit) of the written terms of the Contract. The Engineer will give the Contractor written notice of his determination as to whether or not the requested adjustment of the Contract is warranted and will be made.
- (3) No Contract adjustment will be made unless the Contractor has submitted the request for adjustment within the time prescribed.
- (4) In addition to the other limits and requirements imposed by this article, no Contract adjustment will be allowed under this article to the extent (a) that the Project work would have been suspended or delayed by any cause other than the ones identified in the Contractor's request, or (b) that the requested adjustment or type of adjustment is provided for or barred by another provision of the Contract.

(With regard to Items 1-4, refer to 23 CFR, Section 635.109, "Standardized Changed Condition Clauses," Required FHWA Contract Specification.)

1.08.07--Determination of Contract Time: Unless the Contract requires the Project completion by a specified date, the number of calendar days allowed for the completion of the Project will be fixed by the Department, will be stated in the Contract, and will be known (with any subsequent adjustments) as the "Contract time." The chart or schedule upon which the Contract time is based is available from the Division of Contracts, at the Department headquarters, 2800 Berlin Turnpike, Newington, CT. If at any time the Contractor submits a schedule showing completion of the work more than 30 calendar days in advance of the Contract completion date, the Department will issue a no-cost construction order revising the allowable Contract time to that shown on the Contractor's schedule.

When the Contract time is stated on a calendar-day basis, that time shall be the number of consecutive calendar days contained in the Contract period designated in the Contract, excluding the time period from each December 1 through the following March 31 (the "winter shutdown period"). The Contract time will begin to run on the date designated in the Engineer's "Notice to Proceed" as the date for commencement of the Project, and the time will be computed as herein provided on a consecutive-day basis, including all Saturdays, Sundays, holidays, and non-work days from April 1 through November 30 of each included year.

Time will not be charged for days in the winter shutdown period, except for time used in working on planting projects and any other projects with regard to which the Standard Specifications or Project bid documents provide otherwise. If the Engineer so approves, the Contractor may work on the Project during the winter shutdown period with no charge being made against the Contract time.

If the time specified for completion of the Project, with time extensions, is due to expire before December 1 of a given year, but the Project has not been completed by that December 1, the time charged to the Contractor will continue through the winter shutdown period.

The total elapsed time in calendar days, computed as described above, from the commencement date specified in the Engineer's "Notice to Proceed" to the completion date specified in the Engineer's "Notice of Completion" shall be considered as the time spent in the performance of the Contract work.

Suspension involving cessation of work on all items, except minor construction not affected by or connected with the cause of suspension, shall be considered as total suspension. In case of a total suspension of the Project ordered by the Engineer, not due to any fault of the Contractor, the elapsed time during which the Project is suspended will not be charged against the Contract time. Work of an emergency nature ordered by the Engineer for the convenience or safety of the public or the protection of the Project work, if performed during a period of total suspension, will not be charged against Contract time. No such time allowance will be granted in case of partial suspension; provided, however, that the Contractor may request and the Engineer may grant permission to perform specific limited operations during such a partial suspension, in which case Contract time chargeable for those operations shall be negotiated and agreed to in writing before such operations may commence.

1.08.08--Extension of Time: The Contractor may present to the Engineer a request in writing for an extension of Contract time if the time necessary for completion of the Project has been increased due to extra or added work or delays resulting from unforeseeable causes beyond the control and without the fault or negligence of the Contractor, except for weather or seasonal conditions (unless extraordinary and catastrophic). Such causes include, but are not restricted to, natural catastrophes, acts of the State in either its sovereign or contractual capacity, acts of another contractor in the performance of a contract with the State, the presence of utility facilities (including railroads), fires, strikes, floods, or delays by suppliers arising from unforeseeable causes beyond the control and without the fault or negligence of either the Contractor or such suppliers.

The Contractor's plea that insufficient Contract time was allowed under the Contract before commencement of the Project is not a valid reason for extending the Contract time. Requests for an extension of time, with adequate substantiation, must be presented within 60 calendar days from the event that is the basis of the request or from the first effect of such an event on the Project. The Contractor will be responsible for providing all the documentation necessary to support the reasonableness of the additional time requested.

Such requests will be considered by the Engineer and granted to the extent that he deems to be fair and reasonable. Requests will not be considered if based on delays caused by conditions existing at the time the bids were received and of which the Contractor might reasonably be expected to have had full knowledge at that time, or upon delays caused by failure on the part of the Contractor to anticipate properly the requirements of the Project as to materials, labor or equipment. For all Project delays or time increases, except as provided below, additional Contract time is the sole remedy that the Contractor may have, and such periods of additional Contract time shall be deemed "Non-Compensable Delays." For delays caused by the State in its Contractual capacity, the Contractor may, in addition to a time extension, request additional compensation to reimburse it for damages sustained as a direct result of such delay, and such periods of extended Contract time may be deemed "Compensable Delays."

The period of a compensable delay is limited as follows: (1) it may not include time more than 60 days prior to the Engineer's receiving written notice from the Contractor, with adequate substantiation, of its intent to claim damages for the delay, (2) and it may not include periods of delay for which the State was responsible, but during which the Contractor experienced concurrent delays for which the State was not responsible. Damages for periods of Project delay for which the State had sole responsibility shall be limited to the increased costs incurred by the Contractor (which shall not include lost profits), which the Contractor substantiates and which the Contractor shows were caused by such delays.

If an approved extension of time extends beyond November 30, the number of days of the approved extension remaining on that date will not begin to run again until the following April 1.

1.08.09--Failure to Complete Work on Time: Time is an essential element of the Contract. Since the prosecution of the Project may obstruct traffic, interfere with business, and otherwise inconvenience the public,

it is important that the Project be pressed vigorously to completion. The cost to the Department of the administration of the Contract, including engineering, inspection and supervision, will also be increased as the time for Project completion is lengthened. Therefore, for each calendar day that any work shall remain uncompleted after the Contract time has expired, the per diem sum of liquidated damages specified in the Contract shall be deducted from any money due to the Contractor. Liquidated damages are not a penalty, but are a reasonable estimate of the damages caused by such delay.

If the last day of the initial Contract time or the initial Contract date specified for Project completion is before December 1 in the given year, liquidated damages as specified in the Contract shall be assessed

against the Contractor per calendar day (including any days during a winter shutdown period) from that day until the date on which the Project is completed.

The Engineer has the right to deduct the amount of the liquidated damages assessed against the Contractor from any estimated payment for work performed under the Contract or under any other State contract, or from any other sums owed by the State to the Contractor; or to claim and recover such sums by process of law.

1.08.10--Annulment of Contract: The Commissioner may give notice in writing to the Contractor and its surety of any delay, neglect, or default of the Contractor which the Commissioner believes has occurred, including one or more of the following:

1. Failure to begin the Project on the date specified in the Notice to Proceed.
2. Failure to perform the Project with sufficient personnel, equipment or materials to ensure timely Project completion.
3. Unsuitable performance of the Project or failure to perform Project work in accordance with the Contract.
4. Failure or refusal to remove or correct work rejected by the Engineer.
5. Discontinuance of suitable prosecution of the Project for a period of 72 hours, excluding Sundays and holidays, without written authorization to do so from the Engineer.
6. Failure to recommence discontinued work within 48 hours (excluding Sundays and holidays) after being ordered to do so by the Engineer.
7. Insolvency, filing for bankruptcy, or any act or occurrence which may render the Contractor financially incapable of completing the Project.
8. Failure to satisfy any final judgment for a period of 30 calendar days.
9. Making of any assignment for the benefit of creditors.
10. Violation of any provisions of the Contract.
11. Any other cause which, in the judgment of the Commissioner, warrants annulment, including, but not limited to, violations of the antitrust or criminal laws, and attempts to deceive or defraud the Department in material matters.

If the Contractor or surety within a period of 10 calendar days after such notice does not proceed in conformance with the directions set forth in the notification, or fails to present a remedial plan of operation satisfactory to the Commissioner, then the Commissioner may, at his discretion, order the surety to complete the Project or, without violating the Contract, take the right to control and prosecute the Project out of the hands of said Contractor and surety. No annulment or termination of the Contract for such cause will be deemed to have occurred, however, unless the Commissioner himself or herself (and not merely a designated representative of his or hers) expressly declares it in a writing to the Contractor.

The Department may acquire or rent whatever materials or equipment are necessary in order to complete the Project and may seize and use for purposes of the Project (with any appropriate compensation to the Contractor) any material or equipment that the Contractor acquired or purchased expressly for the Project in accordance with a specific Contract requirement.

The Department may also enter into an agreement, either by negotiation or public letting, for the completion of the Contract according to the terms and provisions thereof, or use such other methods or combinations thereof as in the Commissioner's opinion shall be required or desirable for the completion of the Contract in an acceptable manner. All costs and charges incurred by the Department, in connection with completing the Project under the Contract, or as a result of the Contractor's default, shall be deducted from any monies due to or which may become due to the Contractor. In case such expense exceeds the sum which would have been payable under the Contract, then the Contractor and the surety shall be liable for, and shall pay to the State, the amount of the excess.

1.08.11--Final Cleaning Up: The Project will not be considered complete and will not be accepted until the rights of way, borrow pits, and all other ground, both public and private, occupied by the Contractor in connection with the Project has been cleared of all surplus and discarded materials, rubbish and temporary structures. The Contractor must drain all borrow pits where practicable. All property, both public and private, which has been damaged during the prosecution of the Project, shall be restored by the Contractor to an appearance and condition acceptable to the Engineer.

All ditches, waterways, drainage structures and culverts constructed under the Contract shall be cleaned and cleared of obstructions by the Contractor, and shall be left in a condition acceptable to the Engineer. When so directed by the Engineer, the Contractor shall clean all existing ditches, waterways, drainage structures and culverts of obstructions resulting from Project operations.

1.08.12--Final Inspection: The Engineer shall inspect the Project within 10 calendar days after the Engineer determines that the Project has been completed. If the Engineer deems the Project complete, said inspection shall constitute the final inspection, and the Engineer will notify the Contractor in writing that the final inspection has been performed.

If the inspection discloses any unsatisfactory or incomplete Project work, the Engineer will notify the Contractor of such deficiencies. The Contractor shall immediately correct the deficiencies. Upon such correction, another inspection will be made that shall then constitute the final inspection, provided that the work has been satisfactorily completed. Upon such completion, the Engineer will notify the Contractor in writing that the final inspection has been performed.

On projects consisting of two or more individual, geographically-separated sections of roadways, sites, or physically-separated buildings or portions of buildings, a partial final inspection of individual, fully-completed sections will be performed by the Engineer if the Contractor so requests.

If at any time during the prosecution of the Project the Contractor substantially completes a unit or portion of the Project, such as, but not limited to, a structure, an interchange, a building, a portion of a site, a branch circuit in highway illumination that has been in satisfactory and continuous operation for a period of at least 30 days, or a section of road or pavement, then, to the extent that said portion's stability and integrity are not dependent upon the completion of other Contract work, the completed unit or portion of the Project may be opened (1) to vehicular or pedestrian traffic under the provisions of Article 1.07.11; or (2) to railroad, aircraft, pedestrian or other traffic, or to occupancy, at the direction of the Engineer.

A final inspection of the substantially-completed unit or portion of the Project will be arranged by the Engineer. Upon evidence of such completion, including issuance of a Certificate of Compliance for any building, and upon agreement by the Engineer, the Contractor will be relieved of the responsibility for that work which was placed upon it by Article 1.07.12. The Contractor shall be responsible for all damages to the completed unit or portion of the Project that may be caused by or that may result from the operations of the Contractor or its subcontractors, or their employees; and the Contractor shall take such precautions and shall provide such protection as may be necessary to avoid possible damage to said unit or portion of the Project. The acceptance of the completed unit or portion shall in no way affect any other requirements governing the completion and acceptance of the Project as a whole.

1.08.13--Termination of the Contractor's Responsibility: The Contractor's responsibility for non-administrative Project work will be considered terminated when the final inspection has been held, any required additional work and final cleaning-up have been completed, all final operation and maintenance manuals have been submitted, and all of the Contractor's equipment and construction signs have been removed from the Project site. When these requirements have been met to the satisfaction of the Engineer, the Engineer will certify to the Contractor within 7 days, in writing, that the non-administrative Project work has been satisfactorily completed.

1.08.14--Acceptance of Project: The Project will be accepted by the Commissioner when all Project work has been completed, as defined by the requirements of Article 1.08.13, and the following have been submitted to the satisfaction of the Engineer:

1. Supporting information necessary to substantiate pay quantities, such as cost-plus backup documentation;
2. Reports and forms required on all Federal Aid Projects;
3. Warranties, guaranties, final operation and maintenance manuals, and documentation to the effect that training and start-up support required by the Contract have been completed;
4. Any other documents required by the Contract.

**SECTION 1.09
MEASUREMENT AND PAYMENT**

1.09.01—Measurement of Quantities

1.09.02—Value Engineering

1.09.03—Increased or Decreased Quantities

1.09.04—Extra and Cost-Plus Work

1.09.05—Eliminated Items

1.09.06—Partial Payments

1.09.07—Final Payment

1.09.08—Payment of Costs Owed to the State

1.09.01—Measurement of Quantities: Work completed in compliance with the Contract will be measured by the Engineer according to U.S. Customary (System International) standard measures, and quantities of work performed shall be computed based on such measurements made in accordance with the methods of measurement described herein under provisions regarding the applicable Contract item.

Notwithstanding any other provision in the Contract, only work that is within the payment limits prescribed by the Contract or ordered by the Engineer will be measured for payment. No payment will be made for work that is not actually performed.

Structures shall be measured and quantities computed according to the neat lines shown on the plans (as those plans may be revised by authorization of the Engineer), or as may otherwise be required by the Contract.

Quantities of materials measured for payment by net weight (mass) shall be measured in tons (metric tons), while contained in hauling vehicles on scales furnished by and at the expense of the Contractor. The scales shall be satisfactory to the Engineer and shall be sealed. When required by the Engineer, an inspector will be appointed and compensated by the Department to check the weight (mass) of all materials to be incorporated into the Project. The tare weight (mass) of trucks used to haul materials being paid for by weight (mass) shall be taken at such times as the Engineer directs.

1.09.02—Value Engineering: These Value Engineering provisions apply as an incentive to the Contractor to initiate, develop, and present to the Department for consideration cost-reduction proposals conceived by the Contractor, involving changes in the drawings, designs, specifications, or other requirements of the Contract. These provisions do not apply unless the proposal submitted is specifically identified by the Contractor as being presented for consideration as a Value Engineering Proposal. All such proposals must be made on the Department's Value Engineering Proposal form, copies of which are available from the Engineer.

The proposals which may be considered as Value Engineering Proposals are those which, if implemented, (a) would require modification of the Contract by construction order; (b) would produce a savings to the Department by calling for the use of items or methods less costly than those specified in the Contract; (c) would not alter necessary standardized features of the original Project; and (d) would not impair essential functions or characteristics of the construction called for by the original Contract, such as service life, reliability, economy of operation, and ease of maintenance. Proposals that would produce only a reduction in the time required to complete the Project (without monetary savings to the Department) will not be considered as Value Engineering Proposals.

Value Engineering Proposals shall be subject to the following cautions and conditions:

1. The Contractor is cautioned not to base any bid or bid price on the anticipated approval of a Value Engineering Proposal and to recognize that such Proposal may be rejected. The Contractor will be required to perform the Contract in accordance with the existing Contract plans and specifications at the prices bid unless and until the Department formally accepts, in writing, the Contractor's Value Engineering Proposal.

2. In order for the Department to consider such a Proposal, the savings likely to be generated by the Proposal must be sufficient, in the sole judgement of the Department, to warrant its review and processing by the Department. All costs resulting from such review or processing will be borne by the Department. Before any Value Engineering Proposal will be considered by the Department, the Department must determine, in its sole judgement, that implementation of the Proposal would result in a total cost savings of more than \$200,000, reflecting a savings of at least \$100,000 for the Department. The Department will not consider any Value Engineering Proposal that would require an increase in Contract time.

3. All Value Engineering Proposals apply only to the ongoing Contract, and whether approved or not, such Proposals become the property of the Department. Such Proposals shall contain no restrictions

imposed by the Contractor on their use or disclosure by the State. The Department will have the right to use, duplicate and disclose in whole or in part any data necessary for the use or implementation of the Proposal. The Department retains the right to use any accepted Proposal or part thereof on any other current or subsequent Department projects without any obligation to the Contractor for such use. This provision is not intended to deny rights provided by law with respect to patented materials or processes.

4. If the Department already has under consideration certain revisions of the Contract or has approved certain changes in specifications or standard drawings for general use which subsequently appear in a Value Engineering Proposal, the Department may reject the Contractor's Proposal and may proceed with such revisions without any obligation to the Contractor.

5. The Proposal must be presented and approved in writing prior to the Contractor's undertaking any work on the Contract items involved in the proposal. Savings due to a reduction in quantities or deletion of items which result solely from adjustments to field conditions, and Proposals which would only waive specification or other Contract requirements, are not considered to be Value Engineering Proposals.

6. The Contractor shall have no claim against the Department for any costs or delays due to the Department's review or rejection of a Value Engineering Proposal, including, but not limited to, development costs, anticipated profits, or increased material or labor costs resulting from delays in the review or rejection of such Proposal.

7. The Department will be the sole judge of the acceptability of a Proposal and of the estimated net savings in construction costs that would result from adoption of all or any part(s) of such Proposal. In determining such estimated net savings, the Department reserves the right to disregard the Contract bid prices if, in the judgment of the Engineer, such prices do not represent a fair measure of the value of work to be performed or deleted under the Proposal. Errors in the estimated quantities in the bid proposal form for the Contract shall be corrected by the Department prior to calculating the savings that would likely result from adoption of the Value Engineering Proposal.

8. The Engineer may reject all or any portion of work performed pursuant to an approved Value Engineering Proposal if the Engineer determines that unsatisfactory results are being obtained because of the Proposal's implementation with regard to that work. The Engineer may direct the removal of such rejected work and require the Contractor to proceed in accordance with the original Contract requirements. Payment for any work performed under the Value Engineering Proposal, or for its removal, will be made as per Contract unit price or cost-plus, as determined by the Department. Where modifications of the Value Engineering Proposal have been approved in order to adjust to field or other conditions, payment will be limited to the total amount payable for the work at the Contract bid prices, as if the pertinent work had been constructed in accordance with the original Contract requirements. The Contractor waives the right to use such rejection or limitation of reimbursement as the basis of any claim against the State for delay damages or for any other damages or costs.

9. Value Engineering Proposals must conform to the specifications or standards of the Department. The standards governing the original design of the Contract will be the minimal standard allowed.

10. If additional information is needed in order for the Department to evaluate Proposals, the Contractor must provide the Department with this information within 14 calendar days of such request or within such other time period as may be approved by the Department. Failure to do so will result in rejection of the Proposal.

11. The Contractor shall provide revised Project plans, specifications and estimates to the Department in construction order format, reflecting such changes as would be required for implementation of the Value Engineering Proposal. The Contractor shall be solely responsible for any errors or omissions resulting from such revisions.

12. Savings not directly related to the Contract, such as, but not limited to, reductions in inspection or testing costs or Department overhead, will not be included in the savings calculation for any Value Engineering Proposal.

Before expending considerable funds in development of a formal Value Engineering Proposal, the Contractor may find it beneficial to submit a conceptual Proposal to the Department. The Contractor will be notified in writing of the acceptability of the conceptual Proposal or the reason(s) for its rejection. The Department retains the right to reject the formal Proposal even if the conceptual Proposal was determined acceptable. A conceptual Value Engineering Proposal must be submitted for cost-reduction Proposals involving structures, rights-of-way acquisitions, permits or revisions as per Section 1.10, or the use of railroad property, on forms provided by the Department.

Value Engineering Proposals will be processed in the same manner as are alterations of the Contract that

require a construction order. As a minimum, the following shall be submitted by the Contractor in or with each Proposal:

1. A statement that the Proposal is being submitted as a Value Engineering Proposal.
2. A description of the difference between the existing Contract requirements and the proposed change(s), and the comparative advantages and disadvantages of each, taking into account considerations of service life, economy of operations, ease of maintenance, desired appearance, safety, and environmental impacts or necessary permit changes. When an item's function or characteristics would be altered by implementation of the Proposal, a justification of the anticipated effects of the alteration on the end item's performance must be included in the Proposal. A life-cycle cost analysis must be included for items involving alteration of functional characteristics. Factors for determining future worth will be provided by the Department.
3. Complete plans, specifications, and computations signed and sealed by a Professional Engineer licensed by the State of Connecticut, showing that the proposed Contract revisions would incorporate the same design criteria and restrictions that applied to the original Contract features and requirements. Said revisions shall be presented by the Contractor in the Department's construction order format consisting of mylar-reproducible plans, indicating (a) quantity increases and decreases by item number, with associated cost; (b) new items, with their quantities and costs; (c) specifications in contract format; and, if needed, (d) compliance permit applications and revisions in accordance with Section 1.10.
4. A complete analysis of the probable cost effects of the proposed changes on Project construction, future operations in connection with the completed Project, maintenance and durability of completed Project construction, and other aspects of the Project, as appropriate.
5. The date by which the Proposal would have to be implemented in order for the Department to obtain the maximum cost reduction from the Proposal's implementation. The period established by the date must allow the Department ample time for review and processing of the Proposal. Should the Department find that it does not have sufficient time for such review and processing, it may reject the Proposal solely on such basis. If the Department fails to respond to the Proposal by said date, the Contractor shall consider the Proposal to be rejected and shall have no claims against the State as a result thereof.
6. A description of the effect that the implementation of the Proposal would likely have on the time required to complete the Project.

Payment for accepted Value Engineering Proposals will be made in the following manner:

1. The changes resulting from a Value Engineering Proposal will be incorporated into the Contract by construction order and shall reflect the changes in unit bid item quantities or new agreed price items, as appropriate, in accordance with the Specifications.
2. The Contract prices for the revised Project work will be paid directly as accomplished. In addition to such payment, the Department will pay the Contractor, under a separate item or a Value Engineering Incentive item, 50% of the total savings obtained by the State as a result of its implementation of the Value Engineering Proposal. An estimate of said savings is to be calculated by the Department within one week prior to the Proposal's acceptance, by (a) estimating what it will cost the Department to carry out the Project as revised according to the Value Engineering Proposal; (b) estimating what it would have cost the Department to carry out the Project under the terms of the Contract as modified by any construction orders as of the time that the Department accepted the Proposal; and (c) subtracting the sum estimated as per (a) from the sum estimated as per (b).

The Value Engineering Incentive will be paid in two installments. 60% of the estimated incentive will be paid to the Contractor when the Value Engineering Proposal is accepted. When the implementation of the Proposal, including all related construction, has been completed, the Department will calculate the actual savings that resulted from it. The Department will then divide those savings by two, subtract the amount of the first Incentive payment from the resulting sum, and pay the remainder to the Contractor.

3. The Contractor's costs for development, design, submission and processing of the Value Engineering Proposal are not eligible for reimbursement.
4. The Department will not reimburse the Contractor based on any cost savings not identified in the Value Engineering Proposal prior to its acceptance.

1.09.03—Increased or Decreased Quantities: Whenever the quantity of any item as given in both the bid proposal form and Contract is increased or decreased, the Department will pay for such item at the Contract price, on the basis of the actual quantity completed, except as otherwise expressly authorized under the provisions of Articles 1.04.02, 1.04.03 or 1.04.04.

1.09.04—Extra and Cost-Plus Work: Extra work shall be performed only under the conditions and subject to the requirements outlined in Article 1.04.05. Payment for such work shall be based either on a

unit price or on a lump sum, to be agreed upon before the extra work is started; or, if no agreement as to price can be reached, the Engineer may order that the work will be paid for on a cost-plus basis.

For all work done on a cost-plus basis, the Contractor's compensation shall be determined in accordance with the following requirements:

(a) Labor:

(1) For all labor, the Department shall pay the Contractor the wage rate actually paid as shown by its certified payroll, which shall be at least the minimum rate established for the Project by the State Labor Department or the U.S. Department of Labor. For all foremen in direct charge of Project work, the Department will pay the Contractor the actual wage paid to the foremen as shown on the Contractor's certified payroll.

(2) The Department will reimburse the Contractor for the actual costs paid to, or on behalf of, workers by reason of allowances, health and welfare benefits, pension fund benefits and other such benefits, when such amounts are required by a collective bargaining agreement or another employment contract generally applicable to the classes of labor employed on the Project. The Contractor shall certify all such costs.

(3) For property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on Project cost-plus work, the Department will reimburse the Contractor for its actual Project costs. The Contractor shall provide to the Engineer documentation, satisfactory to the Engineer in form and substance, of all such costs.

(4) The Department will also pay to the Contractor an amount equal to 20% (15% for overhead, 5% for profit) of the total sums described in (a) (1) through (3) above.

No part of the salary or expenses of anyone connected with the Contractor's forces above the grade of foreman, who provides general supervision of Project work, will be included in the above payment calculations, except when the Contractor's organization is entirely occupied with cost-plus work, in which case the salary of a superintendent may be included in said labor item when the nature of the pertinent Project work is such that, in the opinion of the Engineer, a superintendent is required for that work. The allowable rate of pay for such superintendent shall be agreed upon before the Contractor begins the pertinent work. If no agreement on the rate can be reached, the Engineer will make payment based on such rate as he deems reasonable

The Engineer reserves the right to determine the number and type of personnel to be employed for the cost-plus Project work.

(b) Specialized Work: When the Engineer directs the Contractor to perform specialized work requiring skills, tools and equipment substantially unlike those ordinarily used by the Contractor or its authorized Project subcontractors, the Department will pay the Contractor for the use of a specialist to perform the specialized work. For such specialized services, including materials incorporated into the Project, the Department will pay the Contractor its actual costs, plus additional compensation in accordance with subparagraph (e) below. Prior to performing such specialized work, the Contractor shall obtain and submit to the Engineer a minimum of three price quotes for the work, if requested by the Engineer.

(c) Materials: For all materials necessary for cost-plus Project work, the Department will pay the Contractor its actual cost for such materials as delivered to the Project site, including delivery charges as shown by original receipted bills, plus 15 % of the sum of said cost and charges.

In lieu of receipted bills for materials used which were not specifically purchased for the Project, but were taken from the Contractor's stock, the Contractor shall provide to the Engineer an affidavit certifying that such materials were not purchased for the Project, that the materials were taken from the Contractor's stock, that the quantity claimed to have been used on the Project was actually so used, and that the price claimed for the materials is currently their fair market value. The Department will pay for costs of transporting the materials to the Project site, in accordance with subparagraphs (a) and (d) hereof.

The Department will not reimburse the Contractor for any penalty or charge incurred due to the Contractor's late or delayed payment for the pertinent materials.

(d) Equipment: All equipment used for cost-plus Project work must, in the judgment of the Engineer, be in good working condition and suitable for the purpose intended; and the Engineer reserves the right to determine the size and number of units of equipment to be used for such work. The manufacturer's ratings shall be the basis for all Rental Rate Blue Book classifications used for payment purposes. ("Rental Rate Blue Book" as used in these specifications refers to the current edition of the Rental Rate Blue Book, taking into account all current Rate Adjustment Tables, and amendments thereof, which is published by K III Directory Corporation of San Jose, California, including all current Rate Adjustment Tables and amendments thereof.) Trucks will be classified by cubic-yard capacity.

No percentage mark-up will be added for payment purposes to amounts charged by the Contractor based on equipment rental rates.

The Department will not pay rental rates for small tools needed to complete the cost-plus Project work.

For payment purposes, estimated operating costs per hour from the Rental Rate Blue Book will apply only to the actual time during which the equipment is actively being used to perform cost-plus Project work.

For equipment that is also being used for non-cost-plus Project work, the Department will pay the applicable hourly rate only for the actual time that the equipment is assigned to cost-plus Project work. The applicable period of assignment for each piece of equipment shall start when the equipment commences to be used for cost-plus Project work ordered by the Engineer, and shall end at the time designated by the Engineer.

For equipment which has to be brought to the Project site exclusively for cost-plus work, the Department will reimburse the Contractor for loading and unloading costs and costs of transporting such equipment to and from the Project site; provided, however, that payment for return transportation from the Project site shall not exceed the cost of moving the equipment to that site. If such a piece of equipment is self-propelled, and is driven to the Project site under its own power, then the Department will pay only operating costs and labor costs for its transport to and from the Project site. The Department will not, however, pay for any loading, unloading and transportation costs if the equipment is used for any Project work on the site other than cost-plus work.

1) Owned Equipment: The Department will pay the Contractor the applicable rental rate set forth in the Rental Rate Blue Book for any equipment (1) which the Contractor uses, with the Engineer's authorization, to perform cost-plus Project work, and (2) which is owned by the Contractor or a subsidiary, affiliate, or parent company of the Contractor (no matter how far up or down the chain of ownership from the Contractor).

The maximum hourly rate to be used in paying for Contractor-owned equipment assigned to cost-plus work shall be the applicable monthly rate in the Rental Rate Blue Book, divided by 176 (176 working hours per month).

Should the proper completion of the cost-plus Project work require equipment of a type not covered by the Rental Rate Blue Book, the Engineer will determine, and the Department will make payment to the Contractor at, a reasonable rental rate based on rates prevailing in the area of the Project. If practicable, such rates shall be determined by the Engineer before the affected work is begun. If the Contractor proposes that the Engineer use a particular rate in such an instance, the Contractor must disclose to the Engineer the specific sources of, or support for, said rate.

If a piece of equipment owned by the Contractor is assigned to cost-plus Project work, but remains idle for some portion of the period of the cost-plus work, the Department will pay for that idle time at 50% of the applicable rental rate (exclusive of operating costs) in the Rental Rate Blue Book.

For payment purposes, the period of equipment usage shall be deemed to start when the Contractor begins to use the equipment for cost-plus Project work and shall be deemed to end when the equipment is released by the Engineer from use for such work. Any hours during which the equipment is used for work other than cost-plus Project work will be deducted from the pertinent payment period.

For any piece of Contractor-owned equipment assigned to cost-plus Project work, the Department will reimburse the Contractor for an aggregate minimum of 8 hours (of use time, idle time, or a combination thereof) in each 24-hour day (measured from one midnight to the following midnight) during the assignment period. No such reimbursement will be made, however, for Saturdays, Sundays and legal holidays during which the Contractor does no Project work, or for any other day on which the Engineer orders the Contractor to do no Project work. If the equipment is used to perform cost-plus Project work for more than 8 hours in a day, the Department will pay the Contractor at the applicable hourly rate computed on a monthly basis for the actual time of use; however the Department will not pay the Contractor for more than 8 hours of idle time for a piece of equipment during a given day.

The Department shall have the right to limit its aggregate Project payments for idle time for a given piece of equipment to the replacement value of that equipment.

(2) Rented Equipment: If the Engineer determines that in order to perform the cost-plus Project work the Contractor must rent certain machinery, trucks or other equipment not owned by the Contractor or a subsidiary, affiliate, or parent company of the Contractor (no matter how far up or down the chain of ownership from the Contractor), the Contractor shall inform the Engineer, in advance of such rental, (1) of the specific nature of the rental(s), (2) the reasons for its need for such rental(s), (3) the anticipated or

proposed rental rate(s), and (4) the estimated duration for the use of the equipment. Rates for such rented equipment must be provided based on the following:

—A daily rate per hour when the equipment is to be specifically assigned to Project work by the Engineer for a period of 7 consecutive calendar days or less.

—A weekly rate per hour when such assigned time exceeds 7 consecutive calendar days, but does not exceed 21 consecutive calendar days.

—A monthly rate per hour when such assigned time exceeds 21 consecutive calendar days.

The applicable daily, weekly, or monthly rate will be determined at the expiration of 21 calendar days or upon release of the equipment by the Engineer, whichever occurs first. Interruptions of the rental period, when equipment is used on other than assigned cost-plus work, will not entitle the Contractor to payment at a rental rate that would be applicable to the shorter periods arguably occasioned by such interruptions.

Prior to renting such equipment, the Contractor shall obtain and submit to the Engineer a minimum of three quotes, if requested by the Engineer.

The Department will pay the Contractor for such rental at the rate actually paid by the Contractor, provided that the given use and rental rate are acceptable to the Engineer. In order to obtain such payment, the Contractor must provide the Engineer with a copy of the original receipted bill for the rental expenses incurred.

(e) Administrative Expense: When extra work on a cost-plus basis is performed by an authorized subcontractor, the Department will pay the Contractor for that work, based on the following table; such payment will be in addition to the percentage payments described in (a), (b), (c) and (d) above, as a reimbursement for the Contractor's administrative expense in connection with such work.

Amounts of extra work performed by subcontractor, valued at up to \$1,000—an added 10% of that dollar value.

Over \$1,000 to \$10,000—\$100 plus 5% of any amount over \$1,000.

Over \$10,000—\$550 plus 3% of any amount over \$10,000.

Approval of such additional payments will be given only after the Contractor provides to the Engineer receipted invoices for all relevant costs.

(f) Bonding Costs: For bonding on the total cost of the cost-plus work including administrative expenses as outlined in (e) above, the Contractor shall receive its actual cost. The Contractor shall provide to the Engineer documentation, satisfactory to the Engineer in form and substance, of all such costs.

(g) Miscellaneous: The compensation provided for in (a), (b), (c), (d) and (e) above shall be deemed to be payment in full for the extra work and shall be deemed as full compensation for same, including costs of superintendence, use of small tools, equipment for which no rental is allowed, safety equipment, consumables, field office overhead, home office overhead, bonding, other insurance, and profit. The Contractor's representative and the Engineer shall compare their respective records of the extra work done on a cost-plus basis at the end of each day. Copies of these records shall be signed by both the Engineer and the Contractor's representative. The Engineer will then forward a copy of same to the Contractor and to any affected subcontractor in accordance with Department procedures. Upon payment of such costs by the Contractor, the Contractor shall immediately furnish the Engineer with original receipted bills covering the costs, including transportation charges, for all materials used for such work.

1.09.05—Eliminated Items: Should the Engineer determine any Contract items, or portion of Project work contained in a lump sum item, to be unnecessary for completion of the Project, the Engineer may eliminate such items or portion of work from the Contract. Such action shall in no way invalidate the Contract; and no allowance for any items, or portion of work contained in a lump sum item so eliminated, will be made by the Engineer in making final payment to the Contractor, except for (a) such actual work as may have been done on the items, or portion of work contained in a lump sum item, prior to the Engineer's notice to the Contractor that the items or work had been eliminated; and (b) such related material as may have been purchased for the Project prior to said notice. This provision shall apply unless the Engineer determines that an elimination of a given item, or portion of work contained in a lump sum item, constitutes a "significant change" in the character of the Contract work, as defined under Article 1.04.03. In such a case, the terms of Article 1.04.03 shall be applied to the payment issues related to the eliminated item or work.

1.09.06—Partial Payments:

A. Monthly and Semi-monthly Estimates.

(1) Once each month, the Engineer will make, in writing, current estimates of the value of work performed in accordance with the Contract, calculated at Contract unit prices, including but not limited to

the value of materials complete in place and materials not yet incorporated into the Project, but approved by the Engineer for payment (as provided for elsewhere in this article). Two and one half percent (2 1/2%) of the total amount determined by the Engineer will be deducted from the estimate and retained by the Department until the Engineer accepts the Project. The balance, less all previous payments, will be certified for payment. When work equaling the original Contract value has been accomplished, no additional retainage will be withheld.

Exceptions may be made as follows:

(a) When not in conflict with the interests of the State, the Contractor may request, and the Engineer may make, semi-monthly estimates for payment. Semi-monthly estimates will be subject to the same retainage and payment conditions as are monthly estimates.

(b) No estimates for payments will be made when, in the judgment of the Engineer, the Project is not proceeding in accordance with the Contract, or when in his judgment the total value of the Project work done since the last estimate amounts to less than \$2,500 or 2% of the total bid amount, whichever is less.

(c) When Project work with a Contract value equal to at least 95% of the original Contract value has been completed, but prior to the Engineer's acceptance of the entire Project, the Commissioner may make additional payments which draw upon the funds held in retainage if he considers such payment to be in the best interests of the State.

(2) The Engineer may also make payment at Contract unit prices for the number of units that represent the value of the Project work performed to date, if said units are essentially, though not totally, complete.

B. Payment for Stored Materials: Non-perishable materials that meet Contract requirements, that have been produced or purchased specifically for incorporation into the Project, and that have been delivered to the Project site or to such location as the Engineer may have approved, but which have not yet been incorporated into the Project, may be included in current estimates at such fraction of the applicable Contract unit price or lump sum price as the Engineer may deem to represent a fair value for the material, if such materials have been paid for by the Contractor as shown by receipted bills or, in lieu of such receipted bill(s), a duly-executed Certification of Title executed by the Contractor and the Vendor in the form approved by the Department. When partial payment is made for stored materials, such materials shall become the property of the State; but such payment shall in no way release the Contractor from its responsibility for the condition, protection and, in case of loss, replacement of such materials, or from any liability resulting in any manner from the presence of such materials wherever they may be stored or kept. All materials shall be stored in accordance with Article 1.06.03 and in accordance with the manufacturer's recommendations. Material test approval by the Department shall be required prior to payment for such materials.

Offsite storage may be approved by the Engineer provided that the materials proposed for payment are segregated from other materials, clearly labeled as being owned by the Department for use on the identified Project, otherwise handled in compliance with Article 1.06.03, and stored in accordance with the manufacturer's recommendations. All such materials must be readily-available for inventory and inspection by the Engineer. Storage outside of the State of Connecticut may be considered only when a representative of the Department is able to verify that the above requirements have been satisfied.

For items requiring extended fabrication, manufacturing or assembly time, the Contractor may propose to the Engineer a schedule of values for the related material costs. If the Engineer approves such a schedule of values, it shall become the Basis of Payment for the stored materials, so long as all other pertinent Contract requirements have been satisfied.

Generic materials having a use on many projects will be considered for payment prior to their incorporation into the Project only if stored in unopened packaging or in large lots. Stock and raw materials will not be considered for such advance payment without the Engineer's prior written consent thereto.

In no case shall material payments exceed the Contract unit price or lump sum price less the actual value of delivery and installation of the materials; if they do exceed such a price, the Engineer reserves the right to reduce any related payment accordingly. Such reductions in payment shall in no way affect the Department's ownership interest in the stored materials.

1.09.07—Final Payment: When the Commissioner has accepted the Project, the Engineer shall prepare a final payment estimate. It shall state the entire amount of each item of Project work performed, the value thereof, and the amount of all payments made on prior estimates, all such estimated payments being merely partial payments and subject to correction in the calculation of the final payment. Upon certification of the final estimate for payment, the Department shall return to the Contractor any securities that may have been

deposited in lieu of monies retained.

1.09.08—Vacant

1.09.09—Payment of Costs Owed to the State: The State shall have the right to set off against amounts otherwise due to the Contractor under this Contract or under any other contract or arrangement that the Contractor has with the State (a) any costs that the State has incurred due to the Contractor's noncompliance with this Contract and (b) any other amounts that are due and payable from the Contractor to the State. Any sum taken in setoff from the Contractor shall be deemed to have been paid to the Contractor for purposes of payment obligations under Article 1.03.04 of these Specifications.

SECTION 1.10
ENVIRONMENTAL COMPLIANCE

1.10.01--General

1.10.02--Compliance With Laws and Regulations

1.10.03--Water Pollution Control

1.10.04--Air Quality Control

1.10.05--Noise Pollution

1.10.06--Protection of Archaeological and Paleontological Remains and Materials

1.10.07--Controlled and Hazardous Materials

1.10.01--General: This Section identifies those construction activities and other activities under the Department's control or jurisdiction which may have a negative effect on the environment, including the State's native waters and natural resources; and to prevent or minimize any damage to the environment which might result from such activities, either during or following the completion of any transportation Project.

The Contractor shall comply with all Project permits and permit applications as though the Contractor were the permittee. If at the time the permit is issued, its contents differ from those outlined in the application, the permit shall govern. Should the permit be issued after the solicitation of bid proposals, and should the permit requirements significantly change the character of the work as described in the proposals, Contract adjustments will be made in accordance with the applicable articles in Section 1.04.

This Section reinforces those environmental protection requirements which the Contractor is bound to meet under the Contract, or under Federal or State laws or regulations. If the Contractor fails to comply with environmental provisions of the Contract or the law, the Contractor shall be penalized as prescribed in this Section and elsewhere in the Contract.

1.10.02--Compliance With Laws and Regulations: The Contractor shall conduct its operations in conformance with Federal and State permit requirements concerning water, air and noise pollution, and the disposal of controlled or hazardous materials. Permit requirements include, but are not limited to, those established by Federal regulations administered by the United States Coast Guard, Army Corps of Engineers, or Environmental Protection Agency.

Appropriate permits shall be required for all activities associated with or incidental to the Contractor's operations, including, but not limited to, those regarding the Project site or adjacent areas, waste and disposal areas, borrow and gravel banks, storage areas, haul roads, access roads, detours, field offices, or any other temporary staging areas. The Contractor shall be responsible for, and hold the State harmless from, any penalties or fines which may be assessed by any authority due to the Contractor's failure to comply with any term of an applicable permit.

The Department will be responsible for obtaining all environmental permits required for Contract work.

Any request by the Contractor for authorization of activities or methods not specifically called for or allowed by the applicable permits issued for the Project must be submitted by the Contractor in writing to the Engineer. Such a request must include a detailed description of the proposed activities or methods, and must include justifications for same, along with supporting documentation, showing that the proposed activity or method will not create a risk of damage to the environment. If such request is granted by the Engineer, the Department will process an application to the appropriate regulatory agency or agencies for any permit amendment, modification, revision or new permit required for the Contractor to carry out the changed activities or methods in question. The Department does not, however, guarantee that it will be able to obtain the desired permit amendment, modification or revision; and the Department will not be liable for the effects of any inability to do so.

The Contractor will not be entitled to any extension of Contract time as a result of the Engineer's granting of the Contractor's request. If the amendment, modification, or revision of the permit is not necessary except to make possible the changes requested by the Contractor, then no claim may be made by the Contractor based on the amount of time taken by the Department to review the Contractor's proposal, or to apply for or secure the permit amendment, modification or revision. No such proposed additional activity shall commence, nor shall such a changed method be used, until and unless the Engineer approves in writing the Contractor's request.

In case of a failure by the Contractor to perform pollution control work as required by the Engineer, the Engineer may, after having given the Contractor 24 hours advance written notice of its intention to do so,

arrange for said work to be performed by other forces, and may deduct the cost from any monies due or which may become due to the Contractor under the Contract or under any other State contract.

1.10.03--Water Pollution Control:

1. In relation to its Project work, the Contractor shall, throughout the duration of the Contract, control and abate siltation, sedimentation and pollution of all waters, including but not limited to under ground water systems, inland wetlands, and tidal, coastal, or navigable waters. Construction methods proposed by the Contractor must conform to permit application and permit requirements. The Contractor shall assume responsibility for all obligations and costs incurred as a result of the Contractor's failure to comply with such applications or permits.
The Contractor shall obtain any permits and pay any fees required for the performance of Project work (i) which has been made necessary by a failure of the Contractor to comply with any Contract water pollution control requirement which is not in the original Contract, (ii) which is proposed by the Contractor and accepted by the Engineer, (iii) which is to be performed outside the Project limits, (iv) which will involve or necessitate water-handling activities, including, but not limited to, the removal of material from, deposit of materials into, obstruction of, construction within, alteration or pollution of, any inland wetland, tidal wetland, coastal or navigable water, stream, pond, lake, water supply, or other body of water.
2. Provisions of the best management practices may be superseded by specific permits from the D.E.P. The Contractor shall not make any design change in the Contract work which requires a variance from the requirements of the following items until and unless the Contractor has first submitted a detailed written proposal for such change to the Engineer for review by the Department and for transmittal to and review by the D.E.P, and has then received written approval from the Department of the proposed variance.

BEST MANAGEMENT PRACTICES

1. No Project construction shall proceed until (i) the Contractor has submitted in writing to the Engineer its erosion and sedimentation control plans for all Project construction; (ii) the Engineer has given in writing his full, limited, or conditional approval of said plans; and (iii) the Contractor has installed all erosion and sedimentation controls called for by said plans approved by the Engineer. Such plans shall be consistent with the Connecticut Council on Soil & Water Conservation's "Connecticut Guidelines for Soil Erosion and Sediment Control" (which are available from the D.E.P.) and with the version of the Department's "On Site Mitigation for Construction Activities" which is in effect at the time that Contract bid proposals are solicited.
2. Fueling of equipment or machinery within 25 feet (8 m) of any wetland or watercourse shall be allowed only with the advance written approval of the Engineer.
3. No Project construction shall proceed unless and until a written proposal of methods to prevent construction debris, paint, spent blast materials, or other materials from entering any wetland or watercourse has been submitted by the Contractor and approved by the Engineer in writing; and until such methods have been implemented as the Engineer directs. Such materials shall be collected and disposed of in accordance with all applicable Federal and State laws and regulations. The Engineer may order the Contractor to cease such activity if, in the opinion of the Engineer, weather conditions threaten to cause the deposit of such materials into a wetland or watercourse.
4. No materials resulting from Project construction activities shall be placed in or allowed to contribute to the degradation of a wetland or watercourse. Disposal of any material shall be in accordance with Federal and State laws and regulations.
5. Forging of streams with equipment shall be prohibited, except as approved by the Engineer. Such equipment travel shall be minimized. When frequent equipment travel on stream banks and beds is necessary, the Contractor shall place washed stone as and where necessary in order to minimize erosion, scour, and turbidity; provided that no significant grade change will be required for any haul road or temporary structure that has been placed in wetlands or watercourses in accordance with the provisions of Section 1.10.02.
6. All off-site disposal locations for material and debris resulting from Project construction shall be submitted in writing to the Engineer in advance of their use, and the Engineer shall determine if they are acceptable. The Contractor shall ensure that such locations are outside of wetlands or watercourses, floodplains and stream channel encroachment lines, unless otherwise approved by

local, state, or Federal agencies with jurisdiction over the matter. Copies of such approvals shall be kept at the Project site by the Engineer in the environmental inspection folder. Furthermore, the Contractor shall ensure that material from the Project is not placed within an area that has a better water quality classification than does the area from which it was taken, as indicated by the latest D.E.P. Water Quality Classifications Maps. Any proposed location for disposal of material within a State right-of-way must also be submitted in advance by the Contractor in writing to the Engineer for subsequent review and approval by the Office of Environmental Planning and the Office of Engineering.

7. A construction-sequencing plan and a water-handling plan, including a contingency plan for flood events, must be submitted by the Contractor in writing to the Engineer, and approved by the Engineer, prior to the commencement of any Project construction in a waterway. Water shall be kept deep enough in the channel to allow for the passage of fish and the continuous flow of the watercourse unless the Engineer directs otherwise. Any revised version of the water-handling plan must be capable of accommodating a two-year storm. Any water-handling system that may be in place longer than 6 months must be designed in accordance with the Department's Drainage Manual.
8. When dewatering is necessary, pumps used for same shall not be allowed to discharge directly into a wetland or watercourse. Prior to any dewatering, the Contractor must submit to the Engineer a written proposal for specific methods and devices to be used for same, and must obtain the Engineer's written approval of such methods and devices, including, but not limited to, the pumping of water into a temporary sedimentation basin, providing surge protection at the inlet or outlet of pumps, floating the intake of a pump, or any other method for minimizing and retaining the suspended solids. If the Engineer determines that a pumping operation is causing turbidity problems, the Contractor shall halt said operation until a means of controlling the turbidity is submitted by the Contractor in writing to the Engineer, approved in writing by the Engineer and implemented by the Contractor.
9. Work within or adjacent to watercourses shall be conducted during periods of low flow, whenever possible. The Engineer shall remain aware of flow conditions during the conduct of such work, and shall order such work stopped if flow conditions threaten to cause excessive erosion, siltation or turbidity. The Contractor shall make every effort to secure the work site before predicted major storms. A major storm shall be defined as a storm predicted by NOAA Weather Service with warnings of flooding, severe thunderstorms, or similarly severe weather conditions or effects. Unless allowed by a D.E.P. permit, no materials shall be stored and no staging areas shall be placed below the 100-year elevation. Materials which are buoyant, hazardous, flammable, explosive, soluble, expansive, radioactive, and any other materials that could be injurious to human, animal or plant life in the event of a flood shall not be stored below the 500-year flood level.
10. All temporary fill shall be stabilized to prevent erosion and shall be contained so as to prevent sediment or other particulate matter from entering a wetland or watercourse. All areas affected by temporary fills must be restored to their original contours or as directed by the Engineer, and vegetated. Temporary fill shall be placed and excavation shall occur only as and where necessary for Project construction, as determined by the Engineer.
11. The Contractor shall perform any seeding required by the Contract within 7 days of reaching an appropriate grading increment, as determined by the Engineer. If the Engineer directs the Contractor, or if the Contractor intends, that a grading operation will be suspended for a period of 30 or more consecutive days, the Contractor shall, within the first 7 days of that period, accomplish required seeding, or take such other measures to stabilize the soil as may be required by the Engineer.
12. Dumping of oil, chemicals or other deleterious materials on the ground or into a watercourse is forbidden. The Contractor shall provide a means of catching, retaining, and properly disposing of drained oil, removed oil filters, and other deleterious material. The Contractor shall immediately report all spills of such materials to the Engineer and the D.E.P.
13. All application of herbicides or pesticides within 25 feet (8 m) of any wetland or watercourse is prohibited. All permitted applications of such materials must be done by a Connecticut-licensed applicator. The Contractor shall submit in writing to the Engineer the proposed applicator's name and license number, and must receive the Engineer's approval of the proposed applicator, before such application may be performed.
14. During spawning seasons and in spawning areas, as defined in the Contract, discharges and

construction activities shall be restricted so as not to disturb or inhibit aquatic species indigenous to the waters.

3. If the Contractor wants to make a change in construction operations or scheduling which would affect the use of or necessity for any pollution controls, the Contractor must submit before beginning to implement those changes a written proposal detailing them to the Engineer, and must receive the Engineer's approval of those changes before beginning to make them. Such submission must include a plan showing what erosion and sedimentation controls above and beyond those called for in the plans and specifications would be necessitated by the proposed change.
4. The Contractor shall inspect erosion and sedimentation controls immediately after each rainfall of at least .1 inch (3 mm), and at least daily during prolonged rainfall. The Contractor shall maintain all erosion and sedimentation control devices in a functional condition, in accordance with the "Connecticut Guidelines for Soil Erosion and Sediment Control," as revised, and the Department's "On Site Mitigation for Construction Activities," as revised. In the event that the Contractor fails to maintain such devices in accordance with such documents, and the Contractor does not correct said failures within 24 hours after receipt of written notice of such failures from the Engineer, the Department may proceed with its own or other forces to remedy such failures. The cost to the Department of curing any such specified failure will be deducted from monies owed to the Contractor under the Contract or under any other State contract.

1.10.04--Air Quality Control: The Contractor shall exercise every reasonable precaution throughout the duration of the Contract to safeguard the air resources of the State by controlling and abating air pollution in accordance with the D.E.P.'s regulations. These measures shall include the control and abatement of dust, mist, smoke, vapor, gas, aerosol, other particulate matter, odorous substances and any combination thereof arising from Project operations, including but not limited to the hauling, storage, or manufacture of materials. The Contractor shall be responsible for obtaining any permits necessary for the operation of its Project equipment including but not limited to crushers, compressors and generators.

1.10.05--Noise Pollution: The Contractor shall take measures to control the noise caused by its construction operations, including but not limited to noise generated by equipment used for drilling, pile-driving, blasting, excavation or hauling.

All methods and devices employed to minimize noise shall be subject to the continuing approval of the Engineer. The maximum allowable level of noise at the residence or occupied building nearest to the Project site shall be 90 decibels on the "A" weighted scale (dBA). The Contractor shall halt any Project operation that violates this standard until the Contractor develops and implements a methodology that enables it to conduct its Project operations within the 90-dBA limit.

1.10.06--Protection of Archaeological and Paleontological Remains and Materials: The Contractor shall be alert to the possibility that, during the prosecution of the Project, significant archaeological or paleontological remains or other such materials may be uncovered. When archaeological or paleontological materials are uncovered, the Contractor shall immediately halt operations in the location of same and shall notify the Engineer of said discovery. The Contractor shall make every effort to preserve archaeological or paleontological materials intact in their original positions, in order to preserve the archaeological or paleontological nature and importance of such materials in relation to one another and to the enclosing soil.

The Engineer shall have the authority to suspend Project work in the area of such discovery for the purpose of preserving, documenting and recovering the archaeological or paleontological materials. The Contractor shall carry out all instructions of the Engineer for the protection of such materials, including steps to protect the site from vandalism and unauthorized investigations, from accidental damage and from dangers such as heavy rainfall or runoff. The Contractor shall reschedule its work to minimize any loss of the time needed to complete the Project while the State evaluates, records and salvages the archaeological or paleontological materials.

Extra work ordered by the Engineer in this connection will be paid for in accordance with Articles 1.04.05 and 1.09.04. Delays caused by archaeological or paleontological preservation and protection, which the Contractor demonstrates have delayed completion of the Project, will be treated under the provisions for extension of time, Article 1.08.08.

1.10.07--Controlled and Hazardous Materials: The Department will acquire any "Hazardous Waste Generator Permit(s)" required under the Resource Conservation and Recovery Act, for the management and disposal of controlled and hazardous materials on the Project site, provided that:

1. Such material is within the construction limits defined in the Contract,
2. Such material is not comprised of waste materials generated by the Contractor.

If the Department has designated in the Contract, an area of known or suspected contamination within the Project limits, the Contractor shall dispose of such material in accordance with the relevant special provisions.

In the event that the Contractor encounters or exposes any material, not previously known or suspected to be contaminated, but which exhibits properties that may indicate the presence of controlled or hazardous material, the Contractor shall cease all operations in the material's vicinity, and shall immediately notify the Engineer of the material's discovery. The presence of barrels, discolored earth, metal, wood, visible fumes or smoke, abnormal odors or excessively hot earth may indicate the presence of controlled or hazardous material, and shall be treated with extreme caution.

If controlled or hazardous materials, other than those required for Contract operations, are discovered at the Project site, the Department may engage a specialty contractor to handle and dispose of the materials.

When the Contractor performs support work incidental to the removal, treatment or disposal of controlled or hazardous material, the Department will pay for same at the applicable Contract unit prices. When the Contract does not include appropriate pay items, payment will be made in accordance with Article 1.04.05.

The Contractor shall observe all security precautions established pursuant to 29 CFR 1910.120 and 1926.65, including all revisions and amendments thereof, and shall not work in any area known to contain or suspected of containing controlled or hazardous material without prior written approval from the Engineer.

The Contractor shall assume sole responsibility for the proper storage, handling, management, and disposal of all regulated materials and wastes associated with its operations, including, but not limited to, lubricants, antifreeze, engine fluids, paints, and solvents. All costs associated with any failure by the Contractor to properly manage such materials in accordance with Federal and State regulations, and all remedial and punitive costs incurred by the Department as a result of such failure shall be borne by the Contractor.

This article does not apply to coatings removed by the Contractor.

SECTION 1.20
GENERAL CLAUSES FOR FACILITIES CONSTRUCTION

1.20-1.00—General

1.20-1.02.04—Examination of Plans, Specifications, Special Provisions and Site of Work

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1.20-1.07.06—Sanitary Provisions

1.20-1.08.03—Prosecution of Work

1.20-1.08.05—Personnel and Equipment

1.20-1.08.11—Final Cleaning Up

1.20-1.08.13—Termination of the Contractor's Responsibility

1.20-1.08.14—Acceptance of Project

1.20-1.00—General: This Section of the Standard Specifications for Roads, Bridges, and Incidental Construction serves to expand upon the requirements of the remaining sections of Division I to address the special requirements for Facilities Construction. Facilities Construction is defined as the type of construction that requires the issuance of a Certificate of Compliance by the State Building Inspector's representative at the completion of a project, and includes site work considered ancillary to this type of construction.

The organization of this Section is such that the Articles herein relate back to the similarly named and numbered Articles within the remaining sections of Division I where applicable. In the event of conflict with those Articles, the requirements of this Section shall take precedence.

1.20-1.02.04—Examination of Plans, Specifications, Special Provisions and Site of Work: CSI-formatted specifications are organized into Divisions and Sections based on the 16-Division format and CSI's "MasterFormat" numbering system. CSI-formatted specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

(a) Language used is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpreted as the sense requires. Singular words shall be interpreted as plural and plural words shall be interpreted as singular where applicable as the context indicates.

(b) Imperative mood and streamlined language are generally used. Requirements expressed in the imperative mood are to be performed by the Contractor. Subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor or by others when so noted.

(c) The words "shall," "shall be," or "shall comply with" are implied where a colon (:) is used within a sentence or phrase.

1.20-1.02.13—Knowledge of Applicable Laws: All work to be performed by the Contractor shall comply with, as a minimum, The State of Connecticut Building Code as adopted pursuant to CGS 29-252, as amended; and the Connecticut Fire Safety Code as adopted pursuant to CGS 29-292, as amended. These codes include, but are not limited to, the following:

1. The BOCA National Building Code with the State Building Code, including latest Connecticut Supplement and Amendments
2. The International Plumbing Code, including supplement
3. The International Mechanical Code
4. The Model Energy Code

5. ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"
6. The National Electrical Code
7. The Fire Safety Code, including latest Connecticut Supplement
8. The Life Safety Code - NFPA 101, including latest Connecticut Supplement
9. The "ADAAG"

The edition of the code governing the Project shall be the code which is in effect as per the above CGS Sections on the date that the Contract is advertised for solicitation of bids.

1.20-1.03.01—Consideration of Bids: The apparent low bidder shall submit to the Manager of Contracts a Schedule of Values within 14 days after bid opening. Any other Contractor that the Department may subsequently designate as the apparent lowest bidder shall make the aforesaid submission within 14 days from the date on which the Department notifies said Contractor that it has become the apparent lowest bidder. If, however, the Department deems it necessary for such a subsequently designated Contractor to make said submission within a shorter period of time, the Contractor shall make the submission within the time designated by the Department.

The bottom-line total in the Schedule of Values shall equal the bid dollar amount for the Major Lump Sum Item.

The Schedule of Values shall be divided into "Line Items" listed separately for each applicable CSI Section of the Special Provisions. Each section shall be broken down into multiple line items for the various work to be performed and/or materials to be supplied under that Section. Each material within the section shall be assigned a unit price. Unit price terminology and breakdowns shall be consistent with the Department standards when and where applicable.

Where requested by the Department, the Contractor shall breakdown the line items further into more specific line items.

In the event that this Contract is terminated or a portion of this Contract is deleted for any reason or in any way allowable by law under this Contract after the apparent low bidder has been awarded the Contract, the Schedule of Values will not be used for estimating payment due the Contractor for work completed prior to such termination of the Contract or deletion of work thereunder. In the case of Contract termination, payment shall be made in accordance with Article 1.05.14.

1.20-1.04.01—Intent of Contract: It is not the intent of the Contract plans to show every pipe, wire, conduit, fitting, and appurtenance. Such components required to complete the Project in accordance with best trade practices and code requirements, shall nonetheless be included in the Contract work and shall not be deemed extra work.

The organization and divisions of work that are set forth within the Contract shall not determine the appropriate divisions of work or responsibility among the Contractor and individual subcontractors, unless the Contract dictates otherwise.

1.20-1.05.02—Shop Drawings, Product Data, Product Samples and Quality Assurance Submittals:

1. Transmittal of Submittals: The Contractor shall package and transmit each submittal to the Designer. The Designer will not act on submittals received from sources other than the Contractor. Any such submittal shall begin with a cover document which sets forth at least the identity of the Contractor, its telephone number and other contact information, the subject, project number, and the purpose of the submittal. All facsimiles from the Contractor shall be followed by an official transmittal.

On the transmittal form, the Contractor shall record relevant information and requests for data and shall certify that the provided information complies with Contract requirements.

The Contractor shall number each submittal consecutively: When resubmitting a rejected submittal, the Contractor shall label the transmittal with the original transmittal number of the submittal followed by a letter to designate the additional submission. All submittals shall be numbered conforming to the following examples:

A	B	C	D	E
001	07511	2.6B	Substrate joint tape	New
002	0210040A		Manhole	New
003	Sheet S2	4:S-6	Foundation detail	New
001a	07511	2.6B	Substrate joint tape	Resubmittal
002a	0210040A		Manhole	Additional Information
001b	07511	2.6B	Substrate joint tape	Resubmittal

- A. Being the chronological identification number assigned to the submittal package
- B. Being the Special Provision or plan sheet number the item submitted is found under
- C. Being the part number and paragraph or the detail number
- D. Being the item description
- E. Being the status of the submittal

At the beginning of each month, the Contractor shall provide the Engineer and the Designer with a list of all submittals provided during the previous month, including the submittal date, the content of each such submittal, and the disposition of each.

2. Submittal Preparation and Processing: The Contractor shall:

- (a) Coordinate preparation and processing of submittals with performance of construction activities;
- (b) Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay;
- (c) Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity;
- (d) Coordinate transmittal of different types of submittals for related elements of the Project so that processing will not be delayed by the Designer's need to review submittals concurrently.

The Contractor shall allow at least 21 calendar days for initial submittal review by the Designer, and allow additional time for such review if processing must be delayed to permit coordination with subsequent submittals. If a re-submittal is necessary, the Contractor shall allow at least 21 additional calendar days for processing each re-submittal. The Designer reserves the right to withhold action on a submittal if coordination with other submittals is necessary, until all related submittals are received. The Designer will promptly inform the Contractor when a submittal being processed must be delayed for such coordination.

The Contractor shall allow at least 60 calendar days for review of any submittal requiring approval by an outside agency (such as FAA, FTA, Metro-North Railroad, DEP, U.S. Coast Guard, Army Corps of Engineers).

The Engineer will not authorize an extension of Contract time because of the Contractor's failure to transmit submittals to the Designer or outside agencies sufficiently in advance of the work to permit processing.

The Contractor shall be limited to one acceptable submittal per product. Once a product has been accepted either as originally specified, or as an "Or Equal" to the product specified, the Contractor may elect to submit a subsequent product for consideration, but the Contractor shall be required to reimburse the Department for all costs associated with reviewing the subsequent request.

The Contractor shall place a permanent label or title block on each submittal and shall provide a space approximately 4 inches x 5 inches (100 millimeters x 125 millimeters) on the label or beside the title block for the Designer's review and approval markings and notes of actions taken. The Contractor shall include the following information in said space: State project number, date of review by Contractor, name and address of Contractor, name and address of subcontractor/supplier, name of manufacturer, number and title of applicable Contract provisions, and detail references.

Prior to each submission, the Contractor shall carefully review and coordinate all aspects of each item being submitted and verify that each item, and the submittal for it, conforms in all respects with the requirements of the Contract. By affixing its signature to each submittal, the Contractor is certifying that it has carried out these tasks.

3. Submittal Schedule: At the Pre-Construction Meeting, the Contractor must provide a submittal schedule with its construction schedule.

Following the Engineer's response to the initial submittal, the Contractor shall print and distribute copies of the schedule to the Engineer, Designer, the Contractor's subcontractors, and other parties required to comply with submittal dates indicated. The Contractor shall post copies of same in the Department field office.

The Contractor must update its submittal schedule at least once a month, and distribute and post each updated schedule in the manner described above.

The Designer will not review submittals until the initial submittal schedule has been provided. Any delays in construction due to the Contractor's failure to provide a submittal schedule shall be the responsibility of the Contractor.

The submittal schedule shall be complete, comprehensive, and chronological, providing the following: scheduled date for submittal; related Contract provision number or plan sheet number of the submitted item (include part number and paragraph or the detail number, as applicable); submittal category; name of

subcontractor; and date by which the Designer's action will be needed in order for the Contractor to adhere to its construction schedule.

4. Shop Drawings: Shop Drawings consist of fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Standard information prepared without specific reference to the Project shall not be considered to be a Shop Drawing.

Shop drawings shall include the following information: Contract number, Project description, number and title of the drawing, date of drawing, revision number, name of Contractor and subcontractor submitting drawing, dimensions, identification of products and materials included, statement of compliance with Contractual standards, notation of coordination requirements, notation of dimensions established by field measurement, and any other information required by individual Contract provisions.

5. Product Data: Product data consists of printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Product data that must be specially prepared because standard printed data is not suitable shall be considered "Shop Drawings."

The Contractor shall provide all product data in a single submittal to the Designer for each element of construction or system.

The Contractor shall mark each copy of a product data submittal to show applicable choices and options. (Where printed product data includes information on several products that are not required, copies shall be marked to indicate the applicable information). Product data shall include the following information and confirmations to the extent applicable: manufacturer's printed recommendations, compliance with recognized trade association standards, compliance with recognized testing agency standards, application of testing agency labels and seals, notation of dimensions verified by field measurement, notation of coordination requirements, and any other information required by the individual Contract provisions.

6. Product Samples: Product Samples are samples submitted for review and approval by the Designer, which are: (1) physically identical to the proposed product or material cured and finished as required by the Contract; or (2) submitted for review of kind, color, pattern, thickness, and texture. Approved samples shall be used for a final check of these characteristics with other elements, and for a comparison of the characteristics of the approved sample with those of the actual component as delivered and installed.

The following information shall be submitted with product samples to the extent applicable: Contract number; Project description; generic description of the sample (name or trade reference, type or quality or grade, and any further designation necessary to identify the items or materials); sample source; product name; manufacturer's name; confirmation of availability; and anticipated delivery time.

The Designer will retain one set of the approved samples, transmit one set of same to the Engineer, and transmit the remaining sets of samples to the Contractor. The Engineer will retain the approved samples at the Project site for quality comparisons throughout the duration of the Project.

7. Quality Assurance Submittals: Quality assurance submittals consist of design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality assurance information required by individual Contract provisions.

Where Contract provisions require certification that a product, material, or installation complies with specified requirements, the Contractor shall submit a notarized certification from the manufacturer certifying said compliance. An officer of the manufacturer or other individual authorized to sign documents on behalf of the company shall sign the certification.

8. Designer's Action: The Designer will review each submittal, mark each with a uniform, self-explanatory action stamp, and return the stamped submittal promptly to the Contractor. The Contractor shall not proceed with the part of the Project covered by the submittal until the submittal is marked "Conforms" or "Conforms as Noted" by the Designer. The Contractor shall retain sole responsibility for compliance with all Contract requirements. The stamp will be marked as follows to indicate the action taken:

(a) When submittals are marked "Conforms," the submittals are satisfactory in that the Designer has not observed any statement or feature that appears to deviate from the Contract requirements.

(b) When submittals are marked "Conforms as Noted," that mark shall have the same meaning as "Conforms," except that the changes noted by the Designer are necessary in order for the submittal to comply with Contract requirements. The Contractor shall inform the Engineer if any of the changes would lessen the warranty coverage.

(c) When submittals are marked "Revise and Resubmit," the Contractor shall revise and resubmit the submittal as noted by the Designer or provide additional information requested by the Designer's notations.

(d) When submittals are marked “Rejected,” the Contractor shall prepare and submit a new submittal in accordance with the Designer’s notations.

(e) When submittals are primarily for information or record purposes, the Designer will return the submittal marked “No Action Required.”

1.20-1.05.04—Coordination of Special Provisions, Plans, Supplemental Specifications and Standard Specifications and Other Contract Requirements: Each entity engaged in construction of the Contract shall be familiar with industry standards applicable to that entity's construction activities. If printed standards have been established by organizations referenced in Article 1.01.02 or in the Contract, the Contractor shall obtain copies of said standards directly from the publication source.

Unless the Contract includes more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract to the extent referenced. Such standards are made a part of the Contract by reference.

The Contractor shall comply with the standard in effect as of the date of the advertisement for solicitation of bids, unless specifically directed otherwise in writing by the Engineer.

All references in the Contract to industry standards or codes refer to the last editions of same that were in effect at the date for the advertisement for solicitation of bids. Such references include current addenda and errata, if any, and shall be considered a part of the Contract.

The minimum quantity or quality level to be provided or performed is shown or specified in the Contract. The actual installation may comply exactly with the minimum quantity or quality specified or it may exceed the minimum within reasonable limits. Indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. The Contractor shall refer uncertainties to the Engineer for a decision before proceeding.

1.20-1.05.05—Cooperation by Contractor: The Contractor shall maintain in good order, in a secure, fire-resistant location at the Project site, 2 copies of all plans, Special Provisions, Addenda, approved Shop Drawings, Product Data, Product Samples, Construction Orders, and other modifications, schedules and instructions. The Contractor shall mark one set of these documents to record all changes made during construction. The other set shall be kept clean of all markings. Both sets shall be available to the Engineer at all times.

The Contractor shall maintain a complete set of Record Drawings by maintaining a clean, undamaged set of blue or black line prints of Contract drawings and Shop Drawings. The Contractor shall mark whichever drawings within the set that are most capable of showing conditions fully and accurately where the actual installation varies substantially from the Project work as originally shown. Where Shop Drawings are used, the Contractor shall record a cross-reference at the corresponding location on the Contract drawings. The Contractor shall give particular attention to concealed elements that would be difficult to measure and record at a later date. The Contractor shall (1) mark record sets with red erasable pencil, (2) use other colors to distinguish between variations in separate categories of the Project work, (3) mark new information that was not shown on Contract drawings or Shop Drawings, (4) note related Addenda and construction order dates where applicable.

The Contractor shall maintain one complete copy of the Record Specifications, including related Addenda, construction orders and modifications issued in printed form during construction. The Contractor shall (1) mark these documents to show substantial variations in actual Project work performed in comparison with the text of the Specifications and modifications, (2) take care to show clearly on these documents any selected options and information on concealed construction that would be difficult to view at a later date, (3) note related record drawing information and Product Data.

1.20-1.05.10—Inspection: For work requiring inspection by a building code official, the Contractor shall:

1. Provide a minimum 3 days, excluding weekends and State holidays, notice to the Engineer to perform such inspection;
2. Not enclose, cover, or impair any system or component that will require inspecting, testing, or viewing for compliance with the codes defined in Article 1.20-1.02.13.

1.20-1.05.24—Project Meetings: In order to maximize effective use of time, and to minimize disruption during construction, the Contractor shall work closely with the Engineer to combine required meetings when possible.

1. Pre-Construction Meetings: The Engineer will schedule a pre-construction and organizational meeting at the District Office or other convenient location after the Award of the Contract. At such meeting, the Engineer will review the parties’ responsibilities and personnel assignments.

The Engineer, Designer, the Contractor and its project coordinator or superintendent, major subcontractors, and other concerned parties shall attend the meeting. All participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Project.

The meeting participants will discuss items of significance that could affect progress, including tentative construction schedule; critical work sequencing; designation of responsible personnel; procedures for processing field decisions and construction orders; procedures for processing applications for payment; distribution of Contract documents; submittal of shop drawings, product data and samples; preparation of record documents; use of the premises; parking availability; office, work and storage areas; equipment deliveries and priorities; safety procedures; first aid; security; housekeeping; and working hours.

The Engineer will distribute copies of minutes of the Pre-Construction Meeting to all attendees. The Contractor shall distribute copies to other parties who were not present at the meeting.

2. Pre-Installation Meetings: The Engineer, Designer, the Contractor's project coordinator or superintendent, the Installer, technical and field service engineering representatives of each manufacturer and fabricator involved in or affected by the installation, and other representatives required for coordination or integration of Project work or materials shall attend the scheduled Pre-Installation Meeting. All meeting participants shall be familiar with the Project and authorized to conclude matters relating to the Project.

The meeting participants shall review progress of other construction activities and preparations for the particular activity under consideration, including requirements of Contract documents, related construction orders, purchases, deliveries, submittals, review of mockups, possible conflicts, compatibility problems, time schedules, manufacturer's written recommendations, warranty requirements, compatibility of materials, acceptability of substrates, temporary facilities and controls, space and access limitations, regulations of authorities having jurisdiction, testing and inspecting requirements, required performance results, and protection of construction and personnel.

The Engineer will distribute copies of minutes of the meeting to the Designer and the Contractor. The Contractor shall distribute copies to parties who were or should have been at the meeting.

3. Progress Meetings: The Engineer will conduct progress meetings at the Project site at regularly scheduled intervals, but no less than once a month.

The Contractor shall provide the Engineer with a detailed agenda for the proposed meeting, specifying what topics will be covered and which representatives from the Designer (Architect, Civil, Landscape, Structural, Mechanical, or Electrical Engineer) are required to be present. The Contractor shall notify the Engineer which representatives from the Designer must be present at the meeting a minimum of 7 calendar days prior to the meeting.

In addition to representatives of the Engineer, each subcontractor, supplier or other entity concerned with current progress or involved in planning, coordination or performance of future activities shall attend these meetings. All participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Project.

At each progress meeting, the participants shall (1) review and correct or approve minutes of the previous progress meeting; (2) review other items of significance that could affect progress; (3) discuss topics appropriate to the current status of the Project; (4) review progress since the last meeting; (5) determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to the Contractor's Construction Schedule; (6) determine how to expedite any Project work that may be behind schedule; (7) discuss whether or not schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract time; and (8) review the present and future needs of each entity represented at the meeting, including such items as interface requirements, time, sequences, deliveries, off-site fabrication problems, access, site utilization, temporary facilities and services, hours of work, hazards and risks, housekeeping, quality and work standards, change orders, and documentation of information for payment requests.

The Engineer will distribute copies of minutes of the meeting to the Designer and the Contractor. The Contractor shall distribute copies to parties who were or should have been at the meeting. The Contractor shall provide the Engineer, for inclusion in the meeting minutes, a brief summary of the Project's progress since the previous meeting.

4. Coordination Meetings: The Engineer will conduct Project coordination meetings as necessary, and shall follow the procedures established for progress meetings.

The Contractor shall request representation at each meeting by every party currently involved in coordination or planning for the construction activities involved.

The Engineer will record meeting results and distribute copies to everyone in attendance, the Designer,

and to the Contractor to be distributed to others affected by decisions or actions resulting from each meeting.

1.20-1.05.25—Schedules and Reports:

1. Baseline Bar Chart Construction Schedule: The Contractor shall prepare a comprehensive bar-chart construction schedule. The schedule shall be submitted at the Preconstruction Meeting with the corresponding submittal schedule as required by Article 1.20-1.05.02. The schedule shall demonstrate the Contractor's sequence for construction by separating it into major work elements further defined according to individual activities.

Each activity shall have a separate schedule bar. The schedule timeline shall be broken into weekly time periods with a vertical line to identify the first working day of each week, and shall reflect the same breakdown of the Project work as indicated in the "Schedule of Values." The schedule shall be detailed to show all elements of the Project.

The schedule shall show finish-to-start, start-to-start, start-to-finish, and finish-to-finish relationships among activities. The critical path for the Project shall be clearly defined on the schedule. Lag and float time shall be shown also. The schedule shall show milestones for major elements of work. Prepare the schedule on a sheet, or series of sheets of sufficient width to show data for the entire construction period.

Project work shall be scheduled to ensure that a Certificate of Compliance for the Project will be obtained prior to expiration of the Contract time.

In creating its Project schedule, the Contractor shall factor in tasks and factors including, but not limited to, the following: submittals, fabrication, installation, adjusting, testing, startup, and the placement of materials and Project facilities into final use and operation.

Following the Engineer's response to the initial submittal, the Contractor shall print and distribute copies of the schedule (as and whenever it may be revised) to the Engineer, the Designer, and the Contractor's subcontractors. The Contractor shall post copies of each succeeding schedule in the Project field office.

Whenever and however often the schedule is revised, the Contractor shall distribute and post the latest schedule in the manner described above.

2. Monthly Updates: No later than the 10th day of each month, unless directed otherwise by the Engineer, the Contractor shall deliver to the Engineer 3 copies of the schedule to show the work actually accomplished during the preceding month, the actual time spent on each activity, and the estimated time needed to complete any activity which has been started but not completed. Each time bar shall indicate, in 10% increments, the estimated percentage of that activity which remains to be completed. As the Project progresses, the Contractor shall place a contrasting mark in each bar to indicate the actual percentage of the activity that has been completed.

The monthly update shall include revisions of the schedule necessitated by revisions to the Project directed by the Engineer during the month preceding the update. Similarly, any changes of the schedule required due to changes in the Contractor's planning or progress shall also be included within the schedule.

Any schedule revisions shall be identified and explained in a cover letter accompanying the monthly update. The Engineer reserves the right to approve or reject any such revisions. The letter shall also describe in general terms the progress of the Project since the last schedule update and shall identify any items of special interest.

3. Biweekly Schedules: The Contractor shall be required to produce and submit to the Engineer a biweekly schedule. This short-term schedule may be handwritten but shall clearly indicate all work planned for the two-week period.

4. Recovery Schedules: If, in the opinion of the Engineer, the updated schedule indicates that the Contractor has fallen behind schedule, or a revision in sequence of operations may be necessary for any other reason, the Contractor shall immediately institute steps acceptable to the Engineer to improve its progress of the Project. In such a case, the Contractor shall submit a revised plan, as may be deemed necessary by the Engineer, to demonstrate the manner in which an acceptable rate of progress will be regained.

5. Daily Construction Reports: The Contractor shall assist the Engineer in the preparation of a daily construction report, by ensuring that each of the Contractor's employees and subcontractors working on the Project site on a given day signs the Engineer's sign-in sheet for that day; and by keeping and providing to the Engineer its own daily list of employees and subcontractors who worked on the Project site on that day.

1.20-1.06.01—Source of Supply and Quality: The identification of a manufacturer or fabricator in the Contract does not imply acceptability of products from the named entity. All products must satisfy the Contract criteria for performance, efficiency, materials, and special accessories.

To the fullest extent possible, the Contractor shall provide products of the same kind from a single source. When specified products are available only from sources that do not or cannot produce a quantity adequate to complete Project requirements in a timely manner, the Contractor shall consult with the Engineer to determine the most important product qualities before proceeding. Such qualities may include attributes such as visual appearance, strength, durability, or compatibility. When the Engineer has made such a determination, the Contractor shall select products in accordance with said determination to the fullest extent possible.

With respect to the Project, all products selected by the Contractor must be compatible with its previously selected products.

The Contractor shall place a permanent nameplate on each item of service-connected or power-operated equipment. In occupied spaces, the nameplate shall be located on an easily-accessible but inconspicuous surface. The nameplate shall contain: name of product and manufacturer, model and serial number, capacity, speed, ratings, and other essential operating data.

Except for required labels and operating data, the Contractor shall not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on a structure's exterior. The Contractor shall locate required product labels and stamps on concealed surfaces or, if required for observation after installation, on accessible but inconspicuous surfaces.

1.20-1.06.03—Storage: The Contractor shall (1) store products in accordance with the manufacturer's recommendations; (2) store products at the site in a manner that will facilitate inspection and measurement or counting of units; (3) store heavy materials away from Project structures so as not to endanger the supporting construction; (4) if the products are subject to damage by the elements, store them off the ground, under cover in a weatherproof enclosure, with ventilation adequate to prevent condensation; and (5) maintain temperature and humidity within any range recommended by the manufacturer.

1.20-1.06.08—Warranties: Standard product warranties are pre-existing written warranties published by individual manufacturers for particular products, which are specifically endorsed by the manufacturer to the State. Special warranties are written warranties required by the Contract, either to extend time limits provided by standard warranties or to provide greater rights for the State. All required warranties shall be endorsed to, or have named as obligee, the State.

Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the Contractually-required warranty, that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required by the Contract to countersign special warranties with the Contractor.

Unless otherwise directed by the Engineer, the commencement date for warranties shall be the date of the issuance of the Certificate of Compliance. When a designated portion of the Project is completed and used by the Engineer or occupied, by separate agreement with the Contractor during the construction period, the Contractor shall coordinate with the Engineer the submission date for properly-executed warranties and commencement date for the warranties. When a special warranty is required to be executed by the Contractor, or by the Contractor and a subcontractor, supplier or manufacturer, the Contractor shall prepare a written document that contains appropriate terms and identification, ready for execution by the required parties.

Written warranties made to the Engineer shall be deemed to supplement implied warranties, and shall not limit the duties, obligations, rights or remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations of the time in which the Engineer can enforce such other duties, obligations, rights, or remedies.

The Contractor shall submit draft warranties for approval prior to final execution. The Engineer reserves the right to reject warranties and to limit selections to products with warranties that do not conflict with Contract requirements.

Where the Contract requires a special warranty, or similar commitment regarding the Project or part of the Project, the Engineer reserves the right to refuse to accept the related work until evidence is presented that entities required to countersign such commitments are willing to do so.

Prior to the date for the Semi-Final Inspection, the Contractor shall compile 4 copies of each required warranty, properly executed by the Contractor or any other required party. The Contractor shall place the warranty documents in an orderly sequence based on the organization of the Contract provisions (including specific CSI-formatted specifications contained within a particular Special Provision).

The Contractor shall:

- (a) Bind warranties in heavy-duty, commercial-quality, durable 3-ring vinyl-covered loose-leaf binders, thick enough to accommodate the contents, and sized to receive 8 1/2-inch x 11-inch paper (216-millimeter x 279-millimeter) paper.
- (b) Identify the binder's contents on the binder's front and spine with the typed or printed title "WARRANTIES," the Project title or name, and the name of the Contractor.
- (c) Provide a heavy paper divider with a tab for each separate warranty.
- (d) Mark the tab to identify the related product or installation.
- (e) Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the Contractor or pertinent subcontractor.
- (f) Furnish to the Department a written warranty for all Project work accompanied by a cover letter with the following contents:

[Addressed to:]

Commissioner of Transportation
Department of Transportation
P.O. Box 317546
Newington, Connecticut 06131-7546

Project Title and Number

[We] hereby warrant all materials and workmanship for all work performed under this Contract for a period of one (1) year from [date of issuance of Certificate of Compliance] against failures of workmanship and materials in accordance with the Contract.

[Signature:] [Name of authorized signatory]

[Title]

- (g) Countersign all warranties supplied by subcontractors, suppliers or manufacturers.
- (h) Submit to the Engineer, upon completion of installation of materials or assemblies that are required to have either a flame-rating or a fire-endurance hourly rating, a detailed letter certifying that the required rating has been attained.

Upon determination by the Engineer that Project work covered by a warranty has failed, the Contractor shall replace or rebuild the work to an acceptable condition complying with Contract requirements. The Contractor is responsible for the cost of replacing or rebuilding defective construction or components and those which may have needed to be damaged or removed in order to cure the defective work including costs of material, equipment, labor, and material disposal, regardless of whether or not the State has benefited from use of the work through a portion of its anticipated useful service life.

When Project work covered by a warranty has failed and been corrected by replacement or rebuilding, the Contractor shall reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the time that remains on the original warranty period at the time of the failure.

1.20-1.06.25—Product Selection: The Contractor shall provide products that comply with the Contract, that are undamaged and, unless otherwise indicated, unused at the time of installation. The Contractor shall provide products complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and the intended use and effect. The Contractor shall provide standard products of types that have been produced and used successfully in similar situations on other projects, when such products are available, unless the Contract requires otherwise.

Contractor's options for selecting products are limited by the Contract and governing regulations, and are NOT controlled by industry traditions or procedures used by the Contractor on previous construction projects. Procedures governing product selection include the following:

- (a) The Contractor shall not use product substitutes as defined in Article 1.01.01.
- (b) Semi-proprietary Specification Requirements: When the Contract lists 3 or more acceptable products or manufacturers unaccompanied by the term "Or Equal," the Contractor shall provide one of the products indicated. In such a case, no "Equal" will be permitted.
- (c) Non-Proprietary Specification Requirements: When the Contract lists products or manufacturers whose products are available and may be incorporated into the Project, and when the list is accompanied by the term "Or Equal," then the Contractor is not restricted to use those products, but may propose any available product that complies with Contract requirements.

(d) Descriptive Specification Requirements: When the Contract describes a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, the Contractor shall provide a product or assembly that provides those characteristics and otherwise complies with the Contract.

(e) Performance Specification Requirements: When the Contract contains performance requirements, the Contractor shall provide products that comply with those requirements, and that are recommended by the manufacturer for the application indicated. Such recommendations may be derived from the manufacturer's published product literature or by the manufacturer's certification of performance.

(f) Visual Matching: When the Contract requires matching an established sample, the Engineer's decision will be final as to whether or not a proposed product matches satisfactorily. When no product available within the specified category matches satisfactorily and complies with other specified requirements, the Contractor shall comply with Contract provisions concerning "Or Equal" submissions for selection of a matching product in another product category.

(g) Visual Selection: When a Contractual product requirement includes the phrase "...as selected from manufacturer's standard and custom colors, patterns, textures..." or a similar phrase, the Contractor shall select a product line and manufacturer that also complies with other Contract requirements. The Designer will select the color, pattern and texture from the product line selected.

1.20-1.07.06—Sanitary Provisions: The Contractor may not use the State's existing toilet facilities.

1.20-1.08.03—Prosecution of Work:

1. Permanent Utilities: The Contractor shall place all permanent utility services in its name until the requirements of Article 1.20-1.08.13 subarticle 1 are met.

2. Temporary Utilities, Services, and Facilities: All utility usage charges for the Project site for Project construction are the responsibility of the Contractor except as may be provided by the Contract. The Contractor shall place all temporary utility services in its name. Installation or use charges for temporary facilities are not chargeable to the State, and may not be used as a basis for construction orders.

The Contractor shall:

(a) Submit to the Engineer a schedule indicating the Contractor's plan for implementation and termination of each temporary utility within 21 calendar days of the Notice to Proceed.

(b) Obtain required certifications and permits for temporary utilities and submit copies of same to the Engineer as soon as each is obtained.

(c) Arrange for authorities having relevant jurisdiction to inspect and test each temporary utility before use, and after any relocation of same.

(d) Use qualified personnel for installation of temporary facilities, including subsequent relocations.

(e) Install such facilities in locations where they will serve the Project adequately and result in minimum interference with performance of the Project.

(f) Engage the appropriate utility company to install temporary service or connect to existing service. If such company provides only part of the service, the Contractor shall provide the remainder with matching, compatible materials and equipment and shall comply with the company recommendations and arrange with the company and the Engineer for a time when service may be interrupted, if necessary, to make connections for temporary services.

(g) Provide adequate utility capacity at each stage of Project construction.

(h) Prior to temporary utility availability, the Contractor shall provide trucked-in services. The Contractor shall obtain easements to bring temporary utilities to the site, where easements cannot be used for that purpose.

(i) Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during Project construction. The Contractor shall include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters and main distribution switch-gear and shall install underground electric power service, except where overhead service must be used, or the Engineer directs it.

Whenever the Contractor installs an overhead floor or roof deck, the Contractor shall provide temporary lighting with local switching. The Contractor shall provide temporary lighting that will fulfill security and protection requirements, that will be adequate for construction operations and traffic conditions, and that will render signs on the Project site visible when Project work is being performed for the duration of the Project.

The Contractor shall provide temporary heat required for curing or drying activities, for protection of installed construction from adverse effects of low temperatures or high humidity, or for heating of interior building areas. The Contractor shall use safe equipment that will not have a harmful effect on elements

being installed or on completed installations. The Contractor shall coordinate ventilation and temporary heating so as to produce the ambient condition required and to minimize consumption of energy. All temporary heating must comply with OSHA regulations and other applicable codes, statutes, rules and regulations. The Contractor shall bear the costs related to furnishing temporary heat as herein required, including the cost of energy.

Except when use of the permanent heating system is authorized by the Engineer, the Contractor shall provide vented, self-contained LP-gas or fuel oil heaters with individual-space thermostatic control. Use of gasoline-burning space heaters, open flame, or salamander type heating units are prohibited.

The Contractor shall install water service and distribution piping of sizes and pressures adequate for Project construction until permanent water service is in use. The Contractor shall sterilize temporary water piping prior to use.

The Contractor shall collect waste daily from the Project site. The Contractor shall comply with requirements of NFPA 241 for removal of combustible waste material and debris. The Contractor shall not hold such materials more than 7 calendar days during normal weather or 3 calendar days when the temperature is expected to rise above 80 degrees F (27 degrees C). The Contractor shall handle hazardous, dangerous, or unsanitary waste materials separately from other waste by placing them in proper containers. The Contractor shall dispose of material in a lawful manner.

The Contractor shall remove each temporary facility as authorized by the Engineer. Materials and facilities that constitute temporary facilities are the Contractor's property, unless otherwise noted in the Contract.

3. Cutting and Patching:

A. Approval Process: Well in advance of performing any cutting and patching on the Project, the Contractor shall submit to the Engineer a proposal describing the procedures that the Contractor intends to use for same.

The Contractor shall include the following information, as applicable, in the proposal:

- (1) Description of the extent of cutting and patching required, how it will be performed, and an indication as to why it cannot be avoided;
- (2) Changes in structural elements, operating components, and the building's appearance and other significant visual elements;
- (3) List of products to be used and firms or entities that will perform Project work;
- (4) Dates when cutting and patching are to be performed;
- (5) List of utilities that cutting and patching procedures will affect, list of utilities that will be relocated, and list of utilities that will be temporarily rendered out of service (including duration);
- (6) Where cutting and patching involves adding reinforcement to structural elements and is required due to the fault of the Contractor, details and engineering calculations prepared by a Professional Engineer registered in the State of Connecticut to show integration of reinforcement with the original structure; if such is not due to fault of the Contractor, the Designer shall supply details to show integration of reinforcement with the original structure.

Approval by the Engineer to proceed with cutting and patching does not waive the Engineer's right to later require complete removal and replacement of unsatisfactory work.

B. Protection of Structural Elements: The Contractor shall obtain approval of the cutting and patching proposal before cutting and patching any structural element, including but not limited to structural concrete, structural steel, timber and primary wood framing, and structural decking.

The Contractor shall not cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio; or cut and patch operating elements or related components in a manner that would reduce their capacity to perform as intended, increase maintenance needs, or decrease operational life or safety.

C. Protection of Visual Elements: The Contractor shall not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Engineer's opinion, reduce the building's aesthetic qualities; or cut and patch construction in a manner that would result in visual evidence of cutting and patching. The Contractor shall remove and replace any such unsatisfactory work.

If possible, the Contractor shall retain the original installer or fabricator to cut and patch exposed work. If it is impossible to engage the original installer or fabricator, the Contractor shall engage another firm acceptable to the Engineer.

D. Warranty: When replacing, patching, or repairing material or surfaces that have been cut or damaged, the Contractor shall use methods and materials in such a manner as not to void any required or

existing warranties.

E. Materials: To the extent possible, the Contractor shall use materials identical to existing materials. For exposed surfaces, the Contractor shall use materials that visually match adjacent surfaces to the fullest extent possible. The Contractor shall use materials whose performance will equal or surpass that of existing materials.

F. Coordination: Before proceeding with any cutting and patching, the Contractor shall meet at the Project site with parties that will be involved in that work, including the Engineer and mechanical and electrical subcontractors, to review and resolve areas of potential interference and conflicts.

G. Preparation: The Contractor shall (1) provide temporary support of work to be cut; (2) protect existing construction during cutting and patching; (3) protect such construction from adverse weather conditions where it may be exposed during cutting and patching operations; and (4) avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

The Contractor shall avoid cutting existing pipe, conduit, or ductwork which serves the building, but which is scheduled to be removed or relocated, until adequate to bypass, replace, or discontinue those services, as applicable.

H. Performance: The Contractor shall (1) employ skilled workers to perform cutting and patching; (2) proceed with cutting and patching at the earliest feasible time, and complete the work without delay; (3) cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required for restoring surfaces to their original condition; (4) cut existing construction using methods least likely to damage elements retained or adjoining construction; and (5) review proposed procedures with the original installer and comply with the original installer's recommendations, if possible.

In general, for cutting and patching the Contractor shall (1) use hand or small power tools designed for sawing or grinding, not for hammering and chopping; (2) cut holes and slots neatly to the size required, and with minimum disturbance of adjacent surfaces; (3) temporarily cover openings when not in use; (4) cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces; (5) cut through concrete and masonry using a cutting machine such as a carborundum-saw or diamond-core drill; and (6) review any Contract provisions applicable to cutting and patching which requires excavating and backfilling.

Where services are required to be removed, relocated or abandoned, the Contractor shall (1) by-pass utility services such as pipe or conduit, before cutting; (2) cut-off pipe or conduit in walls or partitions to be removed; and (3) cap, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after bypassing and cutting.

The Contractor shall (1) patch with durable seams that are as invisible as possible; (2) comply with specified tolerances; (3) inspect patched areas to ensure integrity of the installation where feasible; and (4) restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

Where removal of walls or partitions extends one finished area into another, the Contractor shall (1) patch and repair floor and wall surfaces in the new space; (2) provide an even surface of uniform color and appearance; (3) remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance; and (4) patch, repair or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.

Where patching occurs in a smooth painted surface, the Contractor shall extend final paint coat over entire unbroken surface containing the patch, after the patched area has received primer and second coat.

I. Cleaning: The Contractor shall (1) clean areas and spaces where cutting and patching are performed or used as access; (2) remove paint, mortar, oils, putty and similar items; (3) clean piping, conduit, and similar features before applying paint or other finishing materials; and (4) restore damaged pipe covering to its original condition.

1.20-1.08.05—Personnel and Equipment: The Contractor shall provide:

(a) Temporary heating units that have been tested and labeled by UL, FM or another recognized trade association related to the type of fuel being consumed.

(b) Hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA recommended classes that comply with NFPA 10 and 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

1.20-1.08.11—Final Cleaning Up: The Contractor shall:

(a) Clean each surface or unit to the satisfaction of the Engineer.

- (b) Comply with all applicable manufacturer's recommendations for cleaning products and methods.
- (c) Complete the following cleaning operations before requesting Final Inspection for issuance of the Certificate of Compliance: remove labels that are not permanent labels; clean transparent materials, including mirrors and glass in doors and windows; remove glazing compound and other substances that are noticeable vision-obscuring materials; replace chipped or broken glass and other damaged transparent materials; clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances; restore reflective surfaces to their original reflective condition; leave concrete floors broom-clean; vacuum carpeted surfaces; wipe surfaces of mechanical and electrical equipment; remove excess lubrication and other substances; clean plumbing fixtures to a sanitary condition; clean light fixtures and lamps; clean the site, including landscape development areas, of rubbish, litter and other foreign substances; sweep paved areas broom-clean; remove stains, spills and other foreign deposits; and rake unpaved and unplanted grounds to a smooth even-textured surface.
- (d) Engage a licensed exterminator to conduct an inspection and rid the Project of rodents, insects, and other pests, as necessary.
- (e) Remove temporary facilities installed for protection of the Project work during construction.
- (f) The Contractor shall not burn waste materials, bury debris or excess materials on the State's property or discharge volatile, harmful or dangerous materials into drainage systems. The Contractor shall remove waste materials from the site and dispose of lawfully.
- (g) The Contractor shall not leave partial or full containers of materials, such as paints and solvents, other than those specified in the Contract, on the Project site. Such materials shall remain property of the Contractor and be removed from State property at the completion of the Project.

1.20-1.08.13—Termination of the Contractor's Responsibility:

1. Utility Services: At the issuance of the Certificate of Compliance or at an earlier date if directed by the Engineer, the Contractor shall request in writing that permanent utility services be placed in the Department's name. The Contractor's written request shall include the following information: account number, meter number, exact street address, and, if applicable, the Certificate of Compliance date. Within 7 calendar days of the receipt of the Contractor's written request, the Department will notify the utility providing the service that it will accept billing. The Department will not accept billing of any utility service until the Certificate of Compliance has been issued, unless the Engineer establishes an earlier date in writing.

2. Spare Parts: The Contractor shall review the Contract and prepare a list of acceptable material to be turned over to the State at the completion of the Project for review and concurrence by the Engineer.

The Contractor shall provide a material safety data sheet with all required items to comply with OSHA requirements.

The Engineer will not accept partially used and open items such as paints and solvents.

1.20-1.08.14—Acceptance of Project:

1. Record Documents: The Contractor shall submit all documents required by Article 1.20-1.05.05 to the Engineer prior to the date of the Semi-Final Inspection.

2. Operation and Maintenance Manuals: Prior to the date of the Semi-Final Inspection, the Contractor shall compile operation and maintenance manuals in the form of instructional manuals for use by the owner. The Contractor shall organize said manuals into suitable sets of manageable size and, where possible, assemble instructions for similar equipment into a single binder.

Where 2 or more binders are necessary to accommodate data, the Contractor shall cross-reference other binders where necessary to provide essential information for proper operation or maintenance of the piece of equipment or system.

For each manual, the Contractor shall:

- (a) Provide heavy-duty, commercial-quality, 3-ring, vinyl-covered, loose-leaf binders, thick enough to accommodate contents, sized to receive 8-1/2-inch x 11-inch (216-millimeter x 279-millimeter) paper.
- (b) Identify the binder's contents on binder's front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter covered, and volume number for multiple volume sets.
- (c) Organize each manual into sections, separated by a heavy paper divider with a tab marked to indicate the contents of the section.
- (d) Provide a title page as the first sheet of each manual with the following information: subject matter covered by the manual; Contract number and title; date of submittal; name, address, and telephone number of the Contractor; and cross-reference to related systems in other sections.

(e) Provide a typewritten table of contents for each volume, arranged systematically according to the organization of the Contract provisions (including specific CSI-formatted specifications within a particular Special Provision).

(f) Provide a general information section immediately following the table of contents, listing each product included in the manual, identified by product name. The Contractor shall list the name, address, and telephone number of the subcontractor, the maintenance contractor, and the local source for replacement parts and equipment for each product.

(g) Include manufacturer's standard printed data and mark each sheet to identify each part or product included in the Project, identify each product using appropriate references from the Contract, and delete references to information that is not applicable. The use of project record documents as part of operation and maintenance manuals is not permitted.

(h) Prepare typewritten text to provide operation and maintenance information when the manufacturer's standard printed data is not available or printed data is insufficient and the information is necessary for proper operation and maintenance of equipment or systems, organize text in a consistent format under separate headings for each procedure, and provide a logical sequence of instruction for each operation or maintenance procedure.

(i) Provide drawings where necessary in order to supplement manufacturer's printed data to illustrate the relationship of component parts of equipment or systems or to provide control or flow diagrams. Where oversized drawings are necessary, the Contractor shall fold drawings to the same size as text pages and use as a foldout. If the drawings are too large to be used practically as a foldout, the Contractor shall place the folded drawing in a 8-1/2-inch x 11-inch (216-millimeter x 279-millimeter) labeled pre-punched envelope or sleeve, and place it with the manufacturer's printed data. The Contractor shall coordinate these drawings with information contained in project record drawings to ensure correct illustration of the completed installation. The use of project record documents as part of operation and maintenance manuals is not permitted.

Material and Finishes Maintenance Manual: The Contractor shall provide:

(a) Manufacturer's data and instructions on care and maintenance of architectural products, including applied materials and finishes.

(b) Complete information on architectural products, including the following, as applicable: manufacturer's catalog number, size, material composition, color, texture, and re-ordering information for specially manufactured products.

(c) Information (including cleaning schedule) on care and maintenance, including manufacturer's recommendations for types of cleaning agents and methods of cleaning, and methods of cleaning that could prove detrimental to the product.

(d) Complete manufacturer's data with instructions on inspection, maintenance, and repair of products exposed to the weather or designed for moisture-protection purposes.

(e) Manufacturer's data giving detailed information, including the following, as applicable: identification of relevant industry standards, chemical composition, installation details, inspection procedures, maintenance information, and repair procedures.

Equipment and Systems Maintenance Manual: The Contractor shall provide:

(a) A complete description of each unit and related component parts, including the following: name of manufacturer, model number and serial number, equipment or system function, operating characteristics, limiting conditions, performance curves, and engineering data and test results.

(b) The following for each unit and related component part: assembly drawings and diagrams required for maintenance, complete list of parts and supplies with current unit prices (identify which items are recommended to be stocked as spare parts and identify which items have an anticipated ordering and delivery time greater than 10 days), complete list of distributors and authorized repair facilities, and telephone numbers for technical service.

(c) Information detailing essential maintenance procedures, including the following or information about the following: routine operations; troubleshooting guide; disassembly, repair, and reassembly; alignment, adjusting, and checking; a list of any special tools required.

(d) Information on equipment and system operating procedures, including the following: startup procedures, equipment or system break-in, normal operating instructions, regulation and control procedures, instructions for shutdown and emergencies, summer and winter operating instructions, required sequences for electric or electronic systems, and special operating instructions.

(e) A schedule of routine servicing and lubrication requirements, including a list of required lubricants for

equipment.

(f) As-installed control diagrams for systems requiring controls.

(g) Contractor's coordination drawings of as-installed piping and other systems, color-coded as needed for identification.

(h) Charts of valve tag numbers, with the location and function of each valve (clearly mark as such any valve intended for emergency shut-off or similar special use).

(i) Complete circuit directories of panelboards, including designations of the following: electric service, controls, and communication.

3. Training: The Contractor shall use experienced instructors thoroughly trained and experienced in operation and maintenance of Project equipment and systems, in order to instruct the owner's operation and maintenance personnel.

The Contractor shall (1) arrange for each installer of equipment that requires regular maintenance to meet with the owner in order to provide instruction in the proper operation and maintenance of any equipment that requires regular maintenance, (2) provide instruction by manufacturer's representatives if installers are not experienced in any relevant procedures, (3) provide instruction at agreed-upon times, and (4) provide Engineer with a minimum of 72 hours advance notice of the training sessions.

The Contractor shall (1) use the operation and maintenance manuals for each piece of equipment or system as the basis of instruction, (2) review contents of operation and maintenance manuals in detail in order to explain all aspects of operation and maintenance, and (3) provide such instruction for operation of equipment during any and all seasons of operation.

SECTION 2.01 CLEARING AND GRUBBING

2.01.01—Description: This work shall consist of clearing the ground of trees, stumps, brush, rubbish and all objectionable material in accordance with these specifications or as directed by the Engineer. This work shall also include the clearing of the ground necessary for the construction and installation of drainage, structures, ditches, channels, fences and other appurtenances. Included in this work shall be the preservation from injury or defacement of vegetation and objects designated to remain.

2.01.03—Construction Methods: The Contractor shall mark all trees, shrubs and plants to be removed in accordance with the plans and these specifications. The Engineer shall have 7 days to field review the markings and make any adjustments prior to the start of the clearing operation. Within the excavation lines all trees shall be cut off and stumps removed to a depth of not less than 12 inches (300 millimeters) below the graded surface.

Within the fill lines where an embankment is to be made not more than 5 feet (1.5 meters) in depth, trees, stumps, roots, etc., shall be removed. Where the embankments to be made exceed 5 feet (1.5 meters) in depth, trees, stumps, roots, etc., shall be cut off to within 6 inches (150 millimeters) of the ground surface.

In areas where clearing is necessary for the construction and installation of various appurtenances, all trees and stumps shall be cut flush with the ground; and all dead or uprooted trees, brush, roots or otherwise objectionable material shall be removed as directed unless otherwise indicated on the plans.

Prior to clearing operations, a meeting must be held. Those attending the meeting should include the Contractor, the Engineer, the designer, local tree warden or equivalent, and the District Environmental Coordinator. All clearing issues shall be resolved to the satisfaction of the Engineer before any trees are cut.

All trees scheduled to be removed outside of the proposed gutter or curblines shall be visibly marked or flagged by the Contractor at least seven days prior to cutting of such trees.

The Engineer will inspect the identified trees within 7 days of the marking of the trees and verify the limits of clearing and grubbing prior to the Contractor proceeding with his cutting operation.

All branches of trees extending within the roadway shall be trimmed as directed to provide a 16-foot (5-meter) minimum vertical clearance including selective trimming of such trees as directed.

The Contractor shall dispose of all such trees, stumps, brush, etc., in a satisfactory manner and shall remove all rubbish and refuse from within the highway limits.

All excavations made below subgrade surface by the removal of trees, stumps, etc., shall be filled with suitable material, which shall be compacted thoroughly in accordance with the provisions governing formation of embankments.

All fences, stonewall fences and ornamental and utilitarian domestic accessories, such as, but not limited to garden pools, arbors, stair railings, fireplaces, sheds and incinerators, within the highway limits shall be removed as directed. However, the removal of materials in stonewalls, that are to be removed and not used in a new stonewall fences, will be paid for according to the provisions of Section 2.02.

All road signs, mail boxes, etc., shall be removed and reset as directed.

2.01.04—Method of Measurement: When no price for "Clearing and Grubbing" is asked for on the proposal form, the cost of the work as described above shall be included in the cost of the grading items and no direct payment for "Clearing and Grubbing" will be made.

When a price is asked for on the proposal form on a lump sum basis, this shall include all the work as described above, which may be necessary to properly complete the project, unless the item is included under another project pay item.

Should the project be increased in length or the scope of work increased due to construction changes beyond the requirements hereinabove, any additional work required will be paid for as extra work. Should the project be decreased in length, a suitable credit, mutually agreed upon and based on the reduction in actual work or scope, will be taken by the State.

The work, material, tools, equipment and labor incidental to the disposal of trees, stumps, etc., will not be measured for payment.

2.01.05—Basis of Payment: Payment for this work will be at the contract lump sum for "Clearing and Grubbing," except as noted above, and shall include all equipment, tools and labor incidental to the completion of this item.

All costs incidental to the disposal of trees, stumps, etc., will be included in the price of "Clearing and Grubbing."

Pay Item
Clearing and Grubbing

Pay Unit
l.s. (l.s.)

**SECTION 2.02
ROADWAY EXCAVATION, FORMATION OF
EMBANKMENT AND DISPOSAL OF
SURPLUS MATERIAL**

2.02.01--Description

2.02.03--Construction Methods

2.02.04--Method of Measurement

2.02.05--Basis of Payment

2.02.01--Description: Roadway excavation shall consist of the removal and satisfactory disposal, in the manner herein required, of all material taken from within the limits of the work contracted for, the removal of which is necessary for the construction of the roadway, subgrade, shoulders, slopes, entrances, retaining walls, gutters, channels and other miscellaneous construction to the dimensions and limits shown on the plans or as ordered and shall include the necessary excavation for pervious structure backfill outside of structure excavation limits. It shall also include the formation of embankments, the disposal of surplus or unsuitable material, removal of old foundations, concrete or masonry walls, crib walls, bin walls, stone wall fences or farm wall fences and filling of cellar or other holes, and in the absence of such items in the contract, the clearing and grubbing and the shaping and cleaning of slopes and of shoulders.

Classification: Roadway excavation shall be classified for the purpose of payment as "Earth," "Rock," "Channel Excavation--Earth," or "Channel Excavation--Rock," in accordance with the following definitions. The classifications applying to any particular project shall be as indicated on the proposal form.

Earth Excavation shall include all materials removed as indicated or directed except water, "Rock," "Channel Excavation--Earth," and "Channel Excavation--Rock."

Rock Excavation shall include rock in definite ledge formation and boulders, or the portion of boulders, 1 cubic yard (cubic meter) or more, in volume.

Channel Excavation--Earth shall include all materials other than water or "Channel Excavation--Rock" removed from the existing new or temporary water courses as indicated on the plans or as directed.

Channel Excavation --Rock shall include rock in definite ledge formation and boulders of 1 cubic yard (cubic meter) or more in volume removed from existing, new or temporary water courses, as indicated on the plans or as directed.

2.02.03--Construction Methods: Excavation shall be made in conformity with the requirements of the plans and as ordered by the Engineer. The Contractor shall, when necessary in excavation areas, provide and maintain ditches which are adequate to prevent free water from becoming incorporated in material to be used to form embankments, such ditching to be at the sole expense of the Contractor. Where buildings have been removed to clear the way for construction or where old foundations, concrete or masonry walls exist, they shall be removed to 2 feet (600 millimeters) below the directed or finished grading; and all cellar and other holes shall be filled with suitable material.

1. Sod and other organic matter shall be disposed of as directed by the Engineer. In the event the Engineer does not direct the disposal of unsuitable material in conformance with Subarticle 2.02.03-8, the Contractor has the option of disposing of the unsuitable material as specified within Subarticle 2.02.03-10.

2. Frozen material, otherwise suitable for formation of embankments, shall be placed on embankment slopes or disposed of as directed by the Engineer. The Engineer may direct the removal of any portion of an accepted layer which has become frozen after placement and compaction. This frozen material shall be placed on embankment slopes or disposed of as directed by the Engineer. The removal and placement of frozen material shall be at the sole expense of the Contractor.

3. Topsoil shall be excavated within pavement and shoulder limits at grade points and to an elevation 3 feet (1 meter) below finish grade and elsewhere as directed. The material excavated may be used in the construction of embankments, if permitted by the Engineer, and shall be thus used if the Engineer so directs. In all cases, the use of topsoil in constructing embankments shall be restricted to locations where the surface of the underlying material is dry, its distance above the free water surface at the time of filling is more than 3 feet (1 meter), and its distance below finish pavement grade is more than 5 feet (1.5 meters).

4. Excavation of Rock: When rock is encountered, it shall be excavated to the slope lines and depths indicated on the plans.

The Contractor shall presplit the rock along the proposed rock slopes to the lines and inclinations shown on the plans except as otherwise provided in the specifications. Presplitting will be required where the backslope is designed at an inclination one (vertical) on one (horizontal) or steeper or where the cut in rock is ten feet (3

meters) or more, measured on the inclination of the proposed slope from the bottom of excavation to the natural surface of sound rock. The maximum vertical height of slope face which can be presplit at any one time shall be 50 feet (15 meters).

The presplitting holes shall follow the required rock slope lines and inclinations. Hole drilling shall commence only when solid rock is encountered and exposed to the satisfaction of the Engineer. Unless otherwise permitted by the Engineer, presplitting holes shall have a spacing of 3 feet (1 meter), center-to-center, and a diameter not greater than 3 inches (75 millimeters). The holes shall be extended from the top of solid rock surface to the toe of finished rock slope, unless lesser depths are specified on the plans. The proper angle of drilling shall be maintained at all times so all presplit holes lie essentially in the same plane and are paralleled to each other. No holes shall deviate more than 6 inches (150 millimeters) at any place in the plane of the specified slope line nor in its vertical alignment. If any cut is presplit by vertical stages (lifts), the presplit holes may be offset, for each stage, a distance not more than 24 inches (600 millimeters) inside the previously presplit face. Presplit holes shall be lightly loaded with a continuous column charge manufactured especially for presplitting. All space in each hole not occupied by the explosive charge shall be filled with clean stone chips less than 3/8 inch (9 millimeters) in size or approved equal. Charges near the top of hole shall be reduced sufficiently to eliminate overbreak and heaving. The top charge shall not be less than 3 feet (1 meter) below the top of the drill hole. The methods of detonation shall be such that a uniform plane of rupture of the rock occurs from top to bottom and between presplit holes. If necessary, the Contractor shall adjust the methods as outlined above so as to result in a uniform plane of rupture in the rock.

Unless otherwise approved by the Engineer, presplit holes shall be drilled at least 50 feet (15 meters) ahead of, and shall be detonated prior to the drilling and blasting, the general pattern holes within the section of any lift of rock to be excavated. The presplitting shall be performed so as to produce a uniform plane of rupture in the rock such that the resulting rock face will not be affected by subsequent blasting and excavation operations.

In the general pattern, blasting following presplitting operations, no portion of any blast hole shall be drilled closer than 4 feet (1.2 meters) to the presplit face. No portion of any blast hole larger than 3 inches (75 millimeters) in diameter shall be permitted closer than 12 feet (3.5 meters) to the presplit face. The spacing of blast holes, distribution and type of explosives, methods of detonation, and the blasting techniques shall be adjusted by the Contractor according to the characteristics and structure of the rock encountered so as not to fracture the rock beyond the presplit face.

Prior to any blasting, the Department will call a blasting conference at which the Contractor shall be represented to determine the methods to be used and the required protection to insure the utmost safety during blasting operations. The Contractor shall be responsible for all damage due either directly or indirectly to such operation.

The Contractor shall schedule his operations so that all rock excavation within a distance of 100 feet (30 meters) of bridge or other large structures, or any portion thereof, is completed to the required slope lines and depths before any structure work is started.

All loose and unstable material, even if located beyond the payment lines, and all breakage and slices shall be removed as directed and as the excavation for each vertical stage (lift) progresses. It shall be, at all times, the responsibility of the Contractor to perform all phases of this work to produce the required rock slope faces to the satisfaction of the Engineer.

Where indicated on the plans or as ordered by the Engineer, rock shall be excavated without the use of explosives. Excavation methods by the use of drilling, splitting, wedging or other approved methods not involving the use of explosives shall be utilized. The method selected by the Contractor shall allow excavation to the slope line(s) and depth(s) as shown on the plans and shall not affect in any way the material or structures outside the excavation line or grade.

5. Placement of Embankment Material: All excavated material and reclaimed waste obtained within the limits of the project shall be used in the formation of embankments, except as provided elsewhere herein or as ordered by the Engineer.

Overhaul will not be allowed; but excavated material shall be transported where directed, provided the designated point of deposit is not more than 100 yards (100 meters) beyond the limits of the work contracted for, unless stated otherwise in the special provisions or plans.

When embankments are to be constructed on slopes steeper than 1 vertical to 3 horizontal, the slope of the existing ground on which the embankment is to be placed shall be plowed deeply or cut into steps before the filling is begun.

Embankments shall be constructed of earth, rock, reclaimed waste or a mixture thereof containing no more than 2% by weight (mass) of asphalt cement. The embankment shall be constructed by depositing successive

layers of fill for the full width of the embankment, unless a partial width is permitted by the contract documents or by the Engineer. If glass and/or clinker are included in reclaimed waste, their individual particles shall be no larger than 1 inch (25 millimeters) in size. Glass and/or clinker shall be thoroughly mixed with other embankment materials such that their content anywhere in the embankment shall not exceed 25% by weight (mass), with the exception that material placed within 5 feet (1.5 meters) from the face of the slope shall be free of glass and clinker. No embankment layer shall be deposited on surfaces of snow or ice, nor shall it be placed on frozen or unstable surfaces except under the conditions permitted elsewhere herein. If the Contractor is permitted to continue work, he shall remove, at no cost to the State, any frozen embankment material unless otherwise directed by the Engineer.

The depth of each layer, before compaction, shall not exceed 12 inches (300 millimeters) except as permitted hereinafter by these specifications, or with the permission of the Engineer.

The embankment shall be crowned or pitched to provide drainage at the close of each day's operations.

Where filling in 12-inch (300-millimeter) layers is impracticable, as in the case of filling in water or over slopes too steep for the operation of equipment, the embankment may be constructed in one layer to the minimum elevation at which equipment can be operated, as determined by the Engineer; and above this elevation, the embankment shall be constructed as specified herein.

Embankments to an elevation 3 feet (1 meter) above the free water surface at the time of filling, shall be constructed of rock or free-draining material, or a mixture of both. Free-draining material shall conform to the requirements of Article M.02.07.

In fills where the top of the proposed pavement will be less than 4 feet (1.2 meters) above an existing flexible pavement, and the existing pavement is not required to be removed, it shall be scarified as directed by the Engineer.

In fills where the top of the proposed pavement will be less than 3 feet (1 meter) above an existing concrete pavement, including all bituminous resurfacing thereon, the concrete pavement shall be removed.

In fills where the top of the proposed pavement will be between 3 and 4 feet (1 meter and 1.2 meters) above an existing concrete pavement, the concrete pavement shall be broken in such a manner that complete fractures are obtained. Intact fragments, undamaged after breaking, shall not be larger than 2 square feet (0.2 square meters).

When present pavement not in cut or fill is removed, as called for on the plans or directed, the area shall be backfilled with a suitable earth material which shall be free from admixture of subsoil, refuse, stumps, roots, rocks, brush, weeds and other material which will prevent the formation of a suitable seed bed.

Wherever portions of existing concrete pavement are to be removed, such removals shall be made to neat lines. The areas in which such concrete surfaces are to be removed will be delineated by the Engineer before such work is done. Where no break or joint exists in the concrete pavement at the line of delineation, a kerf, at least 2 inches (50 millimeters), but no more than 3 inches (80 millimeters) deep, shall be made in the concrete with an approved concrete cutting saw. The concrete shall then be removed from within the delineated area exercising extreme care to avoid "breakbacks" beyond the kerf, break or joint. Concrete pavement remaining in place shall have vertical edges, and that portion below the kerf shall be reasonably smooth.

Wherever portions of existing bituminous concrete pavement are to be removed, they shall be removed to neat lines as shown on the plans or as directed by the Engineer. Where the delineated limits of the areas in which such bituminous surfaces are to be removed are adjacent to existing bituminous concrete pavement that is to remain in place, the line of delineation shall be cut by a method approved by the Engineer.

When the embankment material consists predominantly of rock fragments and/or fragments of reclaimed waste of such size that material cannot be placed in horizontal layers of the thickness specified above without crushing or further breaking down the pieces resulting from the excavation methods, such material may be placed in the embankments in horizontal layers not exceeding 3 feet (1 meter) in thickness. Large stones or fragments of reclaimed waste shall not be placed in nests but shall be distributed over the area; and the interstices shall be filled with spalls, finer fragments or earth to form a solid, compact mass.

The entire area of each layer shall be leveled off by suitable grading equipment and shall be compacted as hereinafter specified.

In portions of embankments where piles are to be driven, the Contractor shall not place any material which might interfere with pile driving operations. The correction of any condition which interferes with the pile driving operations in embankments constructed under the contract shall be made by the Contractor at no cost to the State.

No rock fill or reclaimed waste containing fragments over 12 inches (300 millimeters) in their greatest dimension shall be placed above an elevation which is 2 feet (600 millimeters) below the top of the embankment.

No particle over 5 inches (130 millimeters) in its greatest dimension shall be placed within 12 inches (300 millimeters) of the elevation of the top of the prepared subbase unless otherwise specifically authorized.

Prior to the formation of any embankment, the Contractor may submit a plan in a form acceptable to the Engineer for grading operations detailing the location of embankment material sources and points of deposit for the entire project in order to qualify for payment for overhaul as hereinafter provided. Failure to submit such a plan will be construed as a waiver of any and all rights to payment for overhaul.

6. Compaction: The entire area of each layer of the embankment and the subgrade in the excavated areas shall be uniformly compacted to at least the required minimum density by use of compaction equipment consisting of rollers, compactors or a combination thereof. Earth-moving and other equipment not specifically manufactured for compaction purposes will not be considered as compaction equipment.

The dry density after compaction shall not be less than 95% of the dry density for that soil when tested in accordance with AASHTO T 180, Method D. Each layer of the embankment and the subgrade shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

7. Stability: If after full compliance with the requirements of these specifications with regard to excavation, placement and compaction density requirements, a stable embankment or subgrade has not been obtained, the Contractor shall proceed to perform such corrective work as is necessary to produce a stable embankment or subgrade. This work may include, but not necessarily be limited to control of moisture to within limits suitable for obtaining the required stability; blending with rock or granular material from any project excavation or borrow, or free draining material or any combination thereof; removal and replacement with acceptably compacted material or a combination of these methods approved by the Engineer. Any of the foregoing methods may be supplemented by suspending embankment operations and allowing the material to dry.

When embankments are constructed of material from Project excavation and the Engineer determines that the material properly compacted is not sufficiently stabilized, the cost of corrective measures directed by the Engineer shall be paid for at applicable contract unit prices, or in the absence thereof, as extra work.

If the corrective work on embankments constructed of Project excavation is necessary, and requires departure from the plan for grading operations to obtain material at locations other than shown on the aforementioned plan which result in increased net costs to the Contractor, such increased costs will be paid as extra work, except that no payment will be made for overhaul for any corrective material for the first 1/2 mile (1 kilometer) of increased hauling distance.

When embankments are constructed of borrow, they shall be stable. In this case however, the methods and material used to obtain such stability shall be determined by the Contractor and performed at his expense.

8. Surplus Excavated Material: All surplus excavated material shall be used where directed by the Engineer, to uniformly widen embankments, to flatten slopes, to fill low places in the right of way, or for such other purposes as the Engineer may direct, provided the area designated for deposit does not conflict with Subarticle 2.02.03-5.

Any surplus or unsuitable material not required, nor permitted to be used for such purposes, shall be disposed of in accordance with Subarticle 2.02.03-10.

9. Fences: The Contractor shall erect either the permanent or temporary fence, to the satisfaction of the Engineer, at all points where the land is used for pasturing and where the existing fences are affected by the grading operations. Permanent or temporary fences shall be erected prior to the removal or destruction of any part of the existing fence, and any temporary fence erected shall be removed when no longer required. There will be no direct payment for any temporary fence erected, but the cost thereof shall be considered as included in the cost of the grading operations; permanent fences will be paid for at the contract unit price for this item.

10. Disposal of Unsuitable Material: When the Engineer has not directed otherwise, the Contractor has the option to dispose of unsuitable excavated material by one or both of the following methods:

- (a) By removing such material from within the limits of the highway and disposing of such material at point or points as the Contractor shall determine provided this does not create any detrimental effects to the project and the Engineer does not object to the area selected for disposal.
- (b) By disposing of such material within the limits of the highway in accordance with the details and requirements shown on the plans and the following requirements:

Not less than 15 days prior to disposing of any such material within project limits, the Contractor shall submit to the Engineer for his approval a proposal delineating the locations and extent of the areas in which he intends to dispose of such material. The proposal shall describe the nature of the material and the methods to be employed in placing and covering the material. The proposal will be reviewed for its effects on the completed

construction and the environment. The proposal shall be amended as required by the Engineer. No such material shall be disposed of within project limits until the proposal has been approved by the Engineer.

All work shall be done in accordance with the approved proposal.

Suitable material excavated for the disposal of the unsuitable excavated material shall be placed in the embankment in accordance with the requirements of Section 2.02 or shall be used to cover the unsuitable excavated material.

The State does not guarantee nor imply that the areas available for disposal of unsuitable excavated material within project limits will be adequate for the disposal of all unsuitable excavated material to be removed. The Contractor shall dispose of all unsuitable excavated material in excess of that which can be placed within the permitted areas.

11. Slopes: Earth slopes with a degree of slope from 2:1 to 5:1 shall be tracked unless the Engineer directs that they shall not be tracked. Tracking shall consist of traversing the slopes with cleated tracks so that the cleat indentations are horizontal. Where topsoil is to be placed on slopes, the tracking shall be done prior to the installation of the topsoil.

Tracking is not to be construed to be used for slope compaction. Its sole purpose is to provide indentations in the slope to help reduce soil erosion. Other methods of achieving the desired results may be used, with the permission of the Engineer.

2.02.04--Method of Measurement: Payment lines for earth excavation shall coincide with the slope and subgrade lines or the top of the payment lines for ditch excavation, whichever applies, as shown on the plans or as ordered.

Payment lines for unsuitable material excavation shall be the area designated by the plans, special provisions or the Engineer as unsuitable material below the subgrade in cut sections, below the original ground line in fill sections and beyond the normal payment lines for ditch and channel excavation.

Unsuitable material within the slope and subgrade lines or the top of the normal payment lines for ditch and channel excavation shall be measured as earth excavation, ditch excavation or channel excavation.

Any stockpiling, drying or re-excavation necessary to utilize such material on the project shall not be measured for payment, but shall be included in the payment for unsuitable material.

Also measured for payment shall be the volume of earth moved in cutting or plowing of steps on steep slopes, as described in Article 2.02.03, and the removal of existing flexible pavement where shown on the plans or ordered by the Engineer.

The stockpiling, re-excavation and final placement of material will not be measured for payment, unless such has been made a part of the contract or unless the State has created conditions different from those that existed or could have been foreseen or anticipated when the contract was bid.

Payment limits for Channel Excavation--Earth shall coincide with the side slopes and bottom of channel as shown on the plans or as directed.

Payment lines for Channel Excavation-Rock shall coincide with the depth shown on the plans or to the depth ordered. Payment lines for slopes will be extended to a limit of 12 inches (300 millimeters) outside of and parallel to the slope lines shown on the plans, or as ordered, to include rock actually removed within this limit. In case of natural faults or fissures which make the removal of additional rock necessary for reasons of safety, or which produce slides clearly not attributable to the Contractor's method of operation, the slope payment lines will be fixed to coincide with the natural faults or fissures of the rock.

Payment lines for rock excavation, where presplitting bedrock is required by these specifications, will extend to the slope and depth line shown on the plans or as directed, to include only the rock actually removed within this limit.

Payment lines for rock excavation, where presplitting bedrock is not required by these specifications, shall coincide with the depth shown on the plans or to the depth directed; and payment lines for the slopes will be extended to a limit of 1 foot (300 millimeters) outside of and parallel to the slope lines shown on the plans, or as directed, to include rock actually removed within this limit. Where removal of rock is necessary for reasons of safety or due to conditions clearly not attributable to the Contractor's method of operation, the payment lines will be fixed to coincide with limits ordered by the Engineer.

Presplitting of bedrock performed in accordance with these specifications will not be measured for payment.

Where removal of rock is necessary for reason of safety or due to conditions clearly not attributable to the Contractor's methods of operation, the payment lines for rock excavation where presplitting is required will be fixed to coincide with limits ordered by the Engineer. Payment lines for Rock Excavation (No Explosives), where mechanical means of removal are required by these specifications, will extend to the slope and depth line(s) shown on the plans or as directed, to include only the rock actually removed within these limits.

Concrete and masonry foundation walls, or portions thereof, to be removed will be measured for payment by the volume in cubic yards (cubic meters), in place, before removal.

Existing concrete pavement and concrete base over 5 square yards (4 square meters), including any bituminous surfacing material immediately thereon, shall be measured in place before removal.

Existing concrete and cement masonry structures over 1 cubic yard (1 cubic meter), shall be measured in place before removal.

When rock is encountered, and its removal is to be paid for as "Rock Excavation" or "Channel Excavation--Rock," the Contractor shall strip or expose the rock to such an extent that in the Engineer's opinion the necessary measurements can be taken. The Contractor shall notify the Engineer at least two days prior to disturbing any of the rock to allow ample time to obtain the necessary measurements. If the Contractor shall fail to give such notice, or remove any rock prior to the taking of the measurements, the Engineer shall presume that measurements taken at the time he first sees the material in question will give a true quantity of excavation.

The amount of excavation will be determined by the method of average end areas.

The work of scarifying existing pavement will not be measured for payment, but the cost shall be considered as included in the general cost of the contract.

The work of cutting concrete pavement will be measured for payment by the number of linear feet (meters) of saw cut made with an approved concrete saw to the lines delineated by the Engineer on the concrete pavement.

The cutting of bituminous concrete pavement will be measured for payment by the number of linear feet (meters) of cut made by an approved method to the lines delineated on the plans or as directed by the Engineer. Cuts made necessary by the Contractor's operation, such as, but not limited to, patching, bituminous concrete samples, continuance of previous runs, faulty work or faulty materials shall not be measured for payment. Bituminous driveways and parking areas are considered as bituminous concrete pavement.

The work, materials, tools, equipment and labor incidental to the disposal of unsuitable excavated material or breaking concrete pavement will not be measured for payment.

2.02.05--Basis of Payment: Roadway excavation will be paid for at the contract unit price per cubic yard (meter) for "Earth Excavation," "Rock Excavation," "Rock Excavation (No Explosives)," "Channel Excavation--Earth," or "Channel Excavation--Rock" as the case may be, in accordance with the classification given herein and subject to the method of measurement described above. The price shall include all equipment, tools and labor incidental to the completion of the excavation, the formation and compaction of embankments, and the disposal of surplus or unsuitable material in accordance with the provisions of the plans and of these specifications.

The removal of concrete pavement or concrete base will be paid for at the contract unit price per square yard (square meter) for "Removal of Concrete Pavement," including any bituminous surfacing material immediately thereon.

The removal of concrete or cement masonry structures over 1 cubic yard (cubic meter), other than retaining walls or bridge structures, will be paid for at the contract unit price per cubic yard (cubic meter) for "Rock Excavation" or "Unclassified Excavation," as the case may be.

The removal of drainage structures outside of the limits of Roadway and Structure Excavation will be paid for under the "Trench Excavation" items.

Concrete and masonry foundation walls or portions thereof ordered removed will be paid for at the contract unit price per cubic yard (cubic meter) for "Rock Excavation" or "Unclassified Excavation," as the case may be.

The removal of retaining walls and bridge substructures will be paid for under the item "Removal of Existing Masonry."

The removal of crib walls, bin walls, stone wall fences or farm wall fences will be paid for as Earth Excavation.

The removal of all pavement or pavement bases other than concrete will be paid for at the contract unit price per cubic yard (cubic meter) for "Earth Excavation."

The work of cutting concrete pavement will be paid for at the contract unit price per linear foot (meter) for "Cut Concrete Pavement" including any bituminous surfacing material immediately thereon, which price shall include all materials, equipment, tools and labor incidental thereto.

The work of cutting bituminous concrete pavement will be paid for at the contract unit price per linear foot (meter) for "Cut Bituminous Concrete Pavement" which price shall include all materials, equipment, tools and labor incidental thereto.

Unsuitable material excavation outside of the limits of earth, unclassified, ditch and channel excavation will be paid for at the contract unit price per cubic yard (cubic meter) for "Unsuitable Material Excavation", which price shall include all equipment, tools, labor and material incidental thereto.

All costs incidental to the disposal of unsuitable excavated material will be included in the price for "Earth Excavation."

When no item for "Channel Excavation--Rock" appears in the proposal and rock, conforming to the description given under "Channel Excavation--Rock" in Article 2.02.01 is encountered in the channel excavation, the rock so encountered and removed will be classified and treated as "Channel Excavation--Rock," and its removal will be paid for at 300% of the contract unit price per cubic yard (cubic meter) for "Channel Excavation--Earth."

All costs incidental to breaking concrete pavement will be considered as being included in the general cost of the contract.

Pay Item	Pay Unit
Rock Excavation (No Explosives)	c.y. (cu. m)
Earth Excavation	c.y. (cu. m)
Rock Excavation	c.y. (cu. m)
Channel Excavation--Earth	c.y. (cu. m)
Channel Excavation--Rock	c.y. (cu. m)
Cut Concrete Pavement	l.f. (m)
Cut Bituminous Concrete Pavement	l.f. (m)
Removal of Concrete Pavement	s.y. (s.m)
Unsuitable Material Excavation	c.y. (cu. m)

SECTION 2.03 STRUCTURE EXCAVATION

2.03.01—Description

2.03.03—Construction Methods

2.03.04—Method of Measurement

2.03.05—Basis of Payment

2.03.01—Description: With the exceptions noted below, structure excavation shall include the removal of all material of whatever nature, the removal of which is necessary for the construction of foundations of bridges, box culverts, retaining walls outside the earth excavation payment limits, and other structures shown on the plans; the placing of all necessary fill with the exception of pervious structure backfill hereinafter specified; and the wasting of excavated material which is not required for backfilling or embankment, or which is unsuitable for that purpose.

This item shall also include dewatering; the design and construction of all cofferdams and related environmental controls used in dewatering operations required for the execution of the work; the repair, reconstruction and removal of cofferdams and related environmental controls used in dewatering operations; and the removal of all obstructions necessary for the construction of cofferdams. However, dewatering and the construction of a cofferdam will not be required under any structure excavation item for any foundation or structure that has an item for "Cofferdam and Dewatering" shown on the plans and in the proposal estimate for a given location. In such instances, the provisions of Section 2.04 shall govern for the items described in 2.03.05 (b) below.

"Structure Excavation—Earth" or "Structure Excavation—Rock" are defined as follows:

1. "Structure Excavation—Earth" shall include removal of all materials, other than water or "Structure Excavation—Rock."

2. "Structure Excavation—Rock" shall include the removal of rock in definite ledge formation; boulders or portions of boulders that have a volume of 1 cubic yard (cubic meter) or greater; and masonry structures of 1 cubic yard (cubic meter) or more in volume, except retaining walls and bridge substructures, the removal of which is covered by Section 9.74.

2.03.03—Construction Methods:

1. Dimensions and Elevations of Footings: The elevations of the bottom of footings, as shown on the plans, shall be considered as approximate only; and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

2. Preparation of Foundations: All rock or other suitable foundation material shall be cleared of all overlying material, cleaned and cut to a firm surface, either level, stepped or serrated, as directed by the Engineer. All seams shall be cleaned out and filled with concrete, mortar or grout. Any over-breakage in rock more than 6 inches (150 millimeters) below the plan grade for the bottom of the footing not authorized by the Engineer shall be replaced by the Contractor with Class "A" concrete at the Contractor's expense.

When the structure is to rest on a material other than rock, special care shall be taken not to disturb the material below the bottom of the excavation; and the final removal of the foundation material to grade shall not be made until just before the forms for concrete or masonry are placed. Any foundation material disturbed below plan grade or revised plan grade shall be dressed and compacted at the Contractor's expense. This shall not apply, however, when a granular fill foundation course is required.

3. Cofferdams: If a cofferdam is required under this item, it will be designed and constructed in accordance with the provisions of 2.04.03—1 and 3.

4. Dewatering: If a cofferdam is required under this item, dewatering will be performed in accordance with the provisions of Subarticle 2.04.03—2.

5. Inspection: After each excavation is completed, the Contractor shall notify the Engineer; and no construction shall be started until the Engineer has approved the depth of the excavation and the character of the foundation material.

6. Fill Adjacent to Structures: All spaces excavated and not occupied by the abutments, piers, other permanent work or pervious structure backfill shall be filled to the surface of the surrounding ground with suitable material. Such backfill shall be thoroughly compacted and neatly graded.

Fill placed around arches, rigid frames, box culverts and piers shall be deposited on both sides of the structure to approximately the same elevation at the same time.

Each layer of backfill shall be spread to a thickness not exceeding 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted by the use of power rollers or other motorized

vehicular equipment, by tamping with mechanical rammers or vibrators, or by pneumatic tampers. Any equipment not principally manufactured for compaction purposes or which is not in proper working order in all respects shall not be used within the area described above.

Special attention shall be given to compaction in places close to walls where motorized vehicular compaction equipment cannot reach. Within 3 feet (1 meter) of the back face of walls and within a greater distance at angle points of walls, each layer of backfill shall be compacted by mechanical rammers, vibrators or pneumatic tampers.

The dry density of each layer of backfill after compaction shall not be less than 95% of the dry density for that material when tested in accordance with AASHTO T180, Method D. In conducting this test, material retained on the 3/4-inch (19-millimeter) sieve size shall be replaced with material retained on the No. 4 (4.75- millimeter) sieve, as noted as an option in the specifications for this test.

Adequate provision shall be made for the drainage of all fill in accordance with the provisions of the plans, or as ordered by the Engineer.

Each layer of backfill shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

No fill shall be placed against any structure until the Engineer has given permission to do so, and in no case until after the permitted time for removal of forms.

2.03.04—Method of Measurement: The Contractor shall notify the Engineer before starting any excavation, so that elevations and the measurements of the excavation area may first be obtained. When ledge rock is encountered, the Contractor shall notify the Engineer and shall strip or expose the rock to such an extent that in the Engineer's opinion the necessary measurements can be taken for "Structure Excavation—Rock." If the Contractor fails to give such notice or notices, or removes any material prior to the taking of measurements, the Engineer may presume that measurements taken at the time he first saw the material in question indicates the true quantity of excavation.

Vertical payment limits will be measured for payment as follows:

1. Structure Excavation—Earth will be measured in place by taking the difference in elevation between the existing ground surface or the bottom of roadway excavation or channel excavation, whichever is lower, and the surface of the completed structure excavation at plan grade or approved revised plan grade.

Structure excavation in roadway cuts, or embankment areas where the removal of unsuitable material is indicated on the plans, shall include only the portion below the bottom of the unsuitable material or subbase, if any, or the subgrade, shoulder foundation or cut slope lines, as the case may be or as may be more specifically shown on the plans.

2. Structure Excavation—Rock will be measured in place by taking the difference in elevation between the existing ledge rock or bottom of roadway excavation or channel excavation, whichever is lower, and the bottom of the actual completed and accepted structure excavation, except that any excavation to a depth greater than 6 inches (150 millimeters) below the plan grade or revised plan grade, will not be measured for payment.

Horizontal payment limits for "Structure Excavation—Earth" and "Structure Excavation—Rock" will be measured between plumb lines 2 feet (600 millimeters) outside of the neat lines of the original foundations only, unless otherwise shown on the plans and unless the size of the footing is increased more than 2 feet (600 millimeters) in length or width (or both), in which case the area of the excavation that extends beyond the original contract payment limits, will be used for determining the additional amount of excavation.

2.03.05—Basis of Payment: Payment for this work will be made at the Contract unit price per cubic yard (cubic meter) for:

(a) **Structure Excavation—Earth (complete) or "Structure Excavation—Rock (complete),"** whichever applies, in whole or in part, which price shall include all materials, tools, and equipment; all work related to cofferdams, including their design, construction, dewatering, repair, removal of obstructions, and any required reconstruction; all labor necessary to complete the excavation in conformity with the requirements of the plans or as ordered by the Engineer; the preparation of foundations as described under Article 2.03.03; all necessary filling, except as otherwise provided in the Contract; and the removal of all surplus or unsuitable material resulting from the excavations. Any suitable surplus material shall be placed in the embankments, if so ordered by the Engineer, without additional compensation.

(b) **"Structure Excavation—Earth (excluding Cofferdam and Dewatering)" or "Structure Excavation—Rock (excluding Cofferdam and Dewatering),"** whichever applies in whole or in part, which price shall include all materials, tools, equipment and labor necessary to complete the excavations in

conformity with the requirements of the plans or as ordered by the Engineer. It shall also include the preparation of foundations as described under Article 2.03.03, the necessary filling, except as otherwise provided in the Contract, and the removal of all surplus or unsuitable material resulting from the excavations. Any suitable surplus material shall be placed in the embankments, if so ordered by the Engineer, without additional compensation.

Should it become necessary to change the dimensions of the footings from those shown on the plans or to excavate below the elevation shown on the plans, payment will be made in accordance with the following provisions:

1. The length or width (or both) may be increased horizontally not more than 2 feet (600 millimeters) and the depth of excavation increase not more than 2 feet (600 millimeters) without change in the unit price as specified above.
2. If the depth of the excavation is increased more than 2 feet (600 millimeters), but not more than 10 feet (3 meters) below the original plan grade, payment for excavation below an elevation 2 feet (600 millimeters) below the elevation shown on the plans and within the horizontal payment limits as specified above, will be at the contract unit price plus 100% thereof.
3. When the size of the footing is increased horizontally more than 2 feet (600 millimeters) in length or width, or both, excavation actually required outside the horizontal payment limits defined above will be paid for at the contract unit price plus 100% thereof.
4. In the event the depth of the excavation has to be increased to a depth greater than 10 feet (3 meters) below the original plan elevation, the excavation actually made below the 10-foot (3-meter) limit will be considered extra work and will be paid for in accordance with Article 1.04.05.

Pay Item	Pay Unit
Structure Excavation—Earth (complete)	c.y. (cu. m)
Structure Excavation—Rock (complete)	c.y. (cu. m)
Structure Excavation—Earth (excluding Cofferdam and Dewatering)	c.y. (cu. m)
Structure Excavation—Rock (excluding Cofferdam and Dewatering)	c.y. (cu. m)

SECTION 2.04
COFFERDAM AND DEWATERING

2.04.01—Description: Work under this item shall consist of the design and construction of cofferdams as and where shown and specifically designated as such on the plans; necessary dewatering, adjustments, repair or reconstruction; and the removal of temporary cofferdams and related facilities.

2.04.03—Construction Methods:

1. Cofferdams: Cofferdams shall be carried to adequate depths and heights, shall comply with Section 1.10, and shall be safe and watertight as necessary for the proper performance of the work which must be done inside them. Cofferdams shall be constructed so that the work can be safely carried to an elevation 2 feet (600 millimeters) lower than the elevation shown on the plans for the bottom of the structure footing, or, if a granular fill foundation is shown on the plans, to an elevation 2 feet (600 millimeters) lower than the bottom of the granular fill foundation. The interior dimensions of the cofferdams shall be sufficient for the unobstructed and satisfactory completion of all necessary substructure work, such as pile driving, form building, inspection and pumping. Cofferdams which become tilted or displaced prior to the completion of all work to be done within them, shall be righted, reset, or enlarged as may be necessary to provide the clearance for the unobstructed performance of all necessary work, and such corrections and adjustments of cofferdams shall be at the sole expense of the Contractor. Cofferdams shall be completely dewatered as required to complete the work entirely in the dry, except as specified below.

When conditions are encountered that render it impractical to dewater the cofferdam, the Engineer may require the placing of underwater concrete of such dimensions as will be necessary to allow the Contractor to complete the substructure in the dry. The placement of underwater concrete shall comply with 6.01.03-10.

Cofferdams must be constructed to protect uncured masonry and concrete against damage from a sudden rising of the water and prevent damage to structure foundations by erosion. No part of the cofferdam which extends into the substructure may be left in place without written permission from the Engineer.

At least 30 calendar days prior to the start of constructing or installing a cofferdam, the Contractor shall submit to the Engineer, for his information, detailed plans and computations of its proposal prepared by a professional Engineer licensed in the State. The furnishing of such plans and methods shall not serve to relieve the Contractor of its responsibility for the safety of the work and the successful completion of the Project. The Contractor's proposal must meet all requirements established in regulatory permits for the Project and must also conform to the requirements of Section 1.10.

2. Dewatering: Pumping from the interior of any cofferdam shall be done in such a manner as to preclude the possibility of water moving through uncured masonry or concrete. During the placement of concrete or masonry, and for at least 24 hours thereafter, any pumping shall be done from a suitable sump located outside the horizontal limits and below the elevation of the work being placed or as directed by the Engineer.

The pumped water must be discharged in accordance with the requirements of Section 1.10.

Pumping to dewater a cofferdam shall not start until any underwater concrete has sufficiently set to withstand the hydrostatic pressure created by pumping.

3. Removal of Cofferdams: Unless the Engineer directs otherwise, the Contractor shall remove all parts of the cofferdam after completion of the required work. This shall be done in such a way as not to disturb or otherwise damage any permanent construction.

Sheet piling used in constructing the cofferdam may be left in place with the approval of the Engineer, provided the piling is cut off at elevations approved in advance by the Engineer, and the cut off portions are removed from the site.

2.04.04—Method of Measurement: Work under this item will be measured for payment by the number of linear feet (meters) of cofferdam designated numerically on the plans.

2.04.05—Basis of Payment: Payment for this work will be made at the Contract unit price per linear foot (meter) for "Cofferdam and Dewatering," measured as described above, which price shall include all costs of design, materials, equipment, labor, work, and any related environmental controls used in dewatering operations, which are required for the construction of cofferdams shown in the plans; of any repair, correction, adjustment or reconstruction of such cofferdams required by the plans; removal of obstructions; pumping and dewatering; removal of such cofferdams and related environmental controls used in dewatering operations.

If the Engineer requires the Contractor to construct an additional cofferdam not shown on the plans, or to enlarge a cofferdam beyond the dimensions of same as designated on the plans, or if the Engineer accepts

the Contractor's proposal to do so as being essential for the purposes of the Contract, the Department will revise the Contract to indicate those changes and to designate the revised dimensions of cofferdam deemed necessary by the Engineer. If the total number of linear feet (meters) of any given cofferdam as designated in the revised Contract is greater than the number of such feet (meters) as designated on the original Contract plans, the Department will pay the Contractor for the revised number of such linear feet (meters) at the Contract unit price, subject to the provisions of Articles 1.04.02 and 1.04.03.

To the extent that the Engineer allows the addition or enlargement of a cofferdam for the convenience or other benefit of the Contractor, but does not deem that addition or enlargement essential for the performance of the Contract work, the Department will make no additional payment for the cofferdam or portion of the cofferdam which the Engineer does not so deem essential. The Department shall not in any event pay the Contractor for fewer linear feet (meters) of a cofferdam than were designated on the original Contract plans unless the Department eliminates that cofferdam in its entirety from the Contract.

Even if, however, the Contractor's plan for an additional cofferdam or enlargement of a cofferdam deemed essential by the Engineer includes a previously-existing structure, in no case will a previously-existing natural or built structure, such as an abutment or an embankment, be measured for payment in calculating the revised number of linear feet (meters) of cofferdam on the Project.

Any common cofferdam wall required for staged construction will be measured for payment only once. In no case will a given length or portion of cofferdam be measured for payment purposes more than once.

Pay Item	Pay Unit
Cofferdam and Dewatering	l.f. (m)

**SECTION 2.05
TRENCH EXCAVATION**

2.05.01--Description

2.05.03--Construction Methods

2.05.04--Method of Measurement

2.05.05--Basis of Payment

2.05.01--Description: Trench excavation shall consist of the removal and satisfactory disposal of all materials, the removal of which is necessary for the proper completion of the work, to the dimensions shown on the plans or as ordered, and backfilling, all in accordance with these specifications for the following:

- 1) The construction of pipe culverts, endwalls, catch basins, drop inlets, manholes, underdrains and outlets, sewers, service pipes.
- 2) The removal of drainage structures and appurtenances beyond the limits of roadway and structure excavation.
- 3) The removal of miscellaneous items such as abandoned underground tanks, pipelines, etc.

Classification:

- (1) **Trench excavation** will be allowed only for the construction of the structures and the removals definitely specified above; and no compensation will be made for any other class of excavation, as specified elsewhere herein, that may be necessary for construction or removal.
- (2) **Rock in Trench:** Rock, insofar as it applies to trench excavation, shall be defined as rock in definite ledge formation, boulders, or portions of boulders, cement masonry structures, concrete structures, Portland cement concrete pavement or base, of 1/2 cubic yard (0.5 cubic meters) or more in volume, removed as indicated or directed from within the payment lines for trench excavation.

2.05.03--Construction Methods: Trench excavation shall be made in conformity with the requirements of the plans or as ordered. The Contractor shall furnish and employ such shores, braces, pumps, etc., as may be necessary for the protection of property, proper completion of the work and the safety of the public and employees of the Contractor and the Department. All bracing, etc., shall be removed when no longer required for the construction or safety of the work.

When a drainage structure is to be eliminated, it shall be completely removed and all pipes plugged with cement masonry or removed completely.

Where the plans or contract documents show that a drainage structure is to be abandoned, the structure shall be removed to a depth 2 feet (600 millimeters) below the subgrade or to the depth shown on the plan. The floor of the structure shall be broken and all pipes shall be plugged with cement masonry.

Wherever portions of existing concrete pavement that would otherwise remain in place must be removed in conjunction with trench excavation, such removals shall be made to neat lines. The areas in which such concrete pavements are to be removed will be delineated by the Engineer before such work is done. Where no break or joint exist in the concrete pavement at the line of delineation, a full depth cut shall be made in the concrete with a concrete cutting saw approved by the Engineer. The concrete shall then be removed from within the delineated area, exercising extreme care to avoid "breakbacks" beyond the sawcut or joint. Concrete pavement remaining in place shall have vertical edges.

Wherever the concrete pavement to be removed has been overlaid with bituminous concrete and the adjacent bituminous concrete pavement is to remain in place, the bituminous pavement shall be removed to a neat line that is 1 foot (300 millimeters) beyond the neat line for the concrete pavement removal.

Wherever portions of existing full-depth bituminous concrete pavement are to be removed in conjunction with trench excavation, they shall be removed to neat lines. Where the limits of the areas in which such bituminous pavement is to be removed are adjacent to existing bituminous concrete pavement that is to remain in place, the limits shall be cut by a method approved by the Engineer.

After the excavation is completed, the Contractor shall notify the Engineer; and no masonry, pipe or other material shall be placed in the excavated area until the Engineer has approved the depth of excavation and the character of the foundation material.

When backfilling is required, the material used shall be of a quality satisfactory to the Engineer and shall be free from large or frozen lumps, wood and other extraneous material. All backfill shall be placed in layers of not more than 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted by means of mechanical rammers or vibrators or by pneumatic tampers. Hand tampers shall be used only upon written permission of the Engineer. Unless otherwise ordered by the Engineer, the backfill shall be brought to the surface of the surrounding ground and neatly graded.

All suitable material removed in making the excavation shall be used for backfill if required. All surplus or unsuitable material shall be removed and disposed of as directed. Should additional material be required for backfilling, it may be obtained from the any Project excavation or from borrow pits, gravel pits, or elsewhere as the Engineer may direct.

Each layer of backfill shall be compacted to optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

Fill placed around pipes shall be deposited on both sides to approximately the same elevation at the same time. Rock fill or stones larger than 2 inches (50 millimeters) shall not be placed closer than 2 feet (600 millimeters) from the pipes on the sides as well as the top.

No backfill shall be placed against any structure until permission shall have been given by the Engineer.

2.05.04--Method of Measurement: Except as noted below, trench excavation will be measured in its original position by taking the difference between the ground surface at the time the trench is excavated and that after the excavations are complete. Before starting any excavation, the Contractor shall notify the Engineer so that elevations and measurements of the work may be obtained. Any work done prior to such notification will not be paid for.

Trench excavation in roadway cuts shall include only that portion outside of the limits of roadway excavation and will not include open ditches.

Payment limits shall be as described hereinafter.

There will be no measurement for payment for the cost of plugging existing pipes.

Horizontal Payment Limits: Except as noted below for installations of pipe and pipe arches, fabricated from structural plates, payment lines shall be vertical for pipe culverts, pipe-arches, sewers, and service pipes, and shall be the width to which the material is actually removed, except that in no case, even though the actual excavation is wider, shall the width between payment lines be more than the following:

- (a) 2 feet (600 millimeters) greater than the nominal inside diameter of circular pipe, or nominal inside span of elliptical pipe or pipe-arch for such diameters or spans of less than 30 inches (750 millimeters).
- (b) 3 feet (900 millimeters) greater than the nominal inside diameter of circular pipe or the nominal inside span of elliptical pipe or pipe-arch for such diameters or spans that are 30 inches (750 millimeters) or greater.

For pipes and pipe-arches, fabricated from structural plates specified in Subarticle M.08.01-5, payment lines shall be vertical and between the actual horizontal limits to which the material is removed except that in no case shall the width between payment lines be more than 4 feet (1.2 meters) greater than the nominal inside diameter or nominal horizontal inside span.

For endwalls, manholes, drop inlets and catch basins, payment lines shall be vertical and 2 feet (600 millimeters) outside of the neat lines of the foundations in each direction horizontally.

In case it is necessary to excavate to a greater width than that specified above on account of the removal of existing structures, such additional excavation will be considered as trench excavation and will be measured and paid for as such.

For the removal of underground obstructions such as pipelines, tanks, drainage structures, etc., payment lines shall be vertical and 2 feet (600 millimeters) outside of the underground item measured horizontally in each direction.

If rock is encountered, the Contractor shall strip it of sufficient overlying material to allow for proper measurement and shall then notify the Engineer that the rock surface is ready for measurement. If the Contractor shall fail to give such notice, the Engineer shall presume that the measurements taken at the time he first saw the material in question will give the true quantity of excavation.

Vertical Payment Limits: Where pipe bedding is used, the lower vertical payment limit shall be as shown on the plans. There will be no direct payment for the excavation necessitated by the shaping of the bedding, but the cost shall be included in the cost per linear foot (meter) for the pipe culvert specified.

The upper vertical payment limit shall be that prescribed below; except, when in the opinion of the Engineer, roadway excavation cannot be made prior to or simultaneously with the trench excavation, then the upper vertical payment limit will be the surface existing at the time the trench excavation is made.

Vertical Payment Limits Other Than in Fills; Payment lines will extend vertically from the bottom of the trench to the bottom of the roadway excavation.

If trench excavation is not located within the limits of roadway excavation, payment lines will extend vertically from the bottom of the trench to the existing ground surface.

Vertical Payment Limits in Fills: For the various drainage installations, the vertical payment lines shall extend from the bottom of the completed and accepted trench to the lowest of the following upper limits:

- a. Bottom of subbase.
- b. In the case of culverts, 1 foot (300 millimeters) above the top of the pipe.
- c. In the case of drainage structure other than culverts, 1 foot (300 millimeters) above the top of the uppermost culvert pipe placed in the structure.
- d. In the case of culvert installations transverse to the roadway extending down fill slopes, the vertical payment limit will be the depth below bottom of loam or embankment surface, as the case may be, and measured perpendicular to the bottom of the trench.

Vertical payment limits shall be as described above except that in no case shall the depth measurement used for payment be greater than that actually excavated.

If gravel fill or borrow are used for trench backfill, they will be measured in place within the payment limits described herein.

Trench excavation will not be measured for payment for resetting manholes, catch basins, drop inlets, junction boxes or utility structures and appurtenances, but the cost will be included in the payment for the specified reset item.

The work of cutting concrete pavement and cutting bituminous concrete pavement shall be measured in accordance with Article 2.02.04.

2.05.05--Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for "Trench Excavation 0 feet - 4 feet (0 meters - 1.2 meters) Deep," "Trench Excavation 0 feet - 10 feet (0 meters - 3 meters) Deep," "Trench Excavation 0 feet - 15 feet (0 meters - 4.5 meters) Deep" or "Trench Excavation 0 feet - 20 feet (0 meters - 6 meters) Deep," as the case may be.

When rock, conforming to the description given under Article 2.05.01 is encountered within the payment lines for trench excavation, its removal will be classified and paid for at the contract unit price per cubic yard (cubic meter) for "Rock in Trench Excavation 0 feet - 4 feet (0 meters - 1.2 meters) Deep," "Rock in Trench Excavation 0 feet - 10 feet (0 meters - 3 meters) Deep," "Rock in Trench Excavation 0 feet - 15 feet (0 meters - 4.5 meters) Deep," or "Rock in Trench Excavation 0 feet - 20 feet (0 meters - 6 meters) Deep," as the case may be.

Those portions of trench excavation classified and paid for as "Rock in Trench Excavation" of the various depths will be the actual volumes of rock excavated within the payment lines at the applicable bottom depth price. Those portions of trench excavation above the rock will be the actual volume of earth excavated within the payment lines at the applicable bottom depth for rock in trench.

Where no item or items for "Rock in Trench Excavation" at the applicable depth appear in the proposal and rock is encountered in trench excavation, its removal will be paid for as follows:

In trench excavation 0 feet - 4 feet (0 meters - 1.2 meters) deep, at 500% of the contract unit price for "Trench Excavation 0 feet - 4 feet (0 meters - 1.2 meters) Deep."

In trench excavation 0 feet - 10 feet (0 meters - 3 meters) deep, at 400% of the contract unit price for "Trench Excavation 0 feet - 10 feet (0 meters - 3 meters) Deep."

In trench excavation 0 feet - 15 feet (0 meters - 4.5 meters) deep, at 300% of the contract unit price for "Trench Excavation 0 feet - 15 feet (0 meters - 4.5 meters) Deep."

In trench excavation 0 feet - 20 feet (0 meters - 6 meters) deep at 150% of the contract unit price for "Trench Excavation 0 feet - 20 feet (0 meters - 6 meters) Deep."

When payment is made for trench excavation in fill, no such excavation will be classified as "Rock in Trench."

Excavation necessary for the removal of pipe culverts, or other installations, described herein, will be paid for as trench excavation at the applying depth.

The above prices shall include all materials, tools, equipment and labor necessary to complete the excavation in conformity with the plans or as ordered. They shall also include backfilling where required and the disposal of surplus material. No additional payment will be made for shoring, bracing, pumping, bailing or for material or equipment necessary for the satisfactory completion of the work. When it becomes necessary, in the opinion of the Engineer, to install sheet piling for the support of existing facilities, pavement, utilities, or for other constraints, the sheeting items will be paid for in accordance with Section 7.13, 7.14 or 7.15.

If gravel fill or borrow are used for trench backfill, payment will be made at their respective contract unit prices, or in the absence of such items in the contract, as extra work.

There will be no direct Payment for the plugging of existing pipes, or for the breaking up of floors in drainage structures being abandoned, but the cost thereof shall be included in the contract unit prices of the drainage and excavation items.

Payment for the work of “Cut Concrete Pavement” and “Cut Bituminous Concrete Pavement” will be made in accordance with Article 2.02.05 except that the cut made in the bituminous concrete overlay 1 foot (300 millimeters) beyond the neat line for concrete pavement removal is not included under “Cut Concrete Pavement” and will be paid for as “Cut Bituminous Concrete Pavement”.

Pay Item	Pay Unit
Trench Excavation 0' - 4' (0-1.2 m) Deep	c.y. (cu. m)
Trench Excavation 0' - 10' (0-3 m) Deep	c.y. (cu. m)
Trench Excavation 0' - 15' (0-4.5 m) Deep	c.y. (cu. m)
Trench Excavation 0' - 20' (0-6 m) Deep	c.y. (cu. m)
Rock-in-Trench Excavation 0' - 4' (0-1.2 m) Deep	c.y. (cu. m)
Rock-in-Trench Excavation 0' - 10' (0-3 m) Deep	c.y. (cu. m)
Rock-in-Trench Excavation 0' - 15' (0-4.5 m) Deep	c.y. (cu. m)
Rock-in-Trench Excavation 0' - 20' (0-6 m) Deep	c.y. (cu. m)

**SECTION 2.06
DITCH EXCAVATION**

2.06.01—Description: Ditch excavation shall consist of the removal and satisfactory disposal of all materials except water, the removal of which is necessary for the construction of drainage ditches, paved ditches, and paved leak-offs, except as noted below. Not included herein is excavation for gutters and channels.

2.06.03—Construction Methods: Ditch excavation shall be made in conformity with the requirements of the plans or as ordered by the Engineer. The excavated material shall be removed from the area adjoining the excavation and the suitable excavated material used in the embankments, unless otherwise directed by the Engineer. Unsuitable materials shall be disposed of as directed. The top of the banks of the ditches shall be graded and left in a neat and acceptable condition.

2.06.04—Method of Measurement: Ditch excavation will be measured according to conditions and between the limits set forth in the following:

1. Drainage Ditches (unpaved):

- (a) Within normal cut slopes, excavation will be measured under Section 2.02.
- (b) On fill slopes, between the surface of the embankment and the bottom of the excavation.
- (c) In areas other than (a) and (b), next above, between the original ground surface and that after excavation is completed.

2. Paved Leak-offs and Paved Ditches:

- (a) Within normal cut slopes, between the limits of the top of paved surface and the bottom of the base course.
- (b) Within normal fill slopes, between the surface of the embankment and the bottom of the base course.
- (c) Outside of cut or fill slopes, between the ground surface and that after the excavation is completed.

Before starting any excavation, the Contractor shall notify the Engineer so that elevations and measurements of the work may be obtained. Any work done prior to such notification will not be paid for.

If rock conforming to the description given under Article 2.05.01 is encountered, the Contractor shall strip it of sufficient overlying material to allow for proper measurement. The Contractor shall notify the Engineer at least 2 days prior to disturbing the rock that the rock surface is ready for measurement. If the Contractor shall fail to give such notice, or remove any rock prior to the taking of such measurement, the Engineer shall presume that the measurements taken at the time he first saw the material in question will give the true quantity of excavation.

2.06.05—Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for "Ditch Excavation" or "Rock in Ditch Excavation," whichever may apply in whole or in part. These prices shall include all equipment, tools and labor necessary to complete the work, dispose of the excavated material and leave the site in a neat and workmanlike condition.

When no item for "Rock in Ditch Excavation" appears in the contract and rock conforming to the description given under Article 2.05.01 is encountered in ditch excavation, its removal will be paid for at 500% of the contract unit price per cubic yard (cubic meter) for "Ditch Excavation."

Pay Item	Pay Unit
Ditch Excavation	c.y. (cu. m)
Rock in Ditch Excavation	c.y. (cu. m)

SECTION 2.07 BORROW

2.07.01—Description: When the amount of usable material excavated within the limits of the work contracted for is not sufficient to form the embankments and other features of the work, additional material shall be furnished by the Contractor from borrow pits obtained by him at his expense and located beyond the limits of the highway. This material shall be known as borrow. Borrow shall include the furnishing, removing and satisfactory placing of the additional material necessary to complete the embankments and other features of the work.

Stockpiled hydraulically dredged and/or reclaimed waste material containing no more than 25% of glass or clinker by weight (mass) and no more than 2% by weight (mass) of asphalt cement may be used for part or all borrow requirements. Stockpiles shall be placed at locations arranged for and provided by the Contractor at his expense and will not be allowed within the highway limits except at locations and under conditions stipulated by the Engineer. All permits, easements, rights or other requirements related to dredging and stockpiling shall be the obligation and responsibility of the Contractor.

2.07.02—Materials: Borrow, excluding hydraulically dredged borrow, shall conform to all the requirements of Article 2.02.03 for performance when incorporated in embankments. For purposes other than embankments, it shall be of a satisfactory quality as determined by the Engineer for the purpose intended. Hydraulically dredged borrow shall contain not more than 20% by dry weight (mass) of material passing the No. 200 (75-micron) sieve when placed in the embankment.

2.07.03—Construction Methods: Borrow will be permitted only to the extent necessary to complete the embankments and similar details and only after all usable material from the excavation has been placed. With the approval of the Engineer, the Contractor may be permitted to place borrow before the excavation is completed; but he will be held responsible for the proper placing of all suitable excavated material, and no payment will be allowed for any borrow placed in lieu of suitable excavated material. This permission may be revoked by the Engineer at any time if in his opinion satisfactory progress is not maintained on other operations.

The Contractor shall notify the Engineer at least 5 days prior to obtaining material from any borrow pits so that an examination may be made of the fitness of the material and so that the necessary measurements may be taken. The limits of the proposed borrow pit shall be shown to the Engineer; and prior to the taking of measurements, the Contractor shall be required to clear the area of all unsuitable material. No payment will be made for any material removed outside of the area measured or which was not used in the work. No excavation shall be made within the confines of a borrow pit after the engineers have taken their original measurements, other than for material to be used in the formation of embankments or elsewhere as shown on the plans or as directed by the Engineer; except that material may be taken for contract items other than borrow with the permission of the Engineer under terms and conditions set forth in writing.

If the Contractor elects to obtain borrow from a commercial pit, it will be necessary for him to have a section of the pit set off for his use solely, so that the amount of material removed may be accurately determined. During the period between the original and the final measurements and release by the Engineer, no material shall be taken from a measured borrow pit except by the Contractor—and by him only—for use in the work under this contract. Borrow pits shall be excavated to regular lines as staked, so as to permit accurate measurements, and shall be drained and left in a neat condition as directed.

If the Contractor elects to obtain borrow from a stockpile of reclaimed waste, he shall obtain approval from the Engineer prior to removing any material from the stockpile to the job site. Once the stockpiles have been tested and approved, no additional material shall be added to them.

If the Contractor uses hydraulically dredged material, he shall, at his expense, employ effective dust control measures so that the public will not be adversely affected by dust from stockpiled material or such material in transit. The Contractor shall also provide and maintain at his expense effective and adequate drainage for all dredging and stockpiling operations at all times, and he shall be solely responsible for all damages which result from dredging and stockpiling and for the continuing maintenance and final restoration of all drainage facilities affected by his operations.

Stockpiles of hydraulic material shall be reserved for exclusive use of the State and be placed so as to be readily measured, and no area shall be reused for stockpiling prior to its being re-measured by the Engineer. Dredging to a stockpile and removing material there from simultaneously is expressly prohibited.

Borrow shall be placed where directed and in accordance with the provisions for the formation of embankments of Article 2.02.03.

2.07.04—Method of Measurement: Except as provided under (a), (b), (c), (d) and (e) below, the amount

of borrow to be paid for will be determined by the average end area method, from the results of cross-sectional elevations taken before and after the borrow material has been excavated from the pit or stockpile. Measurements of stockpiles will not be taken until they are firm and can be measured safely and accurately.

(a) If, in the opinion of the Engineer, cross-sections of the stockpiled hydraulically dredged material will not indicate the true volume removed for borrow, supplementary measurements will be taken. This may involve the use of settlement platforms, trenches, test holes or other methods or any combinations thereof. The data so derived will be applied in the adjustment of the computation of the quantity for payment.

(b) At the request of the Engineer or with the written permission of the Engineer, borrow may be measured by the cubic contents of the vehicles used for transportation less a 10% shrinkage factor for earth or less an agreed upon shrinkage factor for rock to be determined by the Engineer.

(c) At the request of the Engineer or with the written permission of the Engineer, borrow may be weighed (measured by mass) and such weight (mass) will be converted to cubic yard (cubic meters) on the basis of 3200 pounds per cubic yard (1900 kilograms/cubic meter).

(d) At the request of the Engineer or with the written permission of the Engineer, the volume of borrow used to construct embankment may be measured in place. The shrinkage factor for earth shall be 10%. The swell factor for rock shall be determined by the Engineer.

(e) At the request of the Engineer or with the written permission of the Engineer, the Contractor may remove material from the borrow pit for purposes other than the formation of embankments, in which event the method of adjusting borrow measurements will be stated in the authorization.

2.07.05—Basis of Payment: Payment will be at the contract unit price per cubic yard (cubic meter) for "Borrow" complete in place, which price shall include furnishing and placing the material and all equipment, tools and labor necessary thereto.

No payment will be allowed for "Borrow" until all excavation has been placed in embankments except under the following conditions: If the Contractor has secured the permission of the Engineer to place borrow before the excavation is complete, as provided for in Paragraph 1 of Article 2.07.03, payment for such borrow material may be made at the discretion of the Engineer, before completion of the excavation. A request for such payment shall be made by the Contractor in writing, and he shall certify therein that he waives payment for any borrow placed in lieu of suitable excavated material.

Deductions will be made from borrow measurements for any materials wasted from the cuts or placed in embankments outside of the cross-sections, except when unsuitable material is ordered wasted by the Engineer.

Pay Item

Pay Unit

Borrow

c.y. (cu. m)

SECTION 2.08
FREE-DRAINING MATERIAL

2.08.01—Description: Free-draining material shall consist of material conforming to the requirements stated elsewhere herein. This material shall be furnished and placed in accordance with these specifications and as indicated on the plans, special provisions, or as ordered by the Engineer for the stabilization or embankments, or for fill in free water areas, or wherever specified.

2.08.02—Materials: Material for this work shall meet the requirements of Article M.02.07.

2.08.03—Construction Methods: The Contractor shall notify the Engineer at least 3 days prior to obtaining free-draining material from any source so that an examination may be made of the material and the necessary measurements may be taken.

The limits of the proposed source shall be shown to the Engineer; and prior to the taking of measurements, the Contractor shall be required to clear the area of all unsuitable material. No payment will be made for any material removed outside of the area measured or which was not used in the contract work. No excavation shall be made within the confines of a source after the Engineer has taken the original measurements, except for material to be used for the purposes hereinbefore indicated, except with the permission of the Engineer.

The Contractor may, with the approval of the Engineer, obtain free-draining material, if available, from within the roadway excavation limits subject to the provisions of Article 1.04.07.

If the Contractor elects to obtain free-draining material from a commercial pit, it will be necessary for him to have a section of the pit set off for his use solely, so that the amount of material removed may be accurately determined. During the period between the original and the final release by the Engineer, no material shall be taken from a measured pit except by the Contractor and for use only in the work under the contract.

If the Contractor elects to use stone from a quarry or reclaimed miscellaneous aggregate, the Contractor shall use only the materials from stockpiles which have been approved for use.

Free-draining material will be permitted only to the extent necessary to construct embankments to 3 feet (1 meter) above free water, or to promote free drainage in areas specified on the plans, in the special provisions, or as directed by the Engineer.

Free-draining material shall be placed in accordance with the provisions for the formation of embankment of Section 2.02.

2.08.04—Method of Measurement: The amount of free-draining material to be paid for will be determined by the average end area method based on the results obtained from cross-sectional elevations taken before and after the free-draining material has been excavated.

When material is drawn from a quarry stockpile or stockpile formed from reclaimed miscellaneous aggregate, the material shall be weighed on scales furnished by and at the expense of the Contractor. The scales shall be of a type satisfactory to the Engineer and shall be sealed at the expense of the Contractor as often as the Engineer may require. All weighing (measurements of mass) shall be done in the presence of a representative of the Department. From the weight (mass) so obtained, the volume shall be computed based on a specific gravity of 2.92 for the aggregate and smaller particles. For material having a different specific gravity, an appropriate correction shall be made.

2.08.05—Basis of Payment: Payment will be made at the contract unit price per cubic yard (cubic meter) for "Free-Draining Material," complete in place, which price shall include furnishing and placing the material and all equipment, tools and labor necessary thereto.

Pay Item	Pay Unit
Free-Draining Material	c.y. (cu. m)

SECTION 2.09
SUBGRADE

2.09.01—Description: The area upon which the pavement structure and paved shoulders are placed, including the shoulder base courses and subbase, shall be known as the subgrade. This is the plane coincident with the bottom of the subbase and the edge of pavement, as shown on the plans and cross-sections or as ordered by the Engineer. The work of formation of subgrade shall be performed at this plane.

Where precast concrete barrier curb is to be permanently installed, the work of formation of subgrade shall be performed on the area under the precast concrete barrier curb.

Where shoulders are to be reconstructed and the existing subbase is to remain, the work of formation of subgrade shall be performed at the plane coincident with the surface of the existing subbase.

After all grading has been substantially completed and all drains laid, the subgrade shall be brought to the lines, grades and cross-sections shown on the plans.

When no item for "Clearing and Grubbing" and no grading items appear in the proposal, the work of clearing waterways, ditches, drainage structures and culverts, as described in Article 2.01.03, shall be performed as part of this work.

2.09.03—Construction Methods: All soft and yielding material and other portions of the subgrade which will not compact readily shall be removed and replaced with suitable material.

In cut areas, the surface shall be uniformly compacted by use of equipment specifically manufactured for that purpose. Rollers shall deliver a ground pressure of not less than 300 pounds per linear inch (52.5 newtons/millimeter) of contact width and weigh not less than 10 tons (have a mass of not less than 9100 kilograms). Vibratory units shall have a static weight of not less than 4 tons (mass of not less than 3650 kilograms). The amount of compactive effort shall be as directed by the Engineer, but in no case shall be less than four (4) complete passes of the compacting equipment being used.

The dry density after compaction shall be as specified in Subarticle 2.02.03-6.

Where more than one compacting unit is to be used, that unit which exerts the larger compactive effort shall make the initial passes. Any portion of the subgrade not accessible to larger compacting units shall be compacted, as directed by the Engineer, to a degree equal to that obtained on the other portions of the subgrade with equipment and by methods appropriate to the size of the inaccessible area.

After compacting, the subgrade shall be true to required line and grade. There will be no direct payment for any materials required to bring the subgrade to the line, grade and cross-section shown on the plans.

The Contractor shall protect the completed subgrade from damage by exercising such precautions as the Engineer deems necessary. The subgrade surface shall be maintained in such condition as to permit proper drainage. It shall be checked and approved by the Engineer prior to placing any pavement structure and shoulders thereon.

2.09.04—Method of Measurement: Payment lines for formation of subgrade shall be coincident with the outside edges of the pavement or where paved shoulders are constructed, with the outside edges of the shoulder. Where precast concrete barrier curb is permanently installed, payment shall include the area under the precast concrete barrier curb. Payment for formation of subgrade will be allowed when such work is done in providing connections to public roads. Payment for formation of subgrade will not be allowed for work at private drives, in areas where traffic bound gravel is constructed or in areas where existing pavement is used as a base for resurfacing with bituminous concrete.

The area computed for payment shall not include the area of any bridge floor where the type of construction is such as to eliminate any necessity for the work described herein.

2.09.05—Basis of Payment: Formation and protection of subgrade, including all work provided for hereinbefore, will be paid for at the contract unit price per square yard (square meter) for "Formation of Subgrade," which price shall include all materials, equipment, tools and labor necessary thereto.

There shall be no specific payment for the work of scarifying existing stone or gravel roads as described in Article 2.02.03, but the cost of such work shall be considered included in the payment for the item providing for the formation of subgrade.

When no item for "Formation of Subgrade" appears in the proposal, the cost of this work shall be included in the contract unit price for the pavement item or items involved.

Pay Item	Pay Unit
Formation of Subgrade	s.y. (s.m)

SECTION 2.10

WATER POLLUTION CONTROL (SOIL EROSION)

2.10.01—Description: This work shall consist of measures to control water pollution and soil erosion through the use of berms, dikes, dams, sediment basins, erosion control matting, gravel, mulches, grasses, slope drains, ditches, channels, riprap, grading to control surface runoff and other erosion control devices or methods.

If the Contractor proposes changes in construction or his scheduling which would affect the designed pollution controls, he shall submit plans before starting construction for revised pollution controls for the approval of the engineer.

The Contractor shall submit a plan showing erosion and sedimentation controls above and beyond those called for in the plans and/or specifications, necessitated by the proposed sequence of operations and/or construction activities. The construction shall not proceed until the erosion and sedimentation control plans have been approved by the Engineer. The Engineer may order additional control measures if the measures mentioned above prove insufficient.

2.10.02—Materials: The materials shall consist of items conforming to the pertinent articles of the Standard Specifications and approved by the Engineer, or other items approved by the Engineer, such as:

- (a) Soil tackifiers, erosion control matting, burlap, and plastic sheets. All materials shall be clean and free from noxious weeds, contaminants, and debris deleterious to plant growth. Erosion control matting shall conform to Sections 9.50 and M.13.
- (b) Slope drains or ditches may be constructed of pipe, rubble, riprap, sod, burlap, plastic sheets, portland cement concrete, bituminous concrete, or other material approved by the Engineer.
- (c) Seeding shall conform to Sections 9.50 and M.13.

2.10.03—Construction Method: The Engineer has the authority to control the surface area of earth material exposed by construction operations and to direct the Contractor to immediately provide permanent or temporary pollution control measured to prevent contamination of adjacent streams, watercourses, lakes, ponds or other areas of water impoundment. Every effort shall be made by the Contractor to prevent erosion on the site and abutting property.

All slopes shall be stabilized by mulching, seeding or otherwise protected as the work progresses to comply with the intent of this specification.

All seeding shall include mulch or other protective covering approved by the Engineer.

When hay is used as a mulch with seeding, it shall be a minimum of 2 inches (50 millimeters) deep and held down with a tackifier.

When wood fiber mulch is used, it shall be applied in a water slurry at a rate of 2000 pounds per acre (900 kilograms/4000 square meters) with or immediately after the application of seed, fertilizer and limestone.

All damaged slopes shall be repaired as soon as possible. The Engineer shall limit the surface area of earth material exposed if the Contractor fails to sufficiently protect the slopes to prevent pollution.

The Contractor shall at all times have on hand the necessary materials and equipment to provide for early slope stabilization and corrective measures to damaged slopes.

Temporary channels, ditches and outfalls shall be protected prior to directing water into them to prevent erosion.

The erosion control features installed by the Contractor shall be maintained by the Contractor, and he shall remove such installations if ordered by the Engineer. Maintenance of erosion control measures by the Contractor shall include the clean out of accumulated sediment.

The Contractor shall operate all equipment and perform all construction operations so as to minimize pollution. The Contractor shall cease any of his operations which will increase pollution during rain storms.

The Contractor shall give the Engineer sufficient notice of impending shutdowns to enable the Engineer and Contractor to examine the project and to implement erosion and pollution control work.

2.10.04—Method of Measurement: Measurement for payment of work and materials involved with the construction, application and installation of water pollution controls will be as provided for under the applicable contract items.

Temporary slope protection will be measured for payment by the number of square yards (square meters) of slope protected in accordance with this specification and as directed by the Engineer. When no applicable contract item appears in the proposal for any additional measures not shown on the plans, the additional work and materials required for those measures shall be measured for payment as provided for under Article 1.09.04 - Extra and Cost-Plus Work. All extra work performed on an agreed-price basis shall be incorporated through construction orders and paid for on an item-by-item basis.

The sum of money shown on the estimate and in the itemized proposal as "Estimated Cost" for this work will be considered the price bid even though payment will be made only for actual work performed. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded and the original price will be used to determine the total amount bid for the contract.

2.10.05—Basis of Payment: Work will be paid for under the applicable contract items or as provided for under Article 1.09.04 - Extra and Cost-Plus Work. No payment will be made for the clean out of accumulated sediment for either permanent or temporary erosion control measures.

Temporary control measures that are made necessary by the Contractor's negligence, carelessness, failure to install permanent controls as a part of the work as scheduled and are ordered by the Engineer, or are made necessary by the Contractor's failure to perform the sequence and scheduling of work as part of his schedule as given in the Preconstruction Conference or as later amended and approved, shall be ordered by the Engineer to be accomplished and performed by the Contractor at his own expense.

On areas off the right-of-way that are selected by the Contractor and which include but are not necessarily limited to borrow pits (other than commercially operated sources), Contractor's haul roads, disposal areas, storage, maintenance, batching areas, etc., temporary control work shall be the responsibility of the Contractor and shall be performed by him at his expense in a manner approved by the Engineer. No direct payment will be made for this work; the cost is to be included in other items of the Contract. Temporary control work on the aforesaid areas which are specifically designated for contractual operations by the State shall be paid for under the provisions of this specification.

Temporary slope protection will be paid for at the contract unit price per square yard (square meter) for "Temporary Slope Protection," which price shall include the installation and removal, where necessary, of the protective material and all equipment, materials, tools and labor incidental thereto.

Pay Item	Pay Unit
Water Pollution Control	est. (est.)
Temporary Slope Protection	s.y. (s.m)

SECTION 2.12

SUBBASE

2.12.01—Description: The subbase shall consist of a clean soil-aggregate mixture of bank or crushed gravel, crusher run stone, reclaimed miscellaneous aggregate containing no more than 2% by weight (mass) of asphalt cement or any combinations thereof, placed where shown on the plans or where directed by the Engineer and constructed in accordance with these specifications.

2.12.02—Materials: All materials for this work shall conform to the requirements of Articles M.02.02 and M.02.06. Grading "B" shall be used.

2.12.03—Construction Methods: The prepared foundation for the subbase shall be carefully shaped to the required cross-section and compacted as specified in Article 2.02.03. Where underdrains and outlets are specified on the plans or ordered by the Engineer, they shall be in place and functioning before any subbase material is placed.

The subbase material shall be spread uniformly upon the required grade, in courses not to exceed 6 inches (150 millimeters) in thickness after final compaction. However, if the required thickness of subbase does not exceed 8 inches (200 millimeters), it may be placed in one course.

After each course has been placed as specified above, its entire area shall be compacted with equipment specifically manufactured for that purpose. The sole use of hauling and spreading equipment shall not be considered as a substitute for compacting equipment. Compaction shall be continued until the entire course is uniformly compacted to the required minimum density. The dry density after compaction shall not be less than 95% of the dry density for that subbase material when tested in accordance with AASHTO T-180, Method D. If a subbase course is formed from reclaimed miscellaneous aggregate containing bituminous concrete, the wet density after compaction on this course shall not be less than 95% of the wet density for that subbase when tested in accordance with AASHTO T180, Method D.

Each layer of subbase shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

Exception to the use of compacting equipment will be allowed where subbase is made of gravel and used in conjunction with a traffic bound gravel surface in which case the work shall be in accordance with Article 4.13.03.

Should the foundation material beneath the subbase become churned up and mixed with subbase material at any time, the Contractor shall, without additional compensation, remove the mixture and replace it with new subbase material to the required thickness shown on the plans or as previously required by the Engineer. Such replaced subbase material shall be compacted to the required minimum density.

2.12.04—Method of Measurement: Subbase will be measured horizontally in place after final grading and compaction. The thickness will be as indicated on the plans, or as ordered by the Engineer, and within the following tolerances:

Less than 24 inches (600 millimeters): minus 1 inch (25 millimeters) to plus 3/4 inch (19 millimeters)

24 inches (600 millimeters) and greater: minus 2 inches (50 millimeters) to plus 1 inch (25 millimeters)

Measurements to determine the thickness will be made by the Engineer at intervals of 500 feet (150 meters), or less, along lanes and shall be considered as representative of the lane. For purposes of these measurements, a shoulder will be considered a lane.

If deficient thicknesses are found, the Engineer will make such additional measurements as he considers necessary to determine the longitudinal limits of the deficiency. Areas not within allowable tolerances shall be corrected, as ordered by the Engineer, without additional compensation to the Contractor.

2.12.05—Basis of Payment: This work will be paid at the contract unit price per cubic yard (cubic meter) for "Subbase," which price shall include all materials, equipment, tools and labor incidental thereto.

Pay Item

Pay Unit

Subbase

c.y. (cu. m)

**SECTION 2.13
GRANULAR FILL**

2.13.01—Description: This material shall be used as a foundation for structures, to replace unstable material in slopes, as a foundation for sidewalks and culverts, in shoulders and elsewhere as indicated on the plans, required by the specifications or ordered by the Engineer. It shall consist of gravel or reclaimed miscellaneous aggregate containing no more than 2% by weight (mass) of asphalt cement conforming to the requirements of these specifications.

2.13.02—Materials: Granular fill shall conform to the requirements of Article M.02.01

2.13.03—Construction Methods: When granular fill is used for foundation for structures or to replace rock or unsuitable material in trenches, it shall be deposited in layers not over 6 inches (150 millimeters) in depth, with each layer thoroughly compacted before the addition of other layers.

2.13.04—Method of Measurement: Granular fill will be measured in place after compaction within the payment lines shown or specified by the Engineer.

2.13.05—Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for "Granular Fill," complete in place, which price shall include all materials, tools, equipment and labor incidental thereto.

Pay Item	Pay Unit
Granular Fill	c.y. (cu. m)

SECTION 2.14

COMPACTED GRANULAR FILL

2.14.01—Description: Work under this item shall consist of furnishing and placing compacted granular fill as foundation for structures where shown on the plans or directed by the Engineer.

2.14.02—Materials: Gravel or reclaimed miscellaneous aggregate shall conform to the requirements of Article M.02.02. Admixtures and surface protective materials used to prevent the gravel from freezing must meet the approval of the Engineer.

2.14.03—Construction Methods: After all excavation has been completed, gravel or reclaimed miscellaneous aggregate shall be deposited in layers not exceeding 8 inches (200 millimeters) in depth over the areas. In exceptional cases, the Engineer may permit the first layer to be thicker than 8 inches (200 millimeters). Each layer shall be leveled off by the use of blade graders or bulldozers with adequate power for the work involved. The entire area of each layer shall be compacted by use of vibratory, pneumatic-tired or tread-type compaction equipment approved by the Engineer. Compaction shall be continued until the dry density over the entire area of each layer is not less than 95% of the dry density achieved by AASHTO T180, Method D. If a layer is formed from reclaimed miscellaneous aggregate containing bituminous concrete, the wet density after compaction on this layer shall not be less than 95% of the wet density for that compacted granular fill when tested in accordance with AASHTO T180, Method D.

Each layer of compacted granular fill shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

In this test, material retained on the 3/4-inch (19-millimeter) sieve shall be replaced with material retained on the No. 4 (4.75-millimeter) sieve, as noted as an option in the specifications for this testing.

The embankment adjacent to the compacted granular fill shall be placed simultaneously with the compacted granular fill, and at no time shall there be a difference of more than 2 feet (600 millimeters) in elevation of the two classes of material. The embankment material to be placed simultaneously with the compacted granular fill shall extend at least 20 feet (6 meters) in every direction beyond the limits of the compacted granular fill, except that where a narrower width is shown on the plans, such narrower width of material shall be placed as prescribed above.

2.14.04—Method of Measurement: Compacted granular fill will be measured in place after compaction, by the average end area method.

2.14.05—Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for "Compacted Granular Fill," complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

The cost of water and work involved in puddling, admixtures and protective materials shall be included in the contract unit price per cubic yard (cubic meter) for "Compacted Granular Fill."

Pay Item	Pay Unit
Compacted Granular Fill	c.y. (cu. m)

SECTION 2.16
PERVIOUS STRUCTURE BACKFILL

2.16.01—Description: Pervious structure backfill shall include the furnishing, placing, and compaction of pervious material adjacent to structures.

2.16.02—Materials: Pervious structure backfill shall conform to the requirements of Article M.02.05.

2.16.03—Construction Methods: Pervious structure backfill shall be placed adjacent to abutments, retaining walls, box culverts, and elsewhere as called for. It shall be placed above a plane extending on a 2 to 1 slope from the upper edge of the footing to the top of the embankment, or as shown on the plans. Where the face of undisturbed material is above or beneath this slope plane, the amount of pervious structure backfill shall be decreased or increased accordingly, if ordered by the Engineer.

In filling behind abutments, retaining walls, box culverts, or other structures, the fill is placed against undisturbed material, or against compacted embankments having a length in a direction at right angles to the abutment wall or culvert not less than twice the height of the structure against which the fill is placed. The slope of the embankment on which the pervious structure backfill is to be placed shall be plowed deeply or cut into steps before and during the placing of pervious structure backfill so both types of material will be thoroughly bonded and compacted.

Each layer of pervious structure of backfill shall be spread to a thickness not exceeding 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted as directed by the engineer by the use of power rollers or other motorized vehicular equipment, by tamping with mechanical rammers or vibrators, or by pneumatic tampers. Any equipment not principally manufactured for compaction purposes and equipment which is not in proper working order in all respects shall not be used within the area described above.

Special attention shall be given to compaction in places close to walls where motorized vehicular equipment cannot reach. Within 3 feet (1 meter) of the back face of walls and within a greater distance at angle points of walls, each layer of pervious structure backfill shall be compacted by mechanical rammers, vibrators, or pneumatic tampers.

The dry density of each layer of pervious structure backfill formed from broken or crushed stone, broken or crushed gravel or reclaimed miscellaneous aggregate free of bituminous concrete shall have a dry density after compaction that is no less than 100% of the dry density for that material when tested in accordance with AASHTO T180, Method D. If a layer formed from reclaimed miscellaneous aggregate containing bituminous concrete is placed as pervious structure backfill, the wet density of this layer after compaction shall not be less than 100 percent of the wet density for that material when tested in accordance with AASHTO T180, Method D.

In this test, material retained on the 3/4-inch (19-millimeter) sieve shall be replaced with material retained on the No. 4 (4.75-millimeter) sieve, as noted as an option in the specifications for this test.

Each layer of the pervious structure backfill shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

Where weep holes are installed, bagged stone shall be placed around the inlet end of each weep hole, to prevent movement of the pervious material into the weep hole.

2.16.04—Method of Measurement: Payment lines for pervious structure backfill shall coincide with the limits of the compacted pervious structure backfill as actually placed and ordered by the Engineer.

2.16.05—Basis of Payment: Pervious structure backfill will be paid for the contract unit price per cubic yard (cubic meter) for "Pervious Structure Backfill," complete in place.

Pay Item	Pay Unit
Pervious Structure Backfill	c.y. (cu. m)

SECTION 2.18
SEDIMENTATION CONTROL BALES

2.18.01—Description: This work shall consist of furnishing, placing, maintaining and removing hay bales for sedimentation control as shown on the plans or as directed by the Engineer. Maintaining shall include the clean-out of accumulated sediment.

2.18.02—Materials: Bales shall be made of hay with 40 pounds minimum weight (18 kilograms minimum mass) and 120 pounds maximum weight (54 kilograms maximum mass). Wood stakes shall be a minimum of 1 inch x 1 inch (25 millimeters x 25 millimeters) nominal size by a minimum of 3 feet (1.0 meters) long.

2.18.03—Construction Methods: Bales shall be placed by the Contractor in locations shown on the plans or as directed by the Engineer. They shall be placed lengthwise with ends of adjacent bales tightly abutting one another. All bales shall be installed so that bindings are oriented around the sides, rather than along the tops and bottoms. Bales shall be entrenched 4 inches (100 millimeters) and backfilled, with the backfilled soil placed toward the potential silt source. They shall be held in place by two wooden stakes in each bale, with loose straw inserted in voids between the bales. Bales shall be maintained or replaced until they are no longer necessary for the purpose intended or are ordered removed by the Engineer. Clean out of accumulated sediment shall be accomplished when one-half of the original height of the bales as installed becomes filled with sediment or as directed by the Engineer.

2.18.04—Method of Measurement: This work will be measured for payment by the actual number of linear feet (meters) of "Sedimentation Control Bales" installed and accepted. Measurement shall be made along the centerline of the bales. Replacement bales shall not be measured for payment.

2.18.05—Basis of Payment: Payment for this work will be made at the contract unit price per linear foot (meter) for "Sedimentation Control Bales" complete in place, which price shall include all materials, equipment, tools and labor incidental to the placement, maintenance, replacement, removal and disposal of the bales and surplus material. No payment shall be made for the clean out of accumulated sediment.

Pay Item	Pay Unit
Sedimentation Control Bales	l.f. (m)

SECTION 2.19

SEDIMENTATION CONTROL SYSTEM

2.19.01—Description: This work shall consist of furnishing, placing, maintaining and removing sedimentation control systems as shown on the plans or as directed by the Engineer. Maintaining shall include the clean out of accumulated sediment.

2.19.02—Materials: Hay bales shall conform to Article 2.18.02. Geotextile shall conform to Section 7.55 and M.08.

2.19.03—Construction Methods: Sedimentation Control Systems shall be installed by the Contractor in locations shown on the plans or as directed by the Engineer. When hay bales are used they shall be installed as specified in Article 2.18.03. Geotextile sedimentation control systems may consist of either a prefabricated geotextile fence or a geotextile fence assembled by the Contractor in the field. Geotextile sedimentation control systems shall be installed so that the bottom 6 inches (150 millimeters) of the fabric is buried by either trenching or by laying the 6-inch (150-millimeter) section horizontally on the ground and burying by ramping the soil up to the control fence. All geotextile fences shall be at least 30 inches (760 millimeters) in exposed height as installed, with not less than a 2-degree and not more than a 20-degree inclination toward the potential silt source. Hardwood posts shall have a minimum cross-section size of at least 1.5 inches x 1.5 inches (38 millimeters x 38 millimeters) and a minimum length of 42 inches (1.1 meters). Steel posts shall be at least 0.5 pounds per linear foot (0.75 kilograms per meter) with a minimum length of 48 inches (1.2 meters). Spacing between posts shall not exceed 10 feet (3 meters), and all posts shall be driven a minimum of 12 inches (304 millimeters) into the ground. When joints between sections of geotextile sedimentation control systems are necessary, geotextile shall be spliced together only at a support post, with a minimum 6-inch (150-millimeter) overlap, and securely sealed.

The Contractor may use brush as a backing for the geotextile by piling the brush 2 to 3 feet (600 millimeters to 900 millimeters) high and then attaching the geotextile to the brush and burying the bottom 6 inches (150 millimeters) of geotextile as in the previous fence method.

The installations shall be maintained or replaced until they are no longer necessary for the purpose intended or are ordered removed by the Engineer. Clean out of accumulated sediment shall be accomplished when one-half of the original height of the sedimentation control system, as installed, becomes filled with sediment or as ordered by the Engineer.

The geotextile fence systems will be completely removed from the project at the completion of the project, unless specifically authorized by the Engineer to be left in place.

Hay bale systems will be allowed to remain in toe of slope areas unless ordered removed by the Engineer.

Unless a specific type of sedimentation control system is indicated on the plans or directed by the Engineer, the type of system will be at the Contractor's option.

2.19.04—Method of Measurement: This work will be measured for payment by the actual number of linear feet (meters) of "Sedimentation Control System" or "Sedimentation Control (Type) System" installed and accepted. Measurement shall be made along the center-line of the system. Replacement systems will not be measured for payment.

2.19.05—Basis of Payment: Payment for this work will be made at the contract unit price per linear foot (meter) for "Sedimentation Control System" or "Sedimentation Control (Type) System" complete in place, which price shall include all materials, equipment, tools and labor incidental to the installation, maintenance, replacement, removal and disposal of the system and surplus material. No payment shall be made for the clean out of accumulated sediment.

Pay Item	Pay Unit
Sedimentation Control System	l.f. (m)
Sedimentation Control (Type) System	l.f. (m)

SECTION 3.02
ROLLED GRANULAR BASE

3.02.01—Description: This base shall consist of one or more courses constructed on the prepared subbase in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross-section as shown on the plans.

3.02.02—Materials: The materials for this work shall conform to the requirements of Article M.02.03.

3.02.03—Construction Methods: Bases of 6 inches (150 millimeters) or less in specified depth may be constructed in one course; bases over 6 inches (150 millimeters) in specified depth shall be constructed in two courses of equal depth.

Gravel or reclaimed miscellaneous aggregate shall be spread upon the prepared subbase to such depth that this course will be of the specified depth after final compaction. If, after the material has been spread and shaped, it is found that additional binder is necessary, it shall be furnished and applied in an amount directed by the Engineer. Such binder material shall be carefully and uniformly incorporated with the material in place by scarifying, harrowing, brooming or other approved methods. The material shall then be shaped, wetted and compacted with a power roller with a mass of not less than 10 tons (9 metric tons) or an equivalent vibratory roller or compactor until thoroughly compacted. All areas of segregated coarse or fine material shall be corrected or removed and replaced with well-graded material, as directed by the Engineer. The compacting and wetting shall be continued until all voids are filled, after which this portion may be left to dry. The compacting shall be continued until the course is thoroughly compacted to a firm and uniform surface satisfactory to the Engineer. The material shall be re-compacted and wetted on succeeding days. The rate and extent of the compacting and the quantity and method of applying water shall be as directed by the Engineer.

After the first course has been compacted and bound as specified herein, the succeeding course, if necessary in order to achieve the specified base depth, shall be similarly placed.

3.02.04—Method of Measurement: This work will be measured for payment horizontally after compaction and to the limits as shown on the plans, or as ordered by the Engineer. The thickness shall be as indicated on the plans or as ordered by the Engineer and within a tolerance of $\pm 3/4$ inch (± 19 millimeters). Measurements to determine the thickness will be taken by the Engineer at intervals of 500 feet (150 meters) or less along lanes and shall be considered representative of the lane. For the purpose of these measurements, a shoulder will be considered a lane. Should a thickness measurement be taken and a deficiency found, the Engineer will take such additional measurements as he considers necessary to determine the longitudinal limits of the deficiency. Areas found to be in excess of the allowable tolerances will be corrected as ordered and at the Contractor's expense.

3.02.05—Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for "Rolled Granular Base" complete in place, which price shall include all materials, tools, equipment and labor incidental thereto.

Pay Item	Pay Unit
Rolled Granular Base	c.y. (cu. m)

SECTION 3.03
CONCRETE BASE

3.03.01—Description: This base shall consist of concrete composed of portland cement and fine and coarse aggregates, mixed in the hereinafter specified proportions and constructed on the prepared subbase to the form and dimensions shown on the plans, and in accordance with these specifications. The base shall be reinforced when so specified.

3.03.02—Materials: All materials for this work shall conform to the requirements of Article M.03.01 for concrete pavement and Article M.06.01 for reinforcing steel.

3.03.03—Construction Methods: The construction methods for the base shall conform to the applicable requirements given in Article 4.01.03 for concrete pavement as modified and supplemented by the following requirements:

Joints will not usually be required in the construction of the base. When called for, joints shall be formed of the type and in the location as shown on the plans or as directed. Joints shall also be formed around all objects that project through the base, also between the base and curbs, concrete gutters, etc., when ordered.

When no transverse joints are to be installed, the operation of placing and spreading shall be continuous during any working period. At the end of any working period, a bulkhead of steel or a 2-inch (50-millimeter) plank conforming to the cross section of the base course shall be placed at right angles to the centerline and perpendicular to the surface; and the concrete shall be finished to it. When work is resumed, the bulkhead shall be removed and the surface roughened and wetted before concrete is placed against it.

3.03.04—Method of Measurement: The method of measurement for the materials entering into the construction of the base shall be described in Article 4.01.04 for concrete pavement.

3.03.05—Basis of Payment: Payment for the concrete base will be made as follows:

1. Concrete: This material will be paid for at the contract unit price per cubic yard (cubic meter) for "Concrete for Base," complete in place, which price shall include all equipment, tools, labor and work incidental thereto and all materials except mat reinforcements, joints, joint supports and joint filler which will be paid for as stated hereinafter.

No direct payment will be made for the concrete in and the curing of the required test cylinders as specified hereinbefore, but the cost of this work shall be considered as included in the general cost of the work. The work of transporting and testing these cylinders will be done by the Department without expense to the Contractor.

2. Reinforcement: The reinforcement for the concrete base will be paid for at the contract unit price per square yard (square meter) of base for "Mat Reinforcement for Concrete Pavement," complete in place, which price shall include all materials, equipment, tools, labor and work incidental hereto.

3. Joints: The expansion joints and the contraction joints will be paid for respectively at the contract unit price per linear foot (meter) for "Transverse Expansion Joint" and for "Transverse Contraction Joint," complete in place, which price shall include all joint filler where required, all joint seal, load transfer devices, and all other materials, equipment, tools, labor and work incidental thereto.

Longitudinal joints and dummy joints including seal, if required, will not be paid for directly, but the cost thereof shall be considered as included in the general cost of the work.

4. Longitudinal Joint Supports: The devices required in connection with longitudinal joints will be paid for at the contract unit price each for "Longitudinal Joint Support," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

5. Expansion Joint Filler: The expansion joint filler, other than that which is a part of the transverse joint assembly, will be paid for at the contract unit price per linear foot (meter) for "Expansion Joint Filler" of the type and thickness specified, complete in place, which price shall include all joint filler, joint seal and all other materials, equipment, tools, labor and work, incidental thereto.

Pay Item	Pay Unit
Concrete For Base	c.y. (cu. m)
Mat Reinforcement for Concrete Pavement	s.y. (s.m)
Transverse Expansion Joints	l.f. (m)
Transverse Contraction Joints	l.f. (m)
Longitudinal Joint Support	ea. (ea.)
Type and Thickness Expansion Joint Filler	l.f. (m)

SECTION 3.04
PROCESSED AGGREGATE BASE

3.04.01--Description

3.04.02--Materials

3.04.03--Construction Methods

3.04.04--Method of Measurement

3.04.05--Basis of Payment

3.04.01--Description: The base shall consist of a two-course foundation constructed on the prepared subbase in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross-section as shown on the plans.

3.04.02--Materials: All materials for this work shall conform to the requirements of Subarticles M.05.01-1, M.05.01-2 and M.05.01-3.

3.04.03--Construction Methods: Coarse aggregate shall be either gravel, broken stone or reclaimed miscellaneous aggregate, the latter containing no more than 2% by mass of asphalt cement, at the option of the Contractor. However, only one type of coarse aggregate shall be used on a project unless otherwise permitted by the Engineer.

Prior to placing the bottom course of the processed aggregate base, the prepared subbase shall be maintained true to line and grade, at all times, for a minimum distance of 200 feet (60 meters) in advance of the work. In addition, none of the aggregate courses shall be placed more than 500 feet (150 meters) ahead of the compaction and binding operation on that particular course.

The bottom course shall be spread uniformly upon the prepared subbase. Only approved spreaders or stone boxes shall be used. Power graders shall not be used unless otherwise permitted by the Engineer. The thickness of the course shall not be more than 4 inches (100 millimeters) after compaction, unless otherwise ordered.

After the aggregate is spread, it shall be thoroughly compacted and bound by use of equipment specifically manufactured for that purpose. Rollers shall deliver a ground pressure of not less than 300 pounds per lineal inch (52.5 newtons/millimeter) of contact width and shall have a weight (mass) of not less than 10 tons (9100 kilograms). Vibratory units shall have a static weight (mass) of not less than 4 tons (3650 kilograms). Water may be used during the compaction and binding operation. Water shall be applied from an approved watering device. The direction and intensity of the stream shall be ordered by the Engineer. The compacting and binding operation shall begin at the outside edges, overlapping the shoulders for a distance of not less than 6 inches (150 millimeters) and progress towards the middle, parallel with the centerline of the pavement. The work shall cover the entire surface of the course with uniform overlapping of each preceding track or pass. Areas of super-elevation and special cross slope shall be compacted by beginning at the lowest edge and proceeding towards the higher edge, unless otherwise directed by the Engineer. The compacting and binding operation shall be continued until the voids in the aggregates have been reduced to provide a firm and uniform surface satisfactory to the Engineer. The amount of compactive effort shall be as directed by the Engineer, but in no case shall be less than 4 complete passes of the compacting and binding operations. All aggregate shall be completely compacted and bound at the end of each day's work or when traffic is to be permitted to operate on the road. The dry density of each layer of processed aggregate base after compaction shall not be less than 95% of the dry density for that material when tested in accordance with AASHTO T180, Method D.

Should the subbase material become churned up or mixed with the bottom course material at any time, the Contractor shall, without additional compensation remove the mixture. The Contractor shall add new subbase material, if required, and reshape and recompact the subbase in accordance with the requirements of Article 2.12.03. New aggregate bottom course material shall be added, compacted and bound, as hereinbefore specified, to match the surrounding surface.

When the bottom course has been completed, as specified above, the top course aggregate shall be spread over it to such thickness that, after final compaction and binding, the total thickness of the two courses will equal that thickness specified for the completed base. The top course shall be spread, compacted and bound exactly as specified above for the bottom course.

Any surface irregularities, which develop during or after work on either course, shall be corrected by loosening material already in place and removing or adding aggregate as required, after which the entire area, including the surrounding surface, shall be re-compacted and rebound until it is brought to a firm and uniform surface satisfactory to the Engineer.

3.04.04--Method of Measurement: The weight (mass) of all aggregate required for this work shall be weighed (measured) on scales furnished by and at the expense of the Contractor, except as otherwise permitted

herein. The scales shall be of a type satisfactory to the Engineer and shall be sealed, at the expense of the Contractor, as often as the Engineer may require. All measuring shall be done in the presence of a Department representative.

If material is shipped by rail, the car's weight (mass) may be accepted; but scales shall be provided as specified above, if the Engineer so directs.

Measurements shall be subject to the following provisions:

Determination of Thickness The thickness shall be as indicated on the plans, or as ordered by the Engineer and within a tolerance of -3/4 inch to +1/2 inch (-19 millimeters to +13 millimeters).

Measurements to determine the thickness will be taken by the Engineer at intervals of 500 feet (150 meters) or less, along lanes, and shall be considered representative of the lane. For the purpose of these measurements, a shoulder will be considered a lane.

If a thickness measurement is taken and found deficient, the Engineer will take such additional measurements as he considers necessary to determine the longitudinal limits of the deficiency.

The Engineer may waive an occasional measurement outside the tolerances if in his judgment it is not representative of true conditions and providing that:

- (a) other thickness measurements taken nearby for the course are within acceptable limits;
- (b) proper controls have been exercised by the Contractor; and
- (c) if there would be no impairment to the serviceability of the complete construction.

No adjustment of the quantity accepted for payment will be made where the thickness does not exceed the allowable plus or minus tolerances.

Where the thickness exceeds that indicated on the plans by more than the prescribed tolerance, that material which is in excess of the total planned depth, plus the tolerance, will not be included for payment.

Areas represented by measurements deficient in thickness in excess of the allowable minus deviation shall be corrected at the Contractor's expense; or with written permission of the Engineer, the deficient areas may remain, and payment will be made at an equitable adjusted price.

An adjustment in quantity will be made in the materials placed beyond the horizontal limits indicated on the plans by deducting the computed weight (mass) of that material extending more than 3 inches (75 millimeters) beyond the horizontal plan dimensions.

Determination of the quantity to be used for adjusted payment or exclusion for payment will be based on .0534 tons per square yard per inch (58 kilograms/square meter per 25 millimeters) thickness.

3.04.05--Basis of Payment: This work will be paid for at the contract unit price per ton (metric ton) for "Processed Aggregate Base," complete in place, which price shall include all materials, tools, equipment and work incidental thereto.

Pay Item	Pay Unit
Processed Aggregate Base	ton (t)

**SECTION 3.05
PROCESSED AGGREGATE**

3.05.01—Description: Work under this item shall consist of furnishing, placing, shaping and compacting processed aggregate to be used for back-up to bituminous concrete overlays in areas shown on the plans or where directed by the Engineer.

3.05.02—Materials: The material for this item shall conform to the requirements of Article M.05.01, except that coarse aggregate shall be broken stone, and fine aggregate shall be stone sand, screenings, or a combination thereof.

3.05.03—Construction Methods: The material shall be placed, shaped, and compacted in one continuous operation to the lines, grades, and cross slopes shown on the plans or as directed by the Engineer. Only the amount of material that can be placed, shaped, and compacted during the work shift shall be placed. No excess loose material shall be left along the edge of road.

Compaction will be by vibratory equipment determined to be acceptable to the Engineer prior to the start of the work. No specific percent of compaction is required; however, no loose material shall be evident after completion of compaction as approved by the Engineer.

During the hauling and placing operations, the Contractor shall immediately remove any material dumped or spilled on the shoulders or pavement.

It shall be the Contractor's responsibility to maintain and restore any eroded areas to the required line, grade, and cross slope with approved material and to keep the areas in acceptable condition until the construction work is considered complete by the Engineer.

3.05.04—Method of Measurement: The quantity of processed aggregate to be included for payment will be determined by the net weight (mass), in tons (metric tons), measured in the hauling vehicles. Scales shall be of a type satisfactory to the Engineer and shall be sealed by the Department of Consumer Protection at the expense of the Contractor, as often as the Engineer may require. When required, weighing shall be done in the presence of a Department representative.

3.05.05—Basis of Payment: This material will be paid for at the contract unit price per ton (metric ton) for "Processed Aggregate", complete in place, which price shall include all materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Processed Aggregate	ton (t)

SECTION 4.01 CONCRETE PAVEMENT

4.01.01--Description

4.01.02--Materials

4.01.03--Construction Methods

4.01.05--Basis of Payment

4.01.05--Basis of Payment

4.01.01--Description: This pavement shall consist of Portland cement concrete, with or without reinforcement, in conformity with the lines, grades, thickness, and typical cross section as shown on the plans.

4.01.02--Materials: The materials for this work shall conform to the requirements for concrete pavement under M.03. Reinforcing steel shall conform to M.06.01.

4.01.03--Construction Methods:

A. Composition: The composition of the concrete shall be in accordance with the requirements set forth in Article M.03.01--General Composition of Concrete Mixes, as well as the applicable sections of ACI 211 and ACI 318. The Contractor shall submit all concrete mix designs to the Division of Materials Testing for review and approval prior to production of the design. At the option of the Contractor, other approved cementitious material may be used to replace a portion of the required Portland cement in accordance with the requirements of Section M.03.

Since the yield is theoretical, the Department will not be responsible for any variation in yield as actually obtained on the job. Consistency of the concrete shall be uniformly maintained within the allowable range of slump. The slump shall be measured in accordance with AASHTO Method T119.

The concrete shall be air-entrained and shall contain an air content of $6\% \pm 1\frac{1}{2}\%$ at the time the concrete is deposited on the grade. Air entrainment shall be obtained by use of an approved air-entraining admixture added to the concrete at the time of mixing.

The air content of the plastic concrete shall be determined in accordance with AASHTO Method T152, Pressure Method. No alternative method will be accepted.

No change in the source or character of the materials shall be made without due notice to the Engineer, and no new material shall be used until the Engineer has accepted such materials and has designated new proportions based upon tests of new trial mixes as provided hereinbefore.

B. Material Storage: Each cementitious material shall be stored in a separate, weatherproof compartment clearly identified.

Sites for aggregate stockpiles shall be reasonably smooth, hard, well-drained areas. Aggregates from different sources and of different gradation shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to minimize segregation of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used.

C. Batching Plant and Equipment: Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. After approval, the Contractor shall maintain all equipment and tools in a satisfactory working condition until the completion of the work.

1. General: The batching plant shall include storage bins, weighing (mass determining) hoppers, scales, and metering equipment as required. A separate scale for cementitious materials shall be used.

2. Scales: Scales for measuring concrete ingredients may be horizontal beam-type, springless scales or electronic devices and shall conform to the applicable requirements of the NIST Handbook 44 except as otherwise specified herein.

Weight (mass)-indicating devices shall be in full view and near enough to be read accurately by the operator while charging the hoppers. The operator shall have convenient access to all controls.

When beam-type scales are used, a "tell-tale" dial shall be provided for indicating to the operator that the required load in the weighing (measuring) hopper is being approached. A device on measuring beams shall indicate critical positions clearly. The dial faces of springless dial scales shall be of a material not affected by moisture. The graduated dial scale shall be provided with the required number of suitable markers in front of the dial face which may be set at the required positions of the indicator for predetermined weights (masses).

Methods for weighing (measuring) (electric, hydraulic, load cells, etc.) other than the methods noted above, which meet the required weighing (measuring) tolerances may be approved by the Engineer.

3. Ten certified standard 50-pound weights (22.7-kilogram masses) shall be available at the batching plant for checking the accuracy of the scales. Weights (masses) shall be certified by the Department of Consumer Protection.

4. The Contractor shall notify the Engineer 2 days in advance that the scales are in proper adjustment and ready to be sealed. The bins shall be filled sufficiently to perform the tests required, and the Contractor shall have available a man skilled in making any adjustments necessary to seal the scales. The Engineer may request that the scales, after checking with a 500-pound weight (227-kilogram mass), be resealed at any time, if in his opinion the scales are out of adjustment. Scales shall be "sealed" at the expense of the Contractor by the "Sealer of Weights and Measures." Scales shall be inspected and sealed at least once every 12 months.

5. **Automation:** All plants shall be equipped with an approved automatic cycling and monitoring system installed as part of the batching equipment, unless otherwise indicated in the plans or specifications or in the opinion of the Engineer, job conditions warrant otherwise. The system shall include equipment for accurately proportioning the various components of the mixture by weight (mass).

Admixtures and water may be measured volumetrically. The automatic proportioning system shall be capable of consistently delivering each constituent within the tolerances specified.

There shall be auxiliary interlock cutoff circuits to interrupt and stop the automatic batching operations whenever an error exceeding the acceptable tolerance occurs in proportioning for all material components except water. Zero return tolerance shall be equal to that of the delivery tolerances for the minimum batch size.

When the aggregate sizes are weighed (When the masses of the aggregate sizes are taken) cumulatively, the tolerance for each bin draw weight (mass) shall be based on the total aggregate batch weight (mass). If aggregate sizes are weighed (measured) separately, the percentage shall apply to each scale weight (mass). When the other approved cementitious material is weighed (measured) cumulatively with the cement, the other approved cementitious material shall be last in the weighing (measuring) sequence, and the batching delivery tolerance for each material draw weight (mass) shall be based upon the total weight (mass) of cement plus other approved cementitious material.

The electrical circuits used to check delivery tolerances may be set at any span within the full allowable tolerance for any approved batch size. For plants not equipped to automatically adjust tolerances, the tolerance span shall be set for the minimum approved batch size whenever varying batch sizes are being produced.

Batching Delivery Tolerances:

Cementitious materials ± 1% (by weight (mass))

Aggregate ± 2% (by weight (mass))

Water ± 1% (by weight (mass) or volume--applies at central mix plants only)

Admixtures ± 3% (by weight (mass) or volume--or ± 1 ounce
(30 milliliters), whichever is greater)

The automatic proportioning system shall be capable of rapidly selecting and proportioning at least 3 classes of concrete. In addition, the system shall have the capability of batching materials in at least 2 batch sizes. These provisions will not be required for project-site plants batching only 1 class of concrete for a project. The system shall be interlocked during the batching of cement and aggregates so that:

No inlet gate can be opened while the weigh (measuring) hopper discharge gate is open.

No weigh (measuring) hopper discharge gates can be opened

(a) While the hopper is being filled.

(b) Until the full batch weight (mass) is within the delivery tolerance.

No new batch can be measured until the hopper is entirely empty of the previous batch and the scale has returned to "zero."

When the manual batching is permitted, the constituents shall be batched within the indicated delivery tolerances for the automatic proportioning system.

6. **Slump Control:** Controls shall be provided so that the batch plant operator can produce concrete of the slump required by the paving operation. Included shall be a moisture compensation system, a slump-meter, and a slump-adjust control. The moisture compensation control can be automatically or manually set for the amount of moisture in the fine aggregate. A moisture compensation system shall compute the adjustment to the water and the fine aggregate components of the concrete to be measured by the automatic batching plant. The actual amounts of each material batched shall be recorded in the manner required elsewhere in these specifications.

7. **Batch Recording Instruments:** All concrete batching plants shall be equipped with digital or graphical recording instruments approved by the Engineer. The recording instruments shall be designed to record the quantities of each aggregate component, cement, other approved cementitious materials (when used), water (at central mix batch plants), and the presence of admixture for each batch of concrete produced. All records of

batches shall show the batch number, the day, the month, the year, and the time of day to the nearest minute for each batch. This information shall be imprinted on the record so that each batch may be permanently identified. The Department shall be provided with a clear and legible copy of all batch records for concrete supplied to the Department.

Cement, other approved cementitious material, and aggregate component weights (masses) shall be recorded separately. Water at central mix plants may be recorded by weight (mass) or volume.

When a digital tape or ticket recorder is used, weights (masses) shall be recorded as indicated on the batching scale or meter within an accuracy of ± 1 scale or meter graduation. The minimum resolution of digital recorders shall be equivalent to the minimum graduation on the scale meter, unless otherwise approved by the Engineer.

If graphical recorders or multiple recorders, either digital or graphical, are used, they shall be subject to the approval of the Engineer.

The control system shall include a mixer timer which is interlocked with the mixer discharge control, such that the concrete will be mixed for the approved time.

If any of the above equipment fails to operate satisfactorily, the Engineer shall be notified immediately, and the Engineer will assign an inspector to the plant to monitor plant operation. Only if job conditions warrant, the Engineer may allow concrete to be delivered to the project without an inspector at the plant to monitor plant operation. When the plant is permitted to operate by manual control during periods of automatic equipment failure, a manually written ticket providing all the specified batch information required from the automatic "batch recording instrument" will be required for each batch supplied to the Department.

The plant shall be returned to compliance with these specifications within 2 working days of the equipment failure. After that period, concrete will not be accepted by the Department. No costs will be incurred by the Department for any production loss, or delays due to the enforcement of this requirement.

D. Mixing Equipment:

1. General: Concrete may be mixed at the site of construction or at a central point. Truck-mixed or transit-mixed concrete may be used with the permission of the Engineer for limited amounts of pavement and for other exceptional cases. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

2. Mixers at site of construction or at a central point: Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mixture without segregation.

3. Mixing time: The mixing time requirements shall be in accordance with the recommendations of the manufacturer of the mixer. If a mixing time of less than 60 seconds is recommended, the Contractor shall furnish test data acceptable to the Engineer, verifying that the reduced mixing time will produce uniform concrete conforming to the provisions of AASHTO M157.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet (meters), as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

E. Hauling Units:

1. Truck mixers and truck agitators: Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central-mixed concrete, shall conform to the requirements of Subarticle 6.01.03-1(b), "Truck-Mixed and Transit-Mixed Concrete."

2. Nonagitator trucks: Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, non-aluminum metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection.

3. Hauling central mix concrete: Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators, except that in hot weather or under other conditions contributing to quick stiffening of concrete, the maximum allowable time may be reduced by the Engineer.

4. Addition of water in truck mixers: When mixed concrete is transported in approved truck mixers, water may be added to the concrete at the delivery site, with the permission of the Engineer, to achieve the

required slump, provided the specified water-cement ratio for the concrete is not exceeded and the concrete is mixed for at least thirty additional revolutions at mixing speed to ensure thorough mixing of the water into the concrete. Further addition of water to the concrete after the initial slump adjustment will not be permitted.

F. Placing Concrete:

All forms, slip form pavers, and other equipment used in the placing, curing, and finishing of concrete shall be of a design acceptable to the Engineer.

1. Forms: Forms shall be set by the contractor to true line and grade.

The specified grade shall be set and compacted prior to the setting of forms.

Conditioning of Subgrade or Base Course: The subgrade or base course shall be brought to proper cross-section. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade. The finished grades shall be maintained in a smooth and compacted condition until the pavement is placed.

2. Slip Form Paving: When slip form paving, the subgrade, or the surface of the subbase over which the tracks of the slip form paver will travel shall not vary more than $\pm 3/16$ inch (± 5 millimeters) from the grade established by the Engineer.

Except when the Contractor elects to place reinforcement in a two-layer procedure, the slip form paving equipment shall spread, consolidate, screed and float finish the freshly placed concrete in 1 pass in a manner such that a minimum of hand floating will be required. The operations of depositing, spreading, consolidating and finishing shall be such that, insofar as possible, continuous operation of the paver will be maintained. Frequent starting and stopping of the paver should be kept to a minimum.

3. Placement: Where concrete is to be placed adjoining a previously constructed lane of pavement, and hauling units and mechanical equipment will be operated upon that previously constructed lane of pavement, that lane shall have attained the strength specified for opening the pavement to vehicular traffic. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after the concrete is tested in accordance with 4.01.03(I) and has attained a modulus of rupture of 400 psi (2800 kilopascals).

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 5 seconds in any one location.

Concrete shall be deposited as close to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper on to a joint assembly unless the hopper is well centered on the joint assembly.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete.

4. Placing Reinforcement: If mechanical means are used to place pavement reinforcement and/or pavement fabric, the mechanical placement equipment shall be capable of positioning the reinforcement or fabric within the tolerances specified.

When reinforced concrete pavement is placed in 2 layers, the entire width of the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off and screeded.

Any portion of the bottom layer of concrete which has been placed more than 45 minutes without being covered with a top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in 1 layer, the reinforcement may be positioned in advance of concrete placement or it may be laced in plastic concrete after spreading, by mechanical or vibratory means.

Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust, which could impair bond of the steel with the concrete.

5. Finishing:

(a) Sequence: The sequence of operations shall be the strike-off and consolidation floating and removal of laitance, and final surface finish. Work bridges or other devices necessary to provide access to the pavement surface for the purpose of finishing, straight-edging, and making corrections as hereinafter specified, shall be provided by the Contractor.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surfaces is permitted, it shall be applied as a fog spray by means of approved spray equipment.

(b) Finishing at Joints: The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated.

(c) Hand Finishing: Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

- i. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.
- ii. Narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods.

Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.

(d) Floating: After the concrete has been struck off and consolidated it shall be further smoothed, trued, and consolidated by means of a float.

(e) Final Finish: When all irregularities have been removed, and the edges of the slabs and joints given their initial edging, the pavement shall be subjected to the following 2-stage texturing treatment:

i. Dragging with Burlap: The burlap shall be at least 3 feet (1.0 meter) wide and a length of 2 feet (0.6 meter) greater than the width of the lane or lanes being placed. The burlap shall not have frayed edges and shall be kept wet and clean of accumulations of dried concrete particles or other foreign materials, which might leave distinctive undesirable marks. The burlap shall be drawn longitudinally along the surface in a slow manner so as to have an even texture. When not in use, the burlap shall not be allowed to rest on the pavement.

ii. Texturing with Tines: As soon as possible, after the pavement surface has been dragged with the burlap, mechanical equipment shall be used to texture the surface with deep transverse grooves.

The equipment shall consist of a self-propelled device capable of applying a textured finish transverse to the centerline of the pavement. The texturing shall be done with tines 0.03 inch (0.75 millimeter) thick, 0.08 inch (2.0 millimeters) wide, and 4 to 6 inches (100.0 millimeters to 150.0 millimeters) in length with an average spacing of 1/2 inch (12.0 millimeters) on centers.

The transverse grooving shall be performed when the condition of the concrete is optimum. This condition will prevail when the grooves can be formed to a depth of 1/8 inch (3.2 millimeters) to 1/4 inch (6.4 millimeters) with relative ease and without the walls of the grooves closing back in on each other. Other adjustments to the tining procedure may be permitted by the engineer to obtain grooves of the proper width and depth.

The tined grooving shall extend from edge to edge of the pavement, and shall be perpendicular to the centerline of the pavement. The tining mechanism shall be aligned so as to prevent overlapping of grooves in any two successive passes. The depth of the grooves formed in the surface by the tines shall be checked randomly with a tire tread depth-measuring gage furnished by the Contractor to ensure compliance with the required limits of 1/8 inch to 1/4 inch (3.2 millimeters to 6.4 millimeters). The original surface of the concrete shall serve as the datum for the depth measurements.

(f) Edging at Forms and Joints: After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the plans.

A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting the tool during use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed. All joints shall be tested with a straight edge before the concrete has set, and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

6. Joints: Joints shall be constructed of the type and dimensions, and at the locations required by the plans or specifications. All joints shall be protected from the intrusion of injurious foreign material until sealed.

(a) Longitudinal Joint: Deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to the longitudinal joints; they shall be placed by approved mechanical equipment or

rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall be coated with epoxy conforming to AASHTO M284. When shown on the plans and when adjacent lanes of pavement are constructed, steel side forms shall be used which will form a keyway along the construction joint. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.

Longitudinal formed joints shall consist of a groove or cleft, extending downward from, and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the plans and while the concrete is in a plastic state. The groove, or cleft, shall be filled with either a pre-molded strip or poured material.

The longitudinal joint, however formed, shall be continuous. There shall be no gaps in either transverse or longitudinal joints at the intersection of the joints.

Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width and line shown on the plans. Suitable guidelines or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the plans. The longitudinal joint shall be sawed within 36 hours of placement and before any other equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned and the joint shall immediately be filled with sealer.

(b) Transverse Expansion Joints: The expansion joint fillers shall be continuous from edge to edge, shaped to the subbase and to the keyway along the edge. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than 1/4 inch (6.4 millimeters) in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

(c) Transverse Contraction Joints: Transverse contraction joints shall consist of planes and of weakness created by forming or cutting grooves in the surface of the pavement and, when shown on the plans, shall include transfer assemblies.

i. Formed grooves shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.

ii. Sawed contraction joints shall be created by sawing grooves in the surface of the pavements of the dimensions and at the spacing and lines shown on the plans with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly cleaned.

Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. If extreme conditions exist, which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above. The engineer will review and approve procedures and methods to correct random cracking.

iii. Transverse formed contraction joints shall comply with the requirements for the longitudinal formed joint.

(d) Transverse Construction Joints: Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 10 feet (3.0 meters) of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet (3.0 meters) long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

(e) Load Transfer Devices: Load transfer devices shall conform to the requirement of Subarticle M.03.01-5.

(f) Sealing Joints: Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including the Contractor's equipment. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound and the joint-faces shall be clean and surface dry when the seal is applied.

The sealing material shall be applied to each joint opening to conform to the details shown on the plans or as directed by the Engineer. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. The use of sand or similar material as a cover for the seal will not be permitted. Poured joint-sealing material shall not be placed when the air temperature in the shade is less than 50°F (10°C), unless approved by the Engineer.

Preformed elastomeric gaskets for sealing joints shall be of the cross sectional dimensions shown on the plans. Seals shall be installed by suitable tools, without elongation, and secured in place with an approved lubricant adhesive which shall cover both sides of the concrete joints. The seals shall be installed in a compressed condition and shall at time of placement be below the level of the pavement surface by approximately 1/4 inch (6.4 millimeters). The seals shall be in one piece for the full width of each transverse joint.

7. Curing: Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the methods below. Liquid Membrane - Forming Cure is the preferred method of curing. Moist curing and cover sheet curing must be approved by the Engineer prior to paving operations. In all cases in which curing requires the use of water, the curing shall have prior right to all water supply or supplies. Failure to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 30 minutes between stages of curing or during the curing period.

When concrete is being placed and the air temperature may be expected to drop below 35°F (2°C) a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be provided along the work and any time the temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. During the period of time such protection, the Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

(a) Liquid Membrane-Forming Cure: The liquid curing compound shall conform to Subarticle M.03.01-10. When resin-based curing compound is used, it shall be applied following the final finishing immediately after the disappearance of the water sheen and before any surface checking or marked dehydration of the concrete occurs.

When water-soluble, linseed oil-based compound is used, it shall be applied immediately following the final finishing.

The compound shall be applied by an approved self-propelled mechanical pressured sprayer delivering a fine, even spray with uniform coverage. This equipment shall be provided with a suitable device for adequate agitation of the compound to prevent settlement. For the sides of concrete pavement exposed after removal of the forms and for areas where the use of self-propelled equipment is not practical, approved hand-held spray bars delivering a fine, even spray may be used; and the compound shall be drawn from a tank equipped with an approved device to prevent settlement or by a method which will prevent settlement.

If the compound is applied in two applications, the second application shall follow the first application within 30 minutes. The compound shall be applied in a continuous, uniform film at not less than one gallon for 150 square feet (one liter for 3.7 square meters).

If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply a new coat of material to the affected areas equal in curing value to that specified for the original coat. The treated surface shall be protected by the Contractor from injury for a period of at least 7 days. All traffic, either foot or otherwise, will be considered as injurious to the film of the applied compound.

The Contractor shall have on the project sufficient approved cover sheet or cotton mats for the protection of the pavement in case of rain or breakdown of the spray equipment. The cotton mats shall be maintained in a wet condition during the period of use, as elsewhere herein specified.

Transverse joints shall be protected from the compound by means or methods approved by the Engineer.

(b) Moist Curing: After the surface of the concrete has been given its final finish, it shall be protected by covering it with moist mats of the size and quality specified in Article M.03.01-10. These mats shall be laid longitudinally over the surface of the finished pavement by unrolling from the supported roll so as not to bring an excessive weight (mass) upon or to mar the new surface of the pavement. After placing, these mats shall be saturated and kept saturated for a period of 7 days, at the end of which time they may be removed, and no further wetting or artificial curing will be required.

(c) Cover Sheet Curing: As soon as practicable after the finishing operations, paper or polyethylene cover sheets conforming to Article M.03.01-10. shall be placed in such a manner that the surface of the concrete shall not be marred. The adjoining covers shall overlap at least 18 inches (500 meters), and the lap shall be securely fastened down to form a closed joint. On removal of the forms, the edges shall be covered down to the bottom of the pavement. The cover sheets shall remain in place for a period of 7 days.

In the event that hair-checking develops before the cover can be placed, the procedure set forth shall be modified at the direction of the Engineer. Moist curing mats shall then be used for the initial 24 hours of the curing period, and the cover sheets placed for the remainder of the curing period.

Before reusing paper or polyethylene covers, they shall be checked for holes or tears, and any such perforations shall be repaired. Covers which have become unserviceable will be rejected by the Engineer.

G. Protection of Pavement: The Contractor shall protect the pavement and its appurtenances against public traffic and traffic caused by his own employees and agents until the pavement is opened to traffic.

Any damage to the pavement occurring prior to the opening of the pavement to traffic by the State shall be repaired or the pavement replaced.

H. Riding Surface Tests:

1. Surface Test (Profilograph) and Correction: The finished surface of all mainline pavement shall be tested and corrected to a smoothness as described herein. Mainline pavement is defined as all pavements for traffic lanes and climbing lanes, but excluding concrete base, acceleration and deceleration lanes, and all taper sections, pavement widening, shoulders, and side street returns. Pavement on horizontal curves having a baseline radius of curvature of 6 degrees or greater and super elevation transitions of such curves will also be excluded.

The surface smoothness of pavement not classified as mainline pavement shall be determined by the Surface Test (straightedge) as described hereinafter. The smoothness of the pavement surface will be determined by using a California Type Profilograph over each designated lane to develop a Profile Index. The equipment shall be furnished and maintained by the Contractor, and will be operated by the Engineer in accordance with Department test methods.

The Contractor shall furnish paving equipment and employ methods that produce a riding surface having a Profile Index of 12 inches per mile (190 millimeters per kilometer), or less. The profile will terminate 50 feet (15 meters) from each pressure relief joint or existing pavement which is joined by the new pavement.

Pavement profiles will be taken 3 feet (1 meter) from and parallel to each edge of pavement for pavement placed at a 12-foot (3.7-meter) width or less. When pavement is placed at a greater width than 12 feet (3.7 meters), the profile will be taken 3 feet (1 meter) from and parallel to each edge and at the approximate locations of each planned longitudinal joint. Additional profiles may be taken only to define the limits of an out of tolerance surface variation.

During the initial paving operations, either when starting up or after a long shut down period, the pavement surface will be tested with the profilograph as soon as the concrete has cured sufficiently to allow testing. Membrane curing damaged during the testing operation shall be repaired by the Contractor as directed by the Engineer. The purpose of this initial testing is to aid the Contractor and the Engineer in evaluating the paving methods and equipment. Once the initial pavement smoothness, paving methods, and paving equipment are acceptable to the Engineer, the Contractor may proceed with the paving operation. Subsequent to the aforementioned initial testing, daily profiles of each day's paving will be run as soon as possible, preferably during the next working day following placement of the pavement.

A daily average Profile Index will be determined for each day's paving. A day's paving is defined as a minimum of 1000 linear feet (300 meters) of full-width pavement placed in a single day. If less than 1000 linear feet (300 meters) is paved, the day's production shall be grouped with the subsequent day's production. If an average Profile Index of 20 inches per mile (315 millimeters per kilometer) is exceeded in any daily paving operation, the paving operation will be suspended and will not be allowed to resume until corrective action is taken by the Contractor. In the event that paving operations are suspended as a result of the average Profile Index exceeding 20 inches per mile (315 millimeters per kilometer), subsequent paving operations will be tested in accordance with the initial paving testing procedures.

For the purpose of determining pavement sections where corrective work or pay adjustments will be necessary, the pavement will be evaluated in 0.1-mile (150-meter) sections. Within each 0.1-mile (150-meter) section, all areas represented by high points having deviations in excess of 0.5 inches in 25 feet (13 millimeters in 7.6 meters) or less shall be removed by the Contractor with an approved grinding device or a device consisting of multiple saws. The final texture of the concrete pavement shall be such that texture, appearance, and skid resistance are comparable to adjacent sections that do not require corrective work. The use of a bush

hammer or other impact device will not be permitted. Deviations in excess of 0.5 inches (13 millimeters) will be determined from the profilogram in accordance with Department Test Methods.

After removing all individual deviations in excess of 0.5 inches in 25 feet (13 millimeters in 7.6 meters), additional cutting shall be performed if necessary to reduce the Profile Index.

On those 0.1-mile (150-meter) sections where corrections are necessary, second profilograph runs will be performed to verify that corrections have produced an average Profile Index 20 inches per mile (315 millimeters per kilometer) or less. If the initial average Profile Index is less than 12 inches per mile (190 millimeters per kilometer), only the areas in excess of 0.5-inch (13-millimeter) deviations will be re-profiled for correction verification.

After removing all individual deviations in excess of 0.5 inches (13 millimeters), as stated above, additional correction shall be performed if necessary to reduce the average Profile Index to 20 inches per mile (315 millimeters per kilometer) or less. All correction work shall be completed prior to determinations of pavement thickness.

2. Surface Test (Straightedge) and Corrections: As soon as the concrete has hardened sufficiently, the pavement surface, except as specified herein above for mainline pavement, shall be tested by the Contractor with an approved 10-foot (3-meter) straightedge placed both transversely and longitudinally to the centerline at sufficient intervals to check the surface profile. Areas showing high spots of more than 1/8 inch (3.2 millimeters), exclusive of tining corrugations, shall be marked by the Engineer and removed by the Contractor to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch (3.2 millimeters) when tested with a 10-foot (3-meter) straightedge. Correction of surface irregularities and resulting surface finish shall conform to the requirements specified herein for mainline pavement.

I. Flexural Testing of Concrete: The flexural strength of the concrete pavement shall be monitored by the evaluation of compressive strength cylinders. The compressive strength specimens shall be cast and cured in the field in accordance with ASTM C 31 (AASHTO T 23). After proper curing, these cylinders shall be transported to the Division of Materials Testing for strength evaluation.

J. Opening to Traffic: Vehicular traffic shall be excluded from the pavement until sufficient curing has taken place. The pavement shall be opened to traffic with the attainment of a compressive strength of 3,500 psi (25 megapascals).

Any damage to the pavement from traffic or any other causes, occurring prior to acceptance of this contract, shall be repaired by the Contractor at his own expense.

In order to expedite the opening of a pavement, or part thereof, to traffic, the Engineer may direct the Contractor to supply a concrete with a higher cement factor, or the substitute TYPE III Portland Cement for the type being used. The mix design for this concrete must be approved by the Engineer. The State shall only pay the extra cost per ton (metric ton) for the cement used.

If the Contractor wants to increase the early strength of the pavement in order to facilitate his plan for the paving sequence, he may substitute TYPE III Portland Cement, or use a concrete with a higher cement factor. The mix design for this concrete must be approved by the Engineer. The extra costs for the cement used shall be borne by the Contractor.

4.01.05--Basis of Payment: It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the thickness and widths shown on the plans. The State will not be liable for payment for any thickness and widths in excess of that required.

A. Pay Adjustment for Surface Smoothness: Payment to the Contractor will be based on the average Profile Index per 0.1-mile (150-meter) section according to the following table:

AVERAGE PROFILE INDEX		CONTRACT UNIT PRICE ADJUSTMENT
Inches per mile per 0.1-mile section (Millimeters per kilometer per 150-meter section)		% of pavement unit bid price
0-6	(0-95)	106
over 6-8	(95-125)	104
over 8-10	(125-160)	102
over 10-12	(160-190)	100
over 12-14	(190-220)	98
over 14-16	(220-250)	96
over 16-18	(250-285)	94

When the average Profile Index exceeds 12 inches per mile per 0.1-mile (190 millimeters per kilometer per 150-meter) section, but does not exceed 20 inches per mile per 0.1-mile (315 millimeters per kilometer per 150-millimeter) section, the Contractor may elect to accept a contract unit price adjustment in lieu of reducing the average Profile Index.

The unit bid price adjustment will be computed using the designed thickness of Portland Cement pavement or as adjusted under Section 4.01.04. This unit bid price adjustment will apply to the total area of the 0.1-mile (150-meter) long section for the lane width represented by the profile (usually 12 feet (3.7 meters) wide). No payment will be made for any pavement which has an average profile index in excess of 20 inches per mile (315 millimeters per kilometer) until corrective work has been completed by the Contractor and the pavement re-profiled to verify that the average Profile Index has been reduced to 20 inches per mile (315 millimeters per kilometer) or less.

B. Pay Adjustment for Pavement Thickness:

1. Determination of Pavement Thickness: The pavement thickness shall be measured after surface correction is completed.

The thickness of fixed form pavement shall be determined by using measurements and/or elevations obtained by the Contractor and submitted to the Engineer prior to the placement of concrete. Thickness measurements using cores tested in accordance with AASHTO T 148 shall remain the option of the Engineer.

The thickness of slip form pavement will be determined by average caliper measurements of cores tested in accordance with AASHTO T 148.

For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined at 1,000 lineal feet (300 meters) of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. The last unit in each lane shall be 1,000 feet (300 meters) plus the fractional part of 1,000 feet (300 meters) remaining. One core will be taken at random by the Department in each unit. When the measurement of the core from a unit is not deficient more than 0.2 inch (5.1 millimeters) from the plan thickness, full payment will be made. When such measurement is deficient more than 0.2 inch (5.1 millimeters) and not more than 1.0 inch (25.4 millimeters) from the plan thickness, two additional cores at intervals not less than 300 feet (100 meters) will be taken and used in the average thickness for that unit. If the average measurement of these three cores is not deficient more than 0.2 inch (5.1 millimeters) from the plan thickness, full payment will be made. If the average thickness of the three cores is deficient more than 0.2 inch (5.1 millimeters), but not more than 1.0 inch (25.4 millimeters) from the plan thickness, an adjusted unit price as provided in (B.2) will be paid for the area represented by these cores.

Other areas such as intersections, entrances, crossover ramps, etc., will be considered as one unit, and the thickness of each unit will be determined separately. Small irregular unit areas may be included as part of another unit. At such points as the Engineer may select in each unit, one core will be taken for each 1,000 square yards (1000 square meters) of pavement, or fraction thereof, in the unit. If the core so taken is not deficient more than 0.2 inches (5.1 millimeters) from the plan thickness, full payment will be made. If the core is deficient in thickness by more than 0.2 inch (5.1 millimeters), but not more than 1.0 inch (25.4 millimeters) from the plan thickness, two additional cores will be taken from the area represented and the average of the three cores determined. If the average thickness of the three cores is deficient more than 0.2 inch (5.1 millimeters), but not more than 1.0 inch (25.4 millimeters) from the plan thickness, an adjusted unit price as provided in (B.2) will be paid for the area represented by these cores.

In calculating the average thickness of the pavement, measurements that are in excess of the specified thickness by more than 0.2 inch (5.1 millimeters) will be considered as the specified thickness plus 0.2 inch (5.1 millimeters), and measurements that are less than the specified thickness by more than 1.0 inch (25.4 millimeters) will not be included in the average.

When the measurement of any core is less than the specified thickness by more than 1.0 inch (25.4 millimeters), the actual thickness of the pavement in this area will be determined by taking additional cores at (not less than) 10-foot (3-meter) intervals parallel to the centerline in each direction from the effected location until in each direction a core is found that is not deficient by more than 1.0 inch (25.4 millimeters). Areas found deficient in thickness by more than 1.0 inch (25.4 millimeters) shall be evaluated by the Engineer, and if, in his judgement, the deficient areas warrant removal they shall be removed and replaced with concrete of the thickness shown on the plans. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. The cost of all thickness measurements made to determine average thickness variation or to isolate

areas that are deficient by more than 1.0 inches (25.4 millimeters), including filling holes with concrete, will be deducted from any monies due or that may come due to the Contractor under the Contract at the rate of \$50.00 per core.

2. Determination of Adjusted Payments: After the thickness of pavement has been determined on the basis of core measurements as hereinbefore described, the following rules for payment shall be applied.

Where the average thickness of pavement is deficient in thickness by more than 0.2 inch (5.1 millimeters), but not more than 1.0 inch (25.4 millimeters), payment will be made at an adjusted price as specified in the following table.

Deficiency in Thickness Determined by Cores		Proportional Part of Contract Price Allowed
Inches	(Millimeters)	
0.00 to 0.20	(0.0 to 5.1)	100%
0.21 to 0.30	(5.2 to 7.6)	80%
0.31 to 0.40	(7.7 to 10.2)	72%
0.41 to 0.50	(10.3 to 12.7)	68%
0.51 to 0.75	(12.8 to 19.1)	57%
0.76 to 1.00	(19.2 to 25.4)	50%

When the thickness of pavement is deficient by more than 1 inch (25.4 millimeters), the Engineer will determine whether the area of such deficiency will be left in place or replaced in accordance with the provisions of subsection 1.05.03. All additional work required and any delay to the Contractor's operation as a result of these specifications will not be cause for additional compensation for an extension of time.

On all sections of pavement which have to be removed, the Contractor shall bear the entire cost of the initial construction and the removal of the pavement including all concrete, reinforcement steel and joint material. Measured for payment hereunder will be only the items of construction entering into the replacement of the concrete pavement to the specified thickness.

C. Measurement for Payment: This work will be measured for payment as follows:

1. Concrete Pavement: The quantity of concrete included under this item shall be the number of cubic yards (cubic meters) of accepted concrete pavement contained in the theoretical computed volume of the pavement having the required thickness and widths, but subject to adjusted proportional payment or non-payment as stated hereinbefore.

2. Fabric or Bar Mat Reinforcement: This material will be measured by the number of square yards (square meters) of completed and accepted reinforced concrete pavement.

3. Transverse Expansion Joint: This material will be measured by the number of linear feet (meters) of completed and accepted transverse expansion joint.

4. Contraction Joint: This material will be measured by the number of linear feet (meters) of completed and accepted contraction joint.

5. Longitudinal Joint Support Assembly: This material will be measured by the number of joint support assemblies actually incorporated in the completed and accepted concrete pavement. If multilane construction methods are used, two longitudinal joint tie bars will be measured as one longitudinal joint support assembly.

6. Expansion Joint Filler: This material, when not part of a transverse joint assembly, will be measured by the number of linear feet (meters) of expansion joint filler of the type and thickness specified and of the width required, actually installed and accepted.

4.01.05--Basis of Payment: Payment for the concrete pavement will be made as follows:

1. Concrete: This material will be paid for at the contract unit price per cubic yard (cubic meter) for "Concrete for Pavement" complete in place, which price shall include all equipment, tools, labor, work incidental thereto and all materials, except reinforcement and joints.

No direct payment will be made for the concrete testing equipment, the instruction in its use, in-situ testing, the concrete in or curing of the required test beams and cylinders as specified hereinbefore, but the cost of this work shall be considered included in the general cost of the work.

The transporting and testing of beams and cylinders will be done by the Department without expense to the Contractor.

2. Reinforcement: The reinforcement for the concrete pavement will be paid for at the contract unit price per square yard (square meter) of pavement for "Mat Reinforcement for Concrete Pavement," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

3. Joints: The expansion joints and the contraction joints will be paid for respectively at the contract unit price per linear foot (meter) for "Transverse Expansion Joint" and for "Transverse Contraction Joint," complete in place, which price shall include all joint filler where required, all joint seal, load transfer devices, and all other material, equipment, tools, labor and work incidental thereto. Longitudinal joints and dummy joints including seal, will not be paid for directly, but the cost thereof shall be considered as included in the general cost of the work.

4. Longitudinal Joint Support Assembly: The devices required in connection with longitudinal construction joints will be paid for at the contract unit price each for "Longitudinal Joint Support," complete in place, which price shall include all materials, supports, equipment, tools, labor and work incidental thereto.

5. Expansion Joint Filler: The expansion joint filler, other than that which is a part of the transverse joint assembly, will be paid for at the contract unit price per linear foot (meter) for "Expansion Joint Filler" of the type and thickness specified, complete in place, which price shall include all joint filler, joint seal and all other materials, equipment, tools, labor and work incidental thereto.

6. Type III Portland Cement: When such material is substituted for other Portland Cement at the direction of the Engineer in order to expedite the opening of pavement to traffic, it will be paid for at the actual unit cost per barrel to the Contractor for the quantity actually incorporated in the pavement less the actual unit cost per barrel to the Contractor for an equal quantity of the Portland Cement so replaced, which cost shall include all equipment, labor, storage, transportation and work incidental to its inclusion in the concrete and incorporation in the finished pavement.

Pay Item	Pay Unit
Concrete for Pavement	c.y. (cu. m)
Mat Reinforcement for Concrete Pavement	s.y. (s. m)
Transverse Expansion Joints	l.f. (m)
Transverse Contraction Joints	l.f. (m)
Longitudinal Joint Support	ea. (ea.)
Type and Thickness Expansion Joint Filler	l.f. (m)

SECTION 4.03
COLD RECLAIMED ASPHALT PAVEMENT

4.03.01—Description: Work under this section shall consist of the in-place recycling of an existing pavement. The pavement will be pulverized to a specified particle size, mixed with a specified depth of existing base, with additional aggregates as required, water and/or a liquid asphalt, and placed in a specified grade and cross section. Where necessary, existing subgrades may be modified (raised, lowered or modified with additional aggregates) to meet required design specifications.

4.03.02—Materials: Materials for reclaimed asphalt pavements shall consist of existing pavements and bases. When it is necessary to improve the base or raise the grade line, additional base material may be specified by the Engineer.

If it is necessary to raise or lower any utilities or underdrains, the trench backfill material will meet Section M.02.05 or have the approval of the Engineer. If a rejuvenator is used during the final mixing operation, the material used shall be approved by the Engineer.

Samples of material will be obtained by the Materials Testing Laboratory as often as deemed necessary by the Assistant Manager of Materials Testing.

4.03.03—Construction Methods: Prior to the start of the pavement rehabilitation, all utilities and drainage systems shall be relocated as necessary.

Methods, equipment, tools, and any machinery to be used during construction shall be approved by the Engineer prior to the start of the Project. Prior to the actual pulverization of the pavement, drop inlets or catch basins that might be affected shall be sufficiently barricaded so as to prevent silt or runoff from plugging the drainage system.

If a rejuvenator is used, an approved metering device shall be used to ensure the accuracy of the amount of rejuvenator used.

Compaction shall be achieved by the use of a vibratory roller having the capability of producing high amplitude and low frequency vibrations. The compaction shall be a minimum of 95% of the proctor wet density (AASHTO T-180D).

4.03.04—Method of Measurement: The cold reclaimed asphalt pavement work will be measured for payment in square yards (square meters). The thickness will be as indicated on the plans, or as ordered by the Engineer and within +2 inches (+50 millimeters) and -1 inch (-25 millimeters).

Measurement to determine the thickness will be made by the Engineer at intervals of 500 feet (150 meters) or less. If deficient thicknesses are found, the Engineer will make such additional measurements as he considers necessary to determine the limits of the deficiency. Areas not within allowable tolerance shall be corrected, as ordered by the Engineer, without additional compensation to the Contractor.

Additional aggregates, as required, shall be measured for payment by the number of tons (metric tons) of aggregate delivered and incorporated into the pavement structure.

4.03.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Cold Reclaimed Asphalt Pavement," which price shall include all materials (except additional aggregate), equipment, tools, and labor incidental thereto.

Additional aggregate shall be paid at the contract unit price per ton (metric ton) delivered to the project site.

Pay Item	Pay Unit
Cold Reclaimed Asphalt Pavement	s.y. (s. m)
Additional Aggregate	ton (t)

SECTION 4.06
BITUMINOUS CONCRETE

4.06.01—Description

4.06.02—Materials

4.06.03—Construction Methods

4.06.04—Method of Measurement

4.06.05—Basis of Payment

4.06.01—Description: Work under this section shall consist of the production and placement of a smooth and dense bituminous concrete mixture with a uniform texture for (1) a completed base course, (2) the surface of an existing pavement or (3) the surface of an existing pavement which has been brought to proper grade and cross section. Work under this section shall also include sawing and sealing of joints and cracks.

4.06.02—Materials: The materials for the bituminous concrete mixture, sources of supply, formula for mix, tack coat, joint seal, mix tolerances, approval of mix formula, and the control of the mixture shall conform to the requirements of Section M.04.

Recycle Option: The Contractor has the option of recycling reclaimed asphalt pavement (RAP). RAP may be recycled in Class 1, Class 2, Class 3, and Class 4.

Crushed Glass Option: The Contractor has the option of adding clean, environmentally acceptable crushed, recycled container glass (CRCG) to Class 1 (Not to be used in the surface course), Class 3 and Class 4.

4.06.03—Construction Methods: The methods employed in performing the work and all equipment, tools, machinery and plant used in handling material and executing any part of the work must be approved by the Engineer prior to their use. If at any time these are unsatisfactory to the Engineer, the Contractor shall change them, as the Engineer requires.

1. Material Documentation: All vendors producing bituminous concrete must have their truck-weighing scales, storage scales, and mixing plant automated to provide a detailed ticket. Delivery tickets must include the following information:

- a. State of Connecticut printed on ticket.
- b. Name of producer, identification of plant, and specific storage bin (silo) if used.
- c. Date and time of day.
- d. Type of material (Class 3 mixture for machine-placed curbing must state "curb mix only")
- e. Net weight (mass) of material.
- f. Gross weight (mass) or tare weight (mass) of truck.
- g. Project number, purchase order number, name of contractor (if contractor other than producer)
- h. Truck number for specific identification of truck.

Notes:

Items a. through f. must be printed on the ticket automatically by the batch control system.

The time of day may be printed by a separate time clock.

Items g. and h. must be printed or handwritten legibly.

The Contractor must notify the Engineer immediately if, during the production day, there is a malfunction of the recording system in the automated plant or truck-weighing scales. Manually written tickets containing all required information will be allowed for one hour, but for no longer, provided that each load is weighed on State-approved scales. One hour after any malfunction of the recording system, trucks will not be approved to leave the plant unless a State inspector is present to monitor weighing. If such a malfunction is not fixed within forty-eight hours, material will not be approved to leave the plant until the system is fixed to the Engineer's satisfaction.

2. Transportation of Mixture:

Trucks with loads of bituminous materials being delivered to State projects must not exceed the State legal weight limits. The State reserves the right to check the gross and tare weight (mass) of any delivery truck. During any check, a variation of the documented weight (mass) from that shown on a producer's ticket of two percent or less shall be considered evidence that the weight (mass) shown on the producer's ticket is correct. If the gross or tare weight (mass) varies from that shown on the delivery ticket by more than two percent, the Engineer will recalculate the net weight (mass).

If a truck delivers material to the project and the ticket shows that the truck is overweight, the truck must then be unloaded. An adjustment for weight (mass) will be taken in accordance with Subarticle 4.06.04.

The State reserves the right to have an inspector present to monitor batching and /or weighing operations.

The mixture shall be transported from the mixing plant in trucks that have previously been cleaned of all foreign material and that have no gaps through which material might inadvertently escape. The use of kerosene, gasoline, fuel oil, or similar products for the coating of the inside of truck bodies is prohibited. Truck body coating and cleansing agents must not have a deleterious effect on the transported materials. If such agents are applied, truck bodies shall be raised immediately prior to loading to remove any excess agent.

Loaded trucks shall be tightly covered with waterproof covers acceptable to the Engineer. Mesh covers are prohibited. The front and rear of the cover must be fastened to minimize air infiltration.

3. Paving Equipment:

The Contractor shall have the paving and compaction equipment at the Project site in a sufficient amount of time before operations so that it can be inspected and approved by the Engineer. The Contractor shall repair or replace any equipment found worn or defective, either before or during paving, to the satisfaction of the Engineer.

A. Pavers: Each paver shall have a receiving hopper with sufficient capacity to provide for a uniform spreading operation and a distribution system that places the mix uniformly, without segregation. The paver shall be equipped with a vibratory screed system with heaters or burners. The screed system shall be capable of producing a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. Pavers with extendible screed units as part of the system shall have auger extensions and tunnel extenders as necessary. The screed unit shall have automatic screed controls for grade and slope unless otherwise approved by the Engineer. The controls shall automatically adjust the screed to compensate for irregularities in the preceding course or existing base. The controls shall maintain the proper transverse slope and be readily adjustable, and shall operate from a fixed or moving reference such as a grade wire or floating beam.

B. Rollers: All rollers shall be self-propelled and designed for compaction of bituminous concrete. Non-vibratory (static) rollers shall be steel wheel types. These rollers may also be of the type that can be used as vibratory rollers.

Pneumatic tire rollers shall be self-propelled and equipped with wide-tread compaction tires capable of exerting an average contact pressure from 60 to 90 pounds per square inch (420 to 620 kiloPascals) uniformly over the surface, adjusting ballast and tire inflation pressure as required. The Contractor shall furnish evidence regarding tire size; pressure and loading to confirm that the proper contact pressure is being developed and that the loading and contact pressure are uniform for all wheels.

Vibratory rollers shall be equipped with indicators that provide the operator with amplitude, frequency and speed settings/readouts to measure the impacts per foot during the compaction process.

C. Lighting: For paving operations, which will be performed during hours of darkness, the paving equipment shall be equipped with lighting fixtures as described below, or with approved lighting fixtures of equivalent light output characteristics. A sufficient number of spare lamps shall be available on site as replacements in the event of failures. The Contractor shall provide brackets and hardware for mounting light fixtures and generators to suit the configuration of the rollers and pavers. Mounting brackets and hardware shall provide for secure connection of the fixtures, minimize vibration, and allow for adjustable positioning and aiming of the light fixtures. Lighting shall be aimed to maximize the illumination on each task and minimize glare to passing traffic. The Contractor shall provide generators on rollers and pavers of the type, size, and wattage, to adequately furnish 120 V AC electric power to operate the specified lighting equipment. A sufficient amount of fuel shall be available on site. There shall be switches to control the lights. Wiring shall be weatherproof and installed to all applicable codes. The minimum lighting requirements are:

Paver lighting

Fixture	Quantity	Remarks
Type A	3	Mount over screed area
Type B (narrow) or Type C (spot)	2	Aim to auger and guideline
Type B (wide) or Type C (flood)	2	Aim 25' (8 m) behind paving machine

Roller Lighting

Fixture	Quantity
Type B (wide)	2
Type B (narrow)	2

OR

Type C (flood)	2
Type C (spot)	2

Note: All fixtures shall be mounted above the roller. Aim floodlights and wide beam lights 50 feet (15 meters) in front of and behind roller; aim spotlights and narrow beam lights 100 feet (30 meters) in front of and behind roller.

Type A: Fluorescent fixture shall be heavy-duty industrial type. It shall be enclosed and gasketed to seal out dirt and dampness. It shall be UL listed as suitable for wet locations. The fixture shall contain two 4-foot (1.2-meter) long lamps - Type "F48T12CWHO." The integral ballast shall be a high power factor, cold weather ballast, and 120 volts for 800 MA HO lamps. The housing shall be aluminum, and the lens shall be acrylic with the lens frame secured to the housing by hinging latches. The fixture shall be horizontal surface mounting, and be made for continuous row installation.

Type B: The floodlight fixture shall be heavy-duty cast aluminum housing, full swivel and tilt mounting, tempered-glass lens, gasketed door, reflector to provide a wide distribution or narrow distribution as required, mogul lamp socket for 250 watt Metal Halide lamp, 120 volt integral ballast, suitable for wet locations.

Type C: The power beam holder shall have a ribbed die cast aluminum housing, and a clear tempered-glass lens to enclose the fixture. There shall be an arm fully adjustable for aiming, with a male-threaded mount with serrated teeth and lock nuts. There shall be a 120-volt heatproof socket with extended fixture wiring for an "Extended Mogul End Prong" lamp base. The fixture shall have gaskets, and shall be UL listed as suitable for wet locations. The lamps shall be 1000-watt quartz PAR64, both Q1000PAR64MFL (flood) and Q1000PARNSP (spot) will be required.

4. Placing of Mixture: Prior to the placement of the bituminous concrete, the underlying base course shall be brought to the plan grade and cross section within the allowable tolerance. Immediately before placing the mixture, the area to be surfaced shall be cleaned by brooming or by other means acceptable to the Engineer.

Weather and Seasonal Limitations: The bituminous concrete mixture shall not be placed whenever the surface is wet or frozen or when the temperature is outside the limitations stated in Table 1 unless the contractor has a Cold Weather Paving procedure approved by the Engineer. The Contractor shall be responsible for submitting the procedure at least one week in advance of any paving operations that may result in placement of the bituminous concrete pavement outside of the temperature limitations stated in Table 1 and 1a.

**TABLE 1- English
TEMPERATURE LIMITATIONS FOR PLACEMENT OF BITUMINOUS CONCRETE
PAVEMENT**

Lift thickness (Inches)	**Minimum Air and Surface Temperatures - Degree F	
	Final Course	All Other Courses
Less than 1- 1/2 in	50	50
1-1/2 to 2-1/2 in	40	40
Over 2-1/2 in.	40	32

**TABLE 1a- Metric
TEMPERATURE LIMITATIONS FOR PLACEMENT OF BITUMINOUS CONCRETE
PAVEMENT**

Lift thickness (mm)	**Minimum Air and Surface Temperatures - Degree C	
	Final Course	All Other Courses
Less than 40 mm	10	10
40 to 60 mm	4	4
Over 60 mm	4	0

Table 1 & 1a- ** Air and surface temperatures are taken in the shade. The surface is defined as the surface on which the new bituminous concrete pavement layer is to be placed.

Placing and Compacting Mixture: The mixtures shall be placed and compacted to provide a smooth and dense surface with a uniform texture. When overtaken by sudden storms, the Engineer may permit placement of the bituminous concrete to continue up to the quantity of material that is in transit from the plant.

The mixture shall be placed at a temperature that is within 25°F (15°C) of the approved job mix formula. Before rolling is started, the mat shall be checked for defects in material or placement. Such defects shall be corrected to the satisfaction of the Engineer. Where it is impracticable due to physical limitations to operate the paving equipment, the Engineer may permit the use of other methods or equipment. Where hand spreading is permitted, the mixture shall be placed by means of suitable shovels and other tools, and in a uniformly loose layer at a depth that will result in a completed pavement having the designed depth. Any deviation from standard crown or section shall be immediately remedied by placing additional material or removing surplus as directed by the Engineer. The Engineer may direct that other means of spreading be used to ensure a better control of the depths of material and the finished surface.

A thin uniform coating of tack coat shall be applied to the pavement immediately before overlaying and be allowed sufficient time to break (set). All surfaces that have been in place longer than five calendar days shall have an application of tack coat. A tack coat shall be applied to all contact surfaces such as gutters, manholes and concrete barriers. The tack coat shall be applied by a non-gravity pressurized spray system that results in uniform overlapping coverage at an application rate of 0.05 to 0.15 gallons per square yard (140 to 450 milliliters per square meter). Gravity-fed systems are not acceptable for tack coat application. The Engineer must approve the equipment and the method of measurement prior to use. The material for tack coat shall not be heated in excess of 160°F (70°C) and shall not be further diluted.

Refueling of equipment is prohibited in any location on the paving project where fuel might come in contact with bituminous concrete mixtures already placed or to be placed. Solvents for use in cleaning mechanical equipment or hand tools shall be stored clear of areas paved or to be paved. Before any such equipment and tools are cleaned, they shall be moved off the paved or to-be-paved area; and they shall not be returned for use until after they have been allowed to dry.

Immediately before placing bituminous concrete on a waterproofing membrane, the membrane shall be swept clean. If the membrane is damaged it shall be repaired by patching as directed by the Engineer.

Temporary and permanent transverse joints shall be formed by saw-cutting a sufficient distance back from the previous run, existing bituminous concrete pavement, or bituminous concrete driveways to expose the full depth of the course. On any cold joint, immediately prior to additional bituminous concrete materials being placed, a brush of tack coat shall be used on all contact surfaces.

The longitudinal joint shall be offset at least six inches (150 millimeters) from the joint in the course immediately below. The joint in the final surface shall be at the centerline or at lane lines.

5. Compaction: In general, rolling shall consist of initial or breakdown rolling, intermediate rolling and final or finish rolling. The contractor shall furnish a sufficient number and type(s) of rollers for each paving machine to properly compact the mat. When operating the roller in the vibratory (dynamic) mode, the operator shall maintain a minimum of ten to twelve impacts per foot (30 to 40 impacts per meter). All vibratory rollers shall be shut off from the vibrating mode when reversing directions and be equipped with automatic reversing eccentrics (weights). The use of a vibratory roller in the dynamic or vibratory mode is prohibited on concrete structures such as bridges and catch basins.

If the Engineer determines that the use of vibratory compaction equipment may damage highway components, utilities or adjacent property, the Contractor shall provide alternate compaction equipment to meet specification requirements unless otherwise approved by the Engineer. The completed pavement course on roadways and bridges will have the mat and longitudinal joints tested for compaction in accordance with the "Density Testing Procedure" established by the Department's Director of Research and

Materials. Each course placed at a depth of one and one-half inches (40 mm) or greater shall have the mat and longitudinal joints compacted to a minimum of 92.0 percent and no more than 97.0 percent density as determined by AASHTO T209 (modified). Class 4 bituminous concrete is excluded from the joint density requirements.

6. Surface Tolerance: The Contractor shall perform random spot-checks with a contractor-supplied ten-foot straightedge placed parallel to the centerline of the road to verify surface tolerances. The final surface course will not vary more than 1/4 inch (6.4 millimeters) from a ten-foot (3 meter) straightedge and 3/8 inch (9.5 millimeters) for all other courses. Such tolerance will apply to all paved areas including bridge approaches, headers, and existing pavement. Any irregularity of the surface exceeding these limits shall be corrected.

7. Protection of the Work: All sections of the newly finished pavement shall be protected by the Contractor from damage by the Contractor's equipment and traffic.

8. Corrective Work Procedures: Any portion of the completed pavement determined by the Engineer to be defective in surface texture, density or composition, or that does not comply with the requirements of the specifications shall be corrected at the expense of the Contractor. Any corrective courses placed as the final wearing surface shall not be less than one and one-half inches (40mm) in depth after compaction.

If pavement placed by the Contractor does not meet the specifications, and the Engineer requires its replacement or correction, the Contractor shall:

- A. Propose a corrective procedure to the Engineer for review and approval prior to any corrective work commencing. The proposal shall include:
 1. Limits of pavement to be replaced or corrected, indicating stationing or other landmarks that are readily distinguishable.
 2. Schedule.
 3. Construction method and sequence of operations.
 4. Methods of maintenance and protection of traffic.
 5. Material sources.
 6. Names and telephone numbers of supervising personnel.
- B. Perform all corrective work in accordance with the Contract and the approved corrective procedure.

9. Joints and Cracks in Bituminous Concrete Pavement: Work under this section shall consist of constructing new joints and repairing existing joints and cracks.

- A. Equipment: All equipment shall be approved by the Engineer prior to its use.
 1. Kettle: The unit shall be a combination melter and pressurized applicator of a double-boiler type with space between the inner and outer shells filled with oil or other material not having a flash point of less than 600°F (320°C). The kettle shall include a temperature control indicator and mechanical agitator. The kettle shall be capable of maintaining the material at a temperature within 15°F (9°C) of the manufacturer's specified temperature.
 2. Compressor: The compressor shall have a sufficient capacity and length of hose to enable a continuous sealing operation.
 3. Saw: The saw shall be capable of providing a straight cut of uniform depth and width.
- B. Control of Joint Seal Material: Material that is heated or cooled beyond the manufacturer's specified temperature range shall be discarded.
- C. Sawing and Sealing Joints in Bituminous Concrete Pavement: Work under this item shall consist of making a straight-line saw cut transversely across the final course of bituminous concrete pavement directly over the new and existing Portland Cement concrete (PCC) transverse joints. The sawing and sealing of joints shall be completed for bituminous concrete pavements with a total depth of three inches (75 millimeters) or greater. The saw cut shall be immediately sealed with a joint seal material. The sawing and sealing shall commence within one week of the completion of any final course of pavement and be a continuous operation until all joints have been completed. If the final course of pavement will not be completed prior to winter shutdown, each exposed course shall have a 1/4 inch (6 millimeters) by 1/4 inch (6 millimeters) kerf cut above the new and existing transverse joints. The kerf shall be cut with a saw or abrasive wheel approved by the Engineer. The kerf cut shall not be sealed. The kerf cuts at the joints will be paid under the contract item "Kerf Cut in Bituminous Concrete Pavement".

Prior to the paving operation, the Contractor shall establish sufficient controls to locate each transverse joint. This work shall include setting markers at each joint to reference its location and

alignment, and having each of these markers tied and referenced. A written procedure for this work shall be submitted to the Engineer for review prior to commencement of such work.

The saw cut will be made by using diamond saw blades with a gang blade arrangement in order to achieve the joint detail as shown on the plans. The saw cut will be in a straight line across the pavement directly over the joint. Transverse joints shall extend to a point two feet (0.6 meter) beyond the underlying PCC pavement. The sawed joints shall be cleaned with compressed air to the satisfaction of the Engineer.

Immediately following the cleaning, the joint seal material shall be installed. When cooled, the top of the sealant material shall be recessed a minimum of 1/16 inch (1.6 millimeters) but not greater than 1/8 inch (3.2 millimeters) below the adjacent pavement surface. The roadway shall not be opened to traffic until the material has become tack free. Any depression in the sealer greater than 1/8 inch (3.2 millimeters) shall be brought up to the specified limit by further addition of joint seal material. Care shall be taken during the sealing operation to ensure that overfilling and spilling of material is avoided.

Any reflective cracking attributable to improper joint referencing or construction shall be repaired at the expense of the Contractor, in a manner approved by the Engineer for a period of one year from the date of completion of any sawed and sealed portion of final pavement.

- D. Cleaning and Sealing Joints and Cracks in Pavement: Work under this item shall consist of cleaning existing joints and cracks of all dirt, dust, loose joint material, and all deleterious matter with compressed air to the satisfaction of the Engineer. After a sufficient number of joints and cracks have been cleaned so as to ensure a continuous operation, all joints and cracks shall be sealed with joint seal material. Sealing of the joints shall be done as described in Subarticle 4.06.03-9C.
- E. Cutting and Sealing Joints in the Bituminous Concrete Shoulder: When PCC pavement is the final wearing surface a longitudinal saw cut at the interface of the bituminous concrete shoulder and PCC pavement shall be made. The saw cut shall be made in the bituminous concrete shoulder to expose the abutting edge of the PCC pavement. The size of the saw cut shall be 1/2 inch (13 millimeters) wide by 1-1/2 (38 millimeters) inches deep. Cleaning and sealing of the joints shall be done as described in Subarticle 4.06.03-9C.

10. Cut Bituminous Concrete Pavement: Work under this item shall consist of making a straight-line cut in the bituminous concrete pavement to the lines delineated on the plans or as directed by the Engineer. The cut shall provide a straight, clean, vertical face with no cracking, tearing or breakage along the cut edge.

4.06.04—Method of Measurement:

1. Bituminous Concrete Class (): The quantity of bituminous concrete mixture measured for payment will be determined by the documented net weight (mass), in tons, in accordance with Subarticle 4.06.03-1 and shall be subject to the following:

- A. Theoretical Yield: A theoretical yield is the amount of material (tons or mtons) required for placement over a given area at a planned thickness and will be calculated by the Engineer and recorded in the project records. The formula to determine theoretical yield is:

English: $(L \times W) / 9 \times PT \times 0.0575 \text{ Tons/SY/inch} = \text{Theoretical Yield (TY)}$

Where: L= Length in Feet W= Width in Feet PT= Planned thickness in inches

Metric: $L \times W \times (PT \times 1\text{m}/1000\text{mm}) \times 2.55 \text{ Mg/m}^3 = \text{TY (Mg)}$

Where: L= Length in meters W= Width in meters PT= Planned thickness in millimeters

- B. Measured Weight (Mass) Adjustments: The material in all courses of bituminous concrete except leveling courses, wedge courses and one-course applications will be subject to adjustments to thickness and area.

1. Thickness Adjustment: The average measured thickness (MT) of each lift will be determined by measurements taken by the Engineer. The total thickness of the class of material will be the sum of the average thickness of each lift. In the event the total thickness of any course of material varies from those specified on the plans beyond the tolerances shown in Table 2, the longitudinal limits of such variation will be determined by the Engineer. The locations and intervals of the measurements and all information relative thereto will be recorded in the project records by the Engineer.

Where the total thickness of the class of material exceeds that shown on the plans beyond the tolerances shown in Table 2, an adjustment will be applied. The quantity of bituminous concrete

representing the adjustment will be determined using the theoretical yield formula in Subarticle 4.06.04-1A substituting MT in lieu of PT to determine the Actual Yield (AY), and will be deducted from the tons measured for payment.

Where the thickness of the class of material is less than that shown on the plans beyond the tolerances shown in Table 2, the Contractor, with the approval of the Engineer, shall take corrective action in accordance with Subarticle 4.06.03-8. The areas where a corrective course of bituminous concrete is placed or reconstruction of pavement is performed, will be measured as though originally constructed. No compensation will be made to the Contractor for the material removed or removal of materials and disposal thereof, or for restoration of affected supporting base or adjacent construction.

TABLE 2 - Thickness Tolerances

Type of Material	Tolerance per Class of material
Class 4	+/- 3/4 inch (19 millimeters)
Classes 1, 2, and 12	+/- 1/2 inch (12.5 millimeters)

2. Area Adjustment: The horizontal limits for each course of material will be determined by measurements taken by the Engineer. The locations and intervals of the measurements and all information relative thereto will be recorded in the project records by the Engineer.

Where the horizontal limit of the course of material exceeds that shown on the plans by more than the planned depth of each course, an adjustment will be applied. The longitudinal limits representing the adjustment will be determined by the Engineer. The quantity of tons (mtons) representing the excess area will be calculated using the theoretical yield in Subarticle 4.06.04-1A and deducted from the tons measured for payment.

3. Over weight (mass) Adjustments - An adjustment to the net weight (mass) will be made when a truck delivers material to the Project and the delivery ticket shows that the truck exceeds the allowable gross weight for the vehicle type. The deduction will be taken even if the excess is not discovered until after its incorporation into the project. The quantity of tons (metric tons) representing the over weight (mass) will be deducted from the tons (metric tons) measured for payment.

- C. Material Deficiency Adjustment (MDA): Ten percent of the total quantity of material determined by the Engineer that exceeds one or more of the tolerances shown in Table 3 will be used for purposes of determining the Material Deficiency Adjustment. The tons (mtons) will be calculated as follows:

$$\text{MDA Tons (mtons)} = \text{DM} \times .10$$

Where: **DM** = Total tons (mtons) of material exceeding tolerance.

TABLE 3- JOB MIX FORMULA TOLERANCES FOR CONSECUTIVE TESTS

Classes	Criteria	% Tolerances (+/-)
-	Bitumen	0.4
1,2,4	#200 (75 µm)	2.0
1,2,4	#50 (300 µm)	4.0
1,2	#30 (600µm)	5.0
1,2,4	#8 (2.36mm)	6.0
1,2,4	#4 (4.75mm)	7.0
1,2,4	3/8", 1/2" & 3/4" (9.5,12.5,19.0mm)	8.0

- D. Density Adjustment:

1. Sampling and Testing: All density testing will be done in accordance with the "Materials Testing Manual" published by the Department's Division of Materials Testing. The density for the lot will be the average of the percent densities from the sub-lots. The density for the lot will be used to determine whether any adjustments for density apply.

a. Bridge Lot: For bridge deck pavement, a bridge lot is defined as that amount of bituminous concrete in tons (metric tons) placed in a continuous paving operation and will be the number of linear feet (meters) of structure paved. For testing purposes, a single paver pass is a sub-lot and the length of the structure will determine the number of tests per sub-lot as shown in Table 4. A test is defined as the average of two (2) density measurements. All tests from the sub-lots will be averaged to determine the density for the bridge lot.

TABLE 4 - Testing Requirement for Bridge Lot

Length of Structure Feet (meter)	MAT No. of Tests per Sub-lot	JOINT No. of Tests per Joint
Less than 1000 (300)	2	2
1000-1500 (300-450)	4	4
Greater than 1500' (450m)	4 plus 2 add'l tests for every 500' (150 m) over 1500' (450m)	4 plus 2 add'l tests for every 500' (150 m) over 1500' (450m)

b. Non-Bridge Lot: A non-bridge lot is defined as that amount of bituminous concrete placed for each lift of material in a continuous paving operation excluding bridge lots as determined by the Engineer. A lot shall be divided into equal sub-lots as indicated in Table 5. Each sub-lot will have at least one test taken. A test is defined as the average of two (2) density measurements. All tests from the sub-lots will be averaged to determine the density for the non-bridge lot.

TABLE 5 - Sub-Lots for Density Testing

Daily Production- tons (mtons)	MAT No. of Sub-lots	JOINT No. Sub-lots per joint
Less than 500 (450)	1 per 100 (90)	1 per 100 (90)
500-1500 (450-1350)	10	5
Greater than 1500 (1350)	20	10

2. Adjustment Schedule: The adjustment will be applied where the compacted depth of pavement is 1-1/2 inches (38 millimeters) or greater. Separate density adjustments will be made for non-bridge lots and bridge lots and will not be combined to establish one density adjustment.

The Contractor may request additional testing if; 1) the tests result in a negative adjustment and 2) it contends the test results are not representative of the entire continuous paving operation. If the Engineer agrees, he will establish the limits of a second lot which will only represent the material not previously tested. Additional testing will be in accordance with Subarticle 4.06.04-D-1. Any adjustment for density will be based on the average of the test results for both lots.

For purposes of making density adjustments, the following apply:

The average of the theoretical maximum specific gravity (Gmm) calculations for the material placed during a continuous paving operation will be used to establish the average percent density for any adjustment in accordance with Table 6. If none is available, the average of the Gmm calculation for the last ten days of production will be used. If more than one source of supply is used, then a weighted average will be computed using the Gmm calculation from each source of supply.

TABLE 6 - Mat and Longitudinal Joint Adjustments

Average % Density	% Adjustment (PA)
100 - 97.1	-2.5
97.0-94.0	+2.5
93.9-92.0	0.0
91.9-91.0	-2.5
90.9-89.1	-5.0
89.0-87.0	-30
86.9 or less	-50 or rejection

The amount of tons (mtons) representing the density adjustment (DA) for each lot will be calculated as follows:

DA tons (metric tons) = { [PA_M x .40] + [PA_J x .60] } X Tons (metric tons)

Where: PA_M = Mat density percent adjustment from Table 6

PA_J = Joint density percent adjustment from Table 6

2. Cut Bituminous Concrete Pavement: The quantity of bituminous concrete pavement cut will be measured in accordance with Article 2.02.04.

3. Sawing and Sealing Joints: The quantity of sawed and sealed joints measured for payment will be the actual number of linear feet (meters) of joints sawed and sealed in the bituminous concrete pavement surface accepted by the Engineer.

4. Kerf Cut in Bituminous Concrete Pavement: The quantity of kerf cuts measured for payment will be the actual number of linear feet (meters) of kerf cuts in the bituminous concrete pavement surface accepted by the Engineer.

5. Cleaning and Sealing Joints and Cracks: The quantity of cleaned and sealed joints and cracks measured for payment will be the actual number of pounds (kilograms) of joint seal material accepted by the Engineer. Weights as marked on the shipping containers shall be used; or if directed by the Engineer, scales shall be furnished by and at the expense of the Contractor, and the joint seal material weighed in a manner satisfactory to the Engineer.

6. Cutting and Sealing Joint in the Bituminous Concrete Shoulder: The quantity of cut and sealed joints measured for payment will be the actual number of linear feet (meters) of joints cut and sealed in the bituminous concrete shoulder and accepted by the Engineer.

7. Material for Tack Coat: The quantity of tack coat will be measured for payment by the number of gallons (liters) furnished and applied on the Project and accepted by the Engineer. There are two methods of measurement allowed: 1) Material furnished in a container will be measured to the nearest one-half gallon (liter). The volume will be determined by either measuring the volume in the original container by a method approved by the Engineer or using a separate graduated container capable of measuring the volume to the nearest one-half gallon. The container in which the material is furnished must include the description of material, including lot number or batch number and manufacturer or product source. 2) The Engineer will establish a weight per gallon (mass/liter) of the bituminous material based on the specific gravity at 60°F (15°C) for the material furnished. The number of gallons (liters) furnished will be determined by weighing the material on scales furnished by and at the expense of the Contractor.

4.06.05—Basis of Payment:

1. Bituminous Concrete, Class (): The furnishing and placing of bituminous concrete will be paid for at the Contract unit price per ton (metric ton) for "Bituminous Concrete, Class ()." The cost for providing lighting for the purpose of illuminating the work area and equipment shall be considered part of the Contractor's equipment and tools, and will not be measured for payment, but will be included in the general cost of the work.

No payment will be made for any work related to the replacement or correction of defective pavement. Related work includes items such as the removal and replacement of bituminous concrete, maintenance and protection of traffic, density testing, pavement repairs, replacement of bridge joints, pavement markings and any other work that is deemed necessary by the Engineer to provide an acceptable pavement.

2. Adjustments: Contract items will be incorporated by construction order for material deficiency and density adjustments as measured in Subarticle 4.06.04-1C and 1D.

1. Material Deficiency Adjustment (MDA): The quantity of MDA tons (metric tons) measured in Subarticle 4.06.04-1C will be used to determine the adjustment value and will be calculated as follows:

MDA tons (metric tons) X Net Price per ton (metric ton)* = MDA Adjustment

***Net Price per ton (metric ton)** is the F.O.B. price at the material vendor's plant furnishing the material as shown in the most recent Annual Bid Contract Award entitled "1304- Bituminous Concrete Materials and Bituminous Materials with Fibers." In the event a vendor has not bid on the above contract award, the price per ton (metric ton) will be computed by averaging the bid price of three vendors closest to the non-bidding vendor's plant.

2. Density Adjustment (DA): The quantity of DA tons (metric tons) measured in Subarticle 4.06.04-1D will be used to determine the adjustment value and will be calculated as follows:

DA Tons (metric tons) X Contract Unit Price = DA Adjustment

3. The cutting of bituminous concrete pavement will be paid in accordance with Article 2.02.05.

4. The sawing and sealing of joints will be paid for at the Contract unit price per linear foot (meter) for "Sawing and Sealing Joints."

5. Kerf cuts will be paid for at the Contract unit price per linear foot (meter) for "Kerf Cut in Bituminous Concrete Pavement."

6. The cleaning and sealing of joints and cracks will be paid for at the Contract unit price per pound (kilogram) for "Cleaning and Sealing Joints and Cracks."

7. The cutting and sealing of joints in the bituminous concrete shoulders will be paid for at the Contract unit price per linear foot (meter) for "Cutting and Sealing Joint in the Bituminous Concrete Shoulder."

8. Material for tack coat will be paid for at the Contract unit price per gallon (liter) for "Material for Tack Coat."

Payment will be for the items completed and accepted by the Engineer, the price of which shall include all labor, materials and equipment incidental thereto.

Pay Item	Pay Unit
Bituminous Concrete, Class ()	ton (mtons)
Sawing and Sealing Joints	l.f. (m)
Kerf Cut in Bituminous Concrete Pavement	l.f. (m)
Cleaning and Sealing Joints and Cracks	lb. (kg)
Material for Tack Coat	gal. (L)
Cutting and Sealing Joint in the Bituminous Concrete Shoulder	l.f. (m)

SECTION 4.14 BITUMINOUS SURFACE TREATMENT

4.14.01—Description: This work shall consist of furnishing and applying a bituminous surface treatment with one or more covers of sand, where called for on the plans or directed by the Engineer. It shall also include sweeping, spotting, dragging, honing or manipulation of the surface after the application of the sand, distributing, mixing and smoothing the combination of bituminous material and sand in such manner as the Engineer shall direct.

Unless specifically authorized by the Engineer, this work shall be performed only when the surface to be treated is free of frost, dry and when the atmospheric temperature is not less than 40°F (5°C).

4.14.02—Materials: The materials for this work shall conform to the requirements of Article M.05.02.

4.14.03—Construction Methods: If the surface of the road is water-bound macadam, the Contractor shall sweep the surface free of screenings and any foreign materials, down to the large stone, before any bitumen is applied, care being exercised not to dislodge any stones. If the surface is gravel, it shall be dragged and honed, leaving the surface true to line and grade before the bituminous material is applied.

When the surface is in proper condition for surface treatment, bituminous material shall be applied at the rate of approximately 1/2 gallon (2.3 liter) per square yard (square meter), or as directed. All equipment used for applying bituminous material shall be in good mechanical condition and capable of distributing the bituminous material uniformly and as required by the Engineer. Operators of distributing equipment shall be competent, experienced and qualified.

All bituminous carriers used in delivering bituminous material shall be clean, free from dirt, foreign material and material from previous loadings. Such carriers shall contain no material which shall tend to clog pipe lines and pumps of distributors.

All bituminous distributors shall be equipped with satisfactory heating apparatus to insure proper application. They must also be equipped with approved tachometers or other acceptable equipment in good working condition to permit accurate determination of rate of application for all grades of tars and asphalts, for varying widths of spraybars, through coordination of vehicle speed and pump output. Distributor operators must be trained in the use of these devices. Distributors must be equipped with hand hose in operating condition for use in covering areas inaccessible to standard spray bars. The distributors shall also have equipment for the effective removal of excess bitumen at stops and starts.

Temperature of the material and method of application shall be as specified by the Engineer.

Areas receiving an initial bituminous treatment, and areas where no sand cover is specified after the first application of bitumen, shall be dragged and honed as required by the Engineer after the first surface treatment with bituminous material.

The Contractor shall protect all curbs and structures from damage or disfigurement due to the application of bituminous material.

Sand cover shall be spread by such equipment and methods as will provide uniform application.

Unless otherwise directed, immediately after the first coat of bituminous material has been applied, sand cover shall be spread in an amount sufficient to prevent the bitumen from seeping off the surface. If ordered by the Engineer, the road shall then be dragged with an approved drag until the bituminous material and sand are thoroughly mixed and uniformly distributed over areas that have received an application of sand. Care shall be exercised to prevent the dragging from cutting through the coat of bituminous sand mixture. Surplus sand shall be removed and disposed of as directed. Additional sand shall be applied if ordered by the Engineer.

When the surface receiving the bituminous treatment is in satisfactory condition, it shall be swept clean of all sand and foreign matter and then a second application of bituminous material, of the grade specified by the Engineer, shall be made at the rate of approximately 1/3 of a gallon per square yard (1.5 liter per square meter).

After the second application of bituminous material is made, the application of sand cover and its manipulation as specified above shall be repeated. The Contractor shall apply a light coat of sand as a final cover in an amount specified by the Engineer. The light coat of sand used as a final cover is not considered to be a separate application and will not be paid for as such.

In cases where a single application of sand cover is indicated on the plans, and where the Engineer does not deem it necessary, the initial treatment of bituminous material shall remain uncovered. In these cases,

sand cover will only be required on the second application of bituminous material.

4.14.04—Method of Measurement: Bituminous material will be measured as follows: The laboratory shall establish a weight per gallon (mass per liter) of the bituminous material, based on the specific gravity at 60°F (16°C), for the material furnished. The number of gallons (liters) furnished will be determined by measuring the material on scales furnished by and at the expense of the Contractor.

The quantity of sand for cover to be measured for payment under this item will be the number of square yards (square meters) of surface actually receiving a sand cover as specified above, after each treatment with bituminous material.

4.14.05—Basis of Payment: When asphalt or asphalt emulsion is ordered used by the Engineer, this work will be paid for at the contract unit price per gallon (liter) for "Bituminous Material for Surface Treatment," furnished and applied, which price shall include all material, labor, equipment and work incidental thereto, including dragging, honing and preparation, as specified above, and all heating as required.

When tar is ordered used by the Engineer, payment will be made on the basis described above, except that the unit price per gallon (liter) will be adjusted by the application of a predetermined cost differential. The amount of this cost differential will be stated in the contract.

Sand for cover will be paid for at the contract unit price per square yard (square meter) measured as above for "Sand Cover for Bituminous Surface Treatment," complete in place, which price shall include all materials, equipment, tools, labor, dragging, honing and work incidental thereto.

Pay Item	Pay Unit
Bituminous Material for Surface Treatment gal. (L)	
Sand Cover for Bituminous Surface Treatment	s.y. (s.m)

**SECTION 4.15
PRESSURE RELIEF JOINT**

4.15.01—Description: Work under this item shall consist of constructing, in the new or existing reinforced concrete pavement, a pressure relief joint composed of a bituminous concrete pavement course on a bituminous concrete base course. The pressure relief joint shall be constructed on the prepared subbase in accordance with these specifications and in conformity with the lines, grades, compacted thickness, pavement class, and cross-sections shown on the plans.

4.15.02—Materials: Materials shall conform to the requirements of Section M.04.

4.15.03—Construction Methods: Construction methods of pressure relief joints shall conform to the applicable requirements of Section 4.06, 2.02, and 2.12. Prior to the installation of the pressure relief joint, the subbase shall be adjusted to the correct grade, with additional material, if required, and compacted.

4.15.04—Method of Measurement: This work will be measured by the actual number of square yards (square meters) of completed and accepted pressure relief joint.

4.15.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Pressure Relief Joint", completed and accepted in place, which price shall include all materials, equipment, tools and labor and work incidental thereto.

There will be no payment for cutting concrete pavement and bituminous concrete pavement, removal of concrete pavement and bituminous concrete pavement, additional subbase, and compaction of subbase, but the cost thereof shall be considered in the general cost of the pressure relief joint.

Pay Item	Pay Unit
Pressure Relief Joint	s.y.(s.m)

STRUCTURES
SECTION 5.01
GENERAL CLAUSES

5.01.01—Preservation of Channel: Unless otherwise specified, no excavation shall be made outside of cofferdams; and the natural bed adjacent to the structure shall not be disturbed without permission from the Engineer. If the Contractor does any excavating or dredging at the site of the structure before cofferdams or similar construction are in place, he shall, without extra charge, after the foundations are in place, backfill all such excavated areas to the level of the original ground surface or stream bed with material satisfactory to Engineer. Material deposited within the stream area from foundation or other excavation or from the filling of cofferdams, and all temporary construction resulting from the Contractor's operations shall be removed so as to leave the whole in a neat and presentable condition satisfactory to the Engineer.

Structures or any portions thereof, which are founded on bedrock, shall not be constructed until all required rock excavation within a minimum distance of 100 feet (30 meters) is completed to the slope lines and depths indicated on the plans.

The Contractor shall carry out his construction operations in conformity with all Federal, State or local requirements relative to the locations and dimensions of channel openings. He shall not obstruct such channels as are required for navigation purposes or the free flow of the stream at any time, except to such extent as the Engineer and other authority may permit; and he shall be responsible for all damage, both to the work and to the property of others, resulting from any temporary obstruction that he may have placed in the channel or stream bed.

5.01.02—Navigable Streams and Harbors: When performing construction work in, over or immediately adjacent to navigable waters, the work shall be carried out subject to the requirements of DEP and the Corps of Engineers, U.S. Army, relative to channel clearance and depth, obstructions, etc.; and the work shall be lighted and protected as may be required by the U.S. Coast Guard or other Federal agency having jurisdiction.

No excavated material shall be deposited in navigable waters or adjacent thereto except as permitted by the Corps of Engineers, U.S. Army.

5.01.03—Railroad Crossings: When the contract includes work to be done on, over, under or immediately adjacent to the right of way of any railroad company, the work shall be subject to inspection by representatives of the railroad company, insofar as its interests are concerned; and all operations affecting railroad property or the operation of trains shall be carried on in accordance with the railroad's requirements. The Contractor shall comply with all instructions given relative to the preservation of property, the operation of trains and the safety of all concerned.

The railroad company will provide flagmen for the protection of railroad traffic and those engaged in the work during periods when the nature of the Contractor's operations is such as to make it necessary. The character and extent of the flag protection necessary shall be determined and agreed upon by the railroad company and the Engineer.

Payment for any special or unusual work required to be done by the Contractor shall be described in the special provisions.

The Contractor shall carry insurance in conformity with the requirements of Article 1.03.07. The amount of coverage required may be varied, depending upon the location and character of the project, and then shall be as stated in the special provisions. The limits of liability with respect to insurance in favor of the Contractor and that in favor of the railroad will then be as stated in the special provisions.

Contractor's public liability and property damage insurance shall furnish protection to the Contractor only in respect to his operations, or those of his subcontractors, in performing the work covered by the contract. However, when railroad employees are assigned or loaned to the Contractor to perform work in connection with his operations which are not in any way connected with the movement of trains of the railroad, or is not done under the direct control of the railroad, and if such employees are subject to the direction and control of the Contractor in all matters pertaining to their work and are employees of the Contractor, as evidenced by his payrolls, then the insurance coverage shall include such railroad employees so assigned or loaned to the Contractor.

Railroads' protective public liability and property damage insurance shall furnish protection to the railroad only in respect to the direct operation of the Contractor and subcontractors in performing the work covered by the contract, including acts and omissions of all regular employees of the Contractor and subcontractors in connection with the work. The policy will definitely exclude coverage from liability imposed upon

railroads by law due to their negligence or the negligence of their agents or employees in connection with all their direct operations, including railroad operations, any construction or other work that may be performed by them in connection with the project, and also in connection with the acts and omissions of all railroad employees assigned to the work covered by the contract. However, when railroad employees are assigned or loaned to the Contractor to perform work in connection with his operations, which is not in any way connected with the movement of trains of the railroad, or is not done under the direct control of the railroad, and if such employees are subject to the direction and control of the Contractor in all matters pertaining to their work and are employees of the Contractor, as evidenced by his payrolls, then such railroad employees so assigned or loaned to the Contractor shall not be deemed to be employees of the railroad under the policy; but in no event will the policy afford coverage for the railroad in respect to injuries to such railroad employees themselves not arising from the negligence of the Contractor or his employees.

SECTION 5.03
REMOVAL OF AND ALTERATIONS TO
EXISTING BRIDGES

5.03.01—Description: This work shall include the removal and satisfactory disposal of all bridges or parts of bridges, including superstructure, substructure and approaches, the removal of which is necessary to the final completion of the work. When stated in the special provisions or on the plans, the bridge may be required to be removed before permanent construction is started; or it may be required to be kept open for the use of traffic during the construction of the new work and to be removed after its final completion.

It shall also include alterations or additions to or strengthening of existing bridges which are not to be removed when such work is included in the requirement of the plans and special provisions.

All work shall be done in accordance with the requirements of the plans or as ordered and in conformity with these specifications.

5.03.02—Materials: The materials required for this work shall be as shown on the plans or as ordered. All materials shall conform to the requirements of these specifications or the special provisions for the material in question; or if not so specified, they shall be of a quality satisfactory to the Engineer.

5.03.03—Construction Methods: Existing bridges which are to be removed by the Contractor shall be taken down and disposed of by such methods as he may propose, subject to the approval of the Engineer. Care shall be taken that the removal does not result in injury to any permanent construction or to adjoining property. Any material designated to remain the property of the Department shall be carefully removed and stored at a point adjacent to the site to be designated by the Engineer. When so required by the Engineer, the several parts shall be match-marked as directed to facilitate re-erection. Any suitable concrete, masonry or similar material removed shall be placed in approach embankments or used for slope or foundation protection if the Engineer so directs. All material not designated for definite use shall be disposed of by the Contractor.

When an existing structure is to be used by traffic during the construction of the new work, the Contractor shall relocate and strengthen it, if so required by the plans and special provisions. Temporary approaches shall be built if required, and the structure and approaches shall be repaired and renewed as necessary to keep them in a safe and satisfactory condition for the use of traffic at all times until the new structure is completed and open to traffic. 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. Such requirements of Article 5.02.03 as are pertinent shall apply equally to this construction.

The Contractor shall take all precautions and do such work as may be necessary to prevent damage to the structure or approaches due to his construction operations. When no longer required for traffic, the structures shall be removed, as specified above, and the approaches graded in accordance with the requirements of the plans or as ordered.

All existing piers, abutments or other portions of structures that constitute obstructions to stream channels shall be removed down to the bed of the stream, unless otherwise specified on the plans. Any portions of existing structures not within a stream channel, shall be removed to a depth of 1 foot (300 millimeters) below the surface of the surrounding ground unless otherwise shown on the plans or directed by the Engineer.

When an existing structure is to be altered, added to or strengthened as part of the permanent construction, the work shall be done in conformity with the plans, special provisions and these specifications for the kind of material or work involved. In widening or altering an existing concrete structure, concrete shall not be removed by methods that are likely to cause damage to the concrete or reinforcement that are to remain in place in the completed structure. All reinforcement intended to be reused shall be cleaned and straightened or bent to the required dimensions.

5.03.04—Method of Measurement: Measurements necessary to determine the quantities for payment under any of the requirements specified above shall be made in accordance with the requirements of these specifications for the items involved unless otherwise stated on the plans or in the special provisions.

5.03.05—Basis of Payment: Payment for the above-described work shall be made as follows:

When a superstructure is to be removed, whether the total structure is to be removed or just the superstructure, the work will be paid for at the contract lump sum price for "Removal of Superstructure", at the location designated, complete including disposal of material and all materials, equipment, tools and labor incidental thereto. In the absence of the item "Removal of Superstructure," the work will be paid as

extra work.

Payment for removing piers, abutments and substructures generally shall be at the contract unit price per cubic yard (cubic meter) for "Removal of Existing Masonry", or in the absence of this item, as extra work.

Where existing bridges are to be strengthened as shown on the plans, maintained for the use of traffic during construction, either in their original position or relocated, such work shall be paid for at the contract lump sum price for "Maintaining Existing Bridge" at the location designated. This price shall include alteration and maintenance of the structure and all materials, tools, equipment and labor incidental thereto. The removal of substructures will be included in the excavation items as specified above. The construction and maintenance and later removal of the approaches will be paid for as extra work, unless the work is covered by contract items.

When existing structures are to be altered, added to or strengthened as part of the permanent construction, the work to be done will be paid for in accordance with the provisions of these specifications for the character of work or material involved; or where not covered herein, the basis of payment shall be as described in the special provisions.

Pay Item	Pay Unit
Removal of Superstructure	l.s. (l.s.)
Maintaining Existing Bridge	l.s. (l.s.)

SECTION 5.04
RAILROAD PROTECTION

5.04.01—Description: This item shall consist of securing protective services such as flagmen, conductors and similar protective labor from the railroad for work occasioned by the operations of the Contractor on, over, under or adjacent to the railroad right-of-way. It shall include the securing of any required protective devices. Such services and devices shall be for the protection of the railroad and those engaged in work during periods when the nature of the Contractor's work is such as to make it necessary.

The amount and type of railroad protection shall be as required by the railroad and it shall be the responsibility of the Contractor to determine from the railroad the amount of protection required and all items of expense related thereto, such as prevailing and future labor rates and other charges.

The service shall be secured by the Contractor and he shall reimburse the railroad in accordance with its terms on such transactions. The Contractor is warned that the railroad may require advance payment of all or a portion of the amount to become due.

5.04.02—Vacant

5.04.03—Vacant

5.04.04—Method of Measurement: This work will be measured for payment by the number of hours for each person rendering such services at the project site as approved by the Engineer. Protective services for railroad crossing at other locations or at locations solely for the convenience or benefit of the Contractor will not be measured for payment.

5.04.05—Basis of Payment: This work will be paid for at the contract unit price per hour for "Railroad Protection," which price shall include all work, material and services provided by the railroad for protective services required by the operations of the Contractor on, over, under or adjacent to the railroad and approved by the Engineer.

Protective services for railroad crossings at other locations or at locations solely for the convenience or benefit of the Contractor shall be the responsibility of and at the expense of the Contractor and will not be included in this item.

Final settlement with the Contractor will be contingent upon proof that the railroad has been reimbursed for all necessary railroad protective services or that satisfactory arrangements have been made for such reimbursement.

Pay Item	Pay Unit
Railroad Protection	hr. (hr.)

SECTION 5.06
RETAINING WALLS, ENDWALLS AND STEPS

5.06.01—Description: Under this heading shall be included all concrete and masonry retaining walls, endwalls, steps and other miscellaneous structures.

All such structures shall be built in the locations indicated or directed, conforming to the lines, grades, dimensions and details shown on the plans and in accordance with the provisions of these specifications for the various contract items which constitute the completed structure.

5.06.02—Materials: The materials furnished and used in the work shall be those prescribed herein for the several contract items which constitute the completed structure.

Unless otherwise noted, concrete shall be Class "A" Concrete conforming to Article M.03.01, except that the concrete for steps and copings shall be Class "C" Concrete conforming to Article M.03.01.

5.06.03—Construction Methods: All construction methods for endwalls, retaining walls, steps and other miscellaneous structures shall be in accordance with the detailed requirements prescribed for the construction of the several contract items entering into the completed structure. All requirements relative to concrete structures that are pertinent shall apply equally to work covered by this section.

1. Foundations shall be excavated to the depth shown on the plans, unless the character of the material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer. Should suitable material not be encountered at depths to which it is practicable to excavate, piles shall be driven or other special treatment employed as the Engineer may direct. Piles shall be driven in conformity with the requirements of the plans and shall be either vertical or battered, as the Engineer may require. Special treatment of foundations shall conform to the requirements of the plans and special provisions; or if not specified therein, shall be as directed by the Engineer and will be classed as extra work or additional work. No construction material shall be placed in any foundation until the Engineer has examined the material encountered and approved its character and the depth of the excavation.

2. Endwalls shall be built in the location and to the dimensions and details shown on the plans; or as ordered, and they shall be neatly and accurately finished, true to the lines and grades given. Pipes shall be of sufficient length to extend to the exposed face of the endwall, and the end shall be finished to provide neat, watertight joints. The ends of pipe culverts which enter endwalls on a skew shall be cut to the angle of the skew; or the short side of the pipe may be built out with adequate forms, if this method is approved by the Engineer.

3. Retaining Walls shall be built in the location and to the dimensions and details shown on the plans or as ordered. Drainage of retained material shall be provided as specified in Section 2.16 and as shown on the plans.

4. Steps shall be built where indicated or directed to the dimensions and details shown on the plans or as ordered and in accordance with the requirements of these specifications.

5.06.04—Method of Measurement: The quantities of the various contract items entering into the completed work shall be determined in accordance with the provisions of the plans and specifications for the several items involved. Only accepted work shall be included, and the dimensions used shall be those shown on the plans, except as modified by the written orders of the Engineer.

5.06.05—Basis of Payment: Payment will be made for the actual quantities of accepted work or materials, measured as provided above, at the contract prices for the several items involved, which prices shall be full compensation for all materials, tools, equipment and labor necessary to the completion of the work.

Concrete for steps and for copings on masonry endwalls or retaining walls will be paid for at the contract unit prices per cubic yard (cubic meter) for "Concrete for Steps and Copings" complete in place including all incidental expense. Reinforcement, if used, will be paid for in accordance with the provisions of these specifications for the kind of material involved.

Excavation necessary for the construction of endwalls will be paid for in accordance with Section 2.05.

Excavation necessary to the construction of steps will not be measured or paid for directly, but the cost thereof shall be included in the cost of the concrete item.

Excavation necessary to the construction of retaining walls will be paid for in accordance with Section 2.02 with respect to the classification applying to the balance of the project, unless otherwise specified.

There will be no direct payment for the cost of forming keys or construction joints, but the cost thereof shall be included in the cost of the concrete items. Where steel dowels are used, this material will be paid for under the reinforcement item.

There will be no direct payment for forming weep holes through the walls or for the pipe necessary for the purpose, but the cost thereof shall be considered as included in the general cost of the work.

Expansion joints will not be paid for as such, but the various materials entering into their construction shall be paid for at the contract prices for the materials in question, complete in place, including all incidental expense.

Pay Item	Pay Unit
Concrete for Steps and Copings	c.y. (cu. m)

**SECTION 5.07
CATCH BASINS, MANHOLES AND
DROP INLETS**

5.07.01—Description

5.07.02—Materials

5.07.03—Construction Methods

5.07.04—Method of Measurement

5.07.05—Basis of Payment

5.07.01—Description: Under this heading shall be included the construction of all catch basins, junction boxes, manholes and drop inlets (and also the alteration, reconstruction or conversion of such existing structures) all in conformity with the lines, grades, dimensions and details shown on the plans, or as ordered, and in accordance with the provisions of these specifications for the various materials and work which constitute the completed structure.

When it becomes necessary to increase the horizontal dimensions of manholes, catch basins, junction boxes and drop inlets to sizes greater than those shown on the plans in order to provide for multiple pipe installations or large pipes or for other reasons, the Contractor shall construct such manholes, catch basins and drop inlets to modified dimensions as directed by the Engineer.

5.07.02—Materials: The materials to be used in the construction shall be those indicated on the plans or ordered by the Engineer and shall conform to Article M.08.02. Protective compound material shall conform to Subarticle M.03.01-11. Galvanizing shall conform to Article M.06.03.

Mortar shall conform to Article M.11.04.

Pervious material shall conform to Article M.02.05.

Geotextile shall be of a type appearing on the Department's Approved Products List for Geotextiles, referred to in Subarticle M.08.01-26.

5.07.03—Construction Methods: These structures shall be constructed in accordance with the requirements contained herein for the character of work involved. The provisions of Article 6.02.03 pertaining to bar reinforcement shall apply except that shop drawings need not be submitted for approval, unless called for on the plans or directed by the Engineer. Welding shall be performed in accordance with the applicable sections of the AWS Structural Welding Code, D1.1.

The surfaces of the tops of all catch basins, junction boxes and drop inlets shall be given a coat of protective compound material immediately upon completion of the concrete curing period at the rate of .04 gallons per square yard (0.2 liter per square meter).

All masonry units shall be laid in full mortar beds.

Metal fittings for catch basins, junction boxes, manholes or drop inlets shall be set in full mortar beds or otherwise secured as shown on the plans.

Inlet and outlet pipes shall extend through the walls for a sufficient distance beyond the outside surface to allow for satisfactory connections, and the concrete or masonry shall be constructed around them neatly to prevent leakage along their outer surfaces. The pipe shall be cut flush with the inside face of the wall, or as shown on the plans.

When constructing a new drainage structure within a run of existing pipe, the section of existing pipe disturbed by the construction shall be replaced with new pipe of identical type and size extending from the drainage structure to the nearest joint of the existing pipe.

Pervious material shall be used for backfilling the upper portion of the excavation made for catch basins and drop inlets down to the elevation of the invert of the outlet pipe but in no case to a depth greater than 3 feet (1 meter) below the top of the structure. Drainage openings shall be formed in the four walls of the structure at or immediately above the bottom of the pervious backfill to convey subsurface drainage. The openings shall be covered with geotextile. Depending on the masonry used in the walls, such openings shall be formed by the insertion of 2-inch (50-millimeter) pipes, omission of a header brick or by leaving two open vertical joints in the masonry.

Frames, covers and tops which are to be reset shall be removed from their present beds, the walls or sides shall be rebuilt to conform to the requirements of the new construction and the tops, frames and covers reset, or the grates or covers may be raised by extensions of suitable height approved by the Engineer.

Extensions shall not be used on catch basins or drop inlets at pavement low points or where adjacent curbing is being raised. Extensions for catch basins or drop inlets shall be tack welded to the frame in four locations approximately at the mid points of each side of the frame. If the frames, covers or tops are broken or so damaged as to be unfit for further use, they shall be replaced with new, sound material conforming to

the above requirements for the material involved.

5.07.04—Method of Measurement: Construction, reconstruction and conversion of catch basins, manholes and drop inlets will be measured as units.

The depth of a unit shall be the total depth, measured from the highest point of the grate or cover to bottom of floor slab.

Conversion of catch basins to catch basins of the type specified or to manholes, as the case may be, will be measured for payment as a unit including excavation, cutting of pavement, removal and replacement of pavement, pervious material, backfill and all necessary alterations to the walls and furnishing and setting the frame and grate or cover, whichever applies.

There will be no measurement or direct payment for the application of the protective compound material, but the cost of this work shall be considered as included in the general cost of the work.

Resetting tops, frames and covers will be measured as units.

Replacement of tops, frames and covers will be paid for as a unit for resetting plus the unit for catch basin top or manhole frame and cover.

When resetting tops, frames and covers, there will be no measurement for excavation; cutting, removal and replacement of pavement; pervious material and backfill.

Measurement for payment for work and materials involved with installing pipes to connect new drainage structures into a run of existing pipe will be as provided for under the applicable contract items.

5.07.05—Basis of Payment: These structures will be paid for as follows:

1. Excavation will be paid for as "Trench Excavation" in accordance with the provisions of Article 2.05.05.

2. Catch Basins, Junction Boxes and Manholes having a depth of not over 10 feet (3 meters) will be paid for at the contract unit price each for "Junction Box," "Catch Basin," of the type specified, or "Manhole," of the type specified, complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

3. Catch Basins, Junction Boxes and Manholes having a depth of more than 10 feet (3 meters) will be paid for at the Contract unit price each for "Catch Basin over 10 feet (3 meters) deep", "Junction Box over 10 feet (3 meters) deep", or "Manhole over 10 feet (3 meters) deep," of the type specified, complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

4. Drop Inlets will be paid for at the contract unit price each for "Drop Inlet," of the type specified, complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

5. Reset Units will be paid for at the contract unit price each for "Reset Manhole," "Reset Catch Basin," or "Reset Drop Inlet," of the type specified, respectively, complete in place, which price shall include excavation, pervious material, backfill, cutting of pavement, removal and replacement of pavement structure, and all materials, equipment, tools and labor incidental thereto, except that when the work requires reconstruction greater than 3 feet (1 meter), measured vertically, then the entire cost of resetting the unit will be paid for as extra work in accordance with the provisions of Article 1.04.05.

6. Manholes, Catch Basins, and Drop Inlets, constructed to modified dimensions as directed by the Engineer, will be paid for as follows:

Where the interior floor area, as measured horizontally at the top of the base of the completed structure, does not exceed 125% of the interior floor area as shown on the plans for that structure, the structure will be paid for at the contract unit price for "Manhole," "Catch Basin," or "Drop Inlet" of the type specified. The increase in the unit price for the individual structure shall be in direct proportion to the increase of the completed interior floor area over the interior floor area as shown on the plans for that structure. Such increased unit price shall include all materials, equipment, tools, and labor incidental to the completion of the structure.

Where shown on the plans or where directed by the Engineer, catch basins shall be constructed with paved inverts and no sumps. Paved inverts in catch basins without sumps shall be formed as shown on the plans for manholes. These will be paid for as catch basins of the type specified, as provided above.

7. Pervious Material and Geotextile will not be paid for directly, but the cost thereof shall be included in the contract unit price each for the type of drainage structure where used.

8. "Frames, Covers and Tops" when required in connection with reset units, will be paid for at the contract unit price each for such "Manhole Frame and Cover or (Type) Catch Basin Top", complete in place, including all incidental expense; or when no price exists, the furnishing and placing of such material will be paid for as extra work.

When the catch basin top has a stone or granite curb in its design, this curb or inlet shall be included in the

cost of the top.

9. Conversion of drainage structures will be paid for at the contract unit price each for "Convert Catch Basin to (Type) Catch Basin," "Convert Catch Basin to Manhole," or "Convert of Manhole to Catch Basin," complete in place, which price shall include excavation, cutting of pavement, removal and replacement of pavement, pervious material, backfill, all alterations to present catch basin, all materials including catch basin frame and grate of the type specified, or manhole frame and cover, all equipment, tools and labor incidental thereto.

The maximum change in elevation of frame under these items shall not exceed 3 feet (1 meter). Greater changes if required will be paid for as extra work, in accordance with the provisions of Article 1.04.05, unless otherwise provided.

Pay Item	Pay Unit
(Type) Catch Basin	ea. (ea.)
(Type) Catch Basin Over 10' (3 m) Deep	ea. (ea.)
(Type) Drop Inlet	ea. (ea.)
Manhole (Type)	ea. (ea.)
Manhole (Type) Over 10' (3 m) Deep	ea. (ea.)
Reset Catch Basin (Type),	
Drop Inlet (Type), Reset Manhole	ea. (ea.)
Manhole Frame and Cover	ea. (ea.)
Convert Catch Basin to (Type) Catch Basin	ea. (ea.)
Convert Catch Basin to Manhole	ea. (ea.)
Convert Manhole to Catch Basin	ea. (ea.)
(Type) Catch Basin Top	ea. (ea.)
(Type) Junction Box	ea. (ea.)
(Type) Junction Box - Over 10' (3 m) Deep	ea. (ea.)

**SECTION 5.08
SHEAR CONNECTORS**

5.08.01—Description: This item shall consist of furnishing, placing and welding stud shear connectors to the top of structural steel supporting members to induce composite action with the concrete slab. The shear connectors shall conform to the details, size and quantity shown on the plans for the designated locations.

5.08.02—Materials: Stud shear connectors shall conform to the requirements of Subarticle M.06.02-12.

5.08.03—Construction Methods: The surface on which the shear connectors are to be welded shall be thoroughly cleaned of mill scale, rust, dirt, paint, grease or other materials which would reduce the quality of the weld. The stud shear connectors shall be free from rust scale, rust pits and oil at the time of welding.

Before welding any stud shear connectors, the Contractor shall submit for the Engineer's approval a notarized laboratory qualification from the manufacturer certifying that each shipment of material meets the minimum requirements. Each separate container shall be clearly tagged or marked by the manufacturer for identification with the certified laboratory qualification.

Stud shear connectors shall be end welded with automatically timed stud welding equipment connected to a recommended power source. If two or more stud welding guns are to be operated from the same power source, they shall be interlocked so that only one gun can operate at a time and so the power source has fully recovered from making one weld before another weld is started. Studs may be stacked to meet heights greater than the 8-inch (200-millimeter) maximum for individual studs.

Welding, either in the shop or field, will not be permitted when the air temperature is below 35°F (2°C), except with the special permission of the Engineer, and in no case will welding be permitted when air temperature is below 25°F (-3°C); or when surfaces to be welded are wet from condensation, rain, snow or ice, when rain or snow is falling on the surfaces to be welded, or during periods of high wind, unless the welding operation and the work are properly protected. The minimum requirement for preheat tabulated elsewhere herein and in the current "ANSI/AASHTO/AWS D1.5 Bridge Welding Code" shall apply, except where the requirements noted above shall take precedence. While in operation, the welding gun shall be held in position without movement until the weld metal has solidified. After cooling, the ferrules shall be removed from each stud.

Two successive studs on each beam or girder shall be welded and withstand the test of being bent to 45° by striking with a hammer (without weld or stud failure) before proceeding with further stud welding. The Engineer shall be promptly informed of any changes in the welding procedure at any time during construction. If the reduction in the height of studs as they are welded becomes less than normal, welding shall be stopped immediately and not resumed until the cause has been determined and corrected.

When so directed by the Engineer, the Contractor shall test additional studs by bending. Studs exhibiting no signs of failure after bending shall be left in the bent position.

Before welding a new stud where a defective one has been removed, the area shall be ground smooth and flush; or in the case of a pullout of metal, the pocket shall be filled with weld metal using the shielded metal-arc process with low-hydrogen welding electrodes and then ground flush. Where a stud is defective or does not have a full 360° weld, a new stud may be welded adjacent to the defective stud. However, this may be done only in areas of compression or where permitted by the Engineer.

The Engineer may at any time require the Contractor to supply sample studs for a requalification test without additional compensation.

5.08.04—Method of Measurement: Shear connectors, being paid for on a lump sum basis, will not be measured for payment.

5.08.05—Basis of Payment: This work will be paid for at the contract lump sum price for "Shear Connectors," which price shall include all materials, tools, equipment and labor incidental thereto for all work under this item on the project.

Pay Item	Pay Unit
Shear Connectors	l.s. (l.s.)

SECTION 5.09

WELDED STUDS

5.09.01—Description: Under this item the Contractor shall furnish and install studs, exclusive of studs used as shear connectors, of the type, detail, size and quantity shown on the plans.

5.09.02—Materials: Steel for the studs shall conform to the requirements of Subarticle M.06.02-12.

5.09.03—Construction Methods: The installation of welded studs shall be in accordance with the requirements of Article 5.08.03.

5.09.04—Method of Measurement: Studs will be measured as units, in place, and acceptable to the Engineer.

5.09.05—Basis of Payment: This work will be paid for at the contract unit price each for "Welded Studs," complete in place, which price shall include all materials, equipment, tools and labor incidental thereto. Welded studs used as shear connectors shall be paid for in accordance with the provisions of Section 5.08.

Pay Item
Welded Studs

Pay Unit
ea. (ea.)

SECTION 5.13

POLYVINYL CHLORIDE PLASTIC PIPE

5.13.01—Description: This item shall consist of furnishing and installing polyvinyl chloride pipe for use as drains through the concrete bridge slab where shown on the plans or as ordered by the Engineer.

5.13.02—Materials: The pipe shall conform to the requirements of Subarticle M.08.01-27 and shall be schedule 40.

5.13.03—Construction Methods: The pipe drain shall be placed through the concrete slab at locations shown and as indicated on the plans. Pipe shall be secured at the proper locations before placing concrete. Where required, couplings and elbows may be used. After placing of the concrete slab, the pipe end shall be trimmed flush with the top surface of the concrete slab.

5.13.04—Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of pipe completed and accepted in place and measured through all fittings.

5.13.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Polyvinyl Chloride Plastic Pipe", of the type specified, complete in place, which price shall include all materials, fittings, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
(size) Polyvinyl Chloride Plastic Pipe	l.f. (m)

SECTION 5.14
PRESTRESSED CONCRETE MEMBERS

5.14.01--Description

5.14.02--Materials

5.14.03--Construction Methods

5.14.04--Method of Measurement

5.14.05--Basis of Payment

5.14.01--Description: Work under this item shall consist of furnishing, erecting, and joining prestressed members, such as beams and deck units of the type and size shown on the plans, including concrete, strands, reinforcing, pipe sleeves, threaded inserts, erection and tie plates, transverse tie strands, tie wires, lifting inserts or devices, mortar, void forms, grout, anchoring hardware, and all other necessary materials and equipment to complete the work.

5.14.02--Materials: The materials for prestressed beams and deck units shall conform to the requirements of Article M.14.01.

Prestressing and reinforcing steel shall be free of corrosion that imparts etching, pitting, or scaling of the surface. Light surface rusting shall be removed as ordered by the Engineer.

Prestressing and reinforcing steel shall be stored under shelter and kept free of deleterious material, such as grease, oil, wax, dirt, paint, loose rust, and other similar contaminants that reduce the bond between steel and concrete. It shall not be stored on surfaces which contribute to galvanic or battery action, nor shall it be used as a ground for electrical welding.

When called for on the plans, the deformed reinforcing steel bars shall be epoxy coated in conformance with the applicable sections of ASTM D3963(M).

A representative 8-ounce (0.23-kilogram) sample of the coating material shall be retained by the manufacturer from each batch. The sample shall be packaged in an airtight container and identified by batch number. When required, infrared spectroscopy, gas chromatography, or any other method which is deemed necessary shall be completed to ensure that the sample is of the same composition as the initial samples.

Epoxy material for touch up and repair work shall be subject to approval by the Engineer. It shall be furnished by the epoxy manufacturer, shall be compatible with the coating material, inert in concrete and shall be suitable for use by the fabricator installing the coated bars.

All wires, clips, chair and bar supports, and other metallic materials used for the installation of the epoxy coated reinforcing bars shall be coated with the powdered epoxy resin; or coated with an acceptable plastic material; or made of rustproof or coated material that has been approved in writing by the Engineer.

All systems for handling coated bars shall have padded contact areas for the bars wherever possible. All bundling bands shall be padded, and all bundles shall be lifted with a strong back, multiple supports, or a platform bridge so as to prevent bar-to-bar abrasion from sags in the bar bundle. Special attention shall be given to loading and unloading procedures and to equipment so that damage to the coating will not occur.

The epoxy coated steel bars shall be carefully unloaded and stored in such a manner as to avoid damage or contamination. The bars shall be installed in accordance with the plans, and care shall be taken to protect and preserve the epoxy coating.

During and after the installation of the bars, the fabricator shall repair all significant cuts, nicks, and abraded places in the coating on the bars with the epoxy repair material supplied by the manufacturer of the powdered epoxy resin. Any damaged metallic accessories shall also be repaired with a suitable material. All touchup material shall be fully cured prior to the pouring of concrete.

Damage caused during shipment of epoxy bars, or by installation, or by both, need not be repaired when the damaged area is 1/8 inch square (3 millimeters x 3 millimeters) or smaller and the sum of all damaged areas in each 1-foot (300-millimeter) length of bar does not exceed 2% of the bar surface area. All damaged areas larger than 1/8 inch square (3 millimeters x 3 millimeters) shall be repaired and all bars with total damage greater than 2% of bar surface shall be rejected and removed. The total bar surface area covered by patching material shall not exceed 3%.

The Fabricator shall exercise care to ensure that the coated bars incorporated into the work are reasonably free from dirt, paint, oil, grease, or other foreign substance; and when deemed necessary, the bars shall be cleaned to the satisfaction of the Engineer. The placing of the concrete shall be performed by using methods and equipment which will not damage the coated material.

Since the epoxy coating is flammable, the coated bars shall not be exposed to any fire or flame. Cutting coated bars by burning will not be permitted.

The coating applicator shall be responsible for performing quality control, tests and repairs of coated reinforcing steel bars in accordance with the requirements listed in ASTM D3963(M).

The Department shall have free access to the plant of the epoxy coating applicator, and shall be permitted to have any or all the work specified performed in his presence. The inspector shall be furnished with check samples of the coated bars on a random basis for testing by the Department. If access to this facility is denied, the material shall be rejected.

Prior to fabrication of the prestressed item, the Contractor shall provide a Certified Test Report in accordance with Article 1.06.07 for epoxy coated bars to verify their conformance to specifications.

The Contractor shall also provide a Materials Certificate in accordance with Article 1.06.07 for the epoxy powder to verify its conformance with these specifications.

5.14.03--Construction Methods: The members shall be manufactured in a concrete products plant with approved facilities and equipment for pretensioning.

1. Shop Drawings: Before fabrication, the Contractor shall submit shop drawings to the Engineer for approval in accordance with Subarticle 1.05.02-3. These drawings shall include complete details of the methods, materials and equipment he proposes to use. Such details shall outline the method and sequence of stressing and give complete material designations and details of the prestressing steel and anchorage devices, and other data pertaining to the prestressing operations.

2. Prestressing: In all methods of tensioning, stress induced in the strands shall be determined by monitoring applied force and independently by measurement of elongation. Applied force may be monitored by direct measurement using a pressure gauge piped into the hydraulic pump and jack system, dynamometer or load cell. The two control measurements shall agree with their computed theoretical values, within a tolerance of $\pm 5\%$. If discrepancies are in excess of 5% between the two calculated forces, determined by elongation measurement and gauge reading, the tensioning operation shall be suspended and the source of error determined and evaluated by qualified personnel before proceeding. Additionally, the control measurements of force and elongation shall algebraically agree with each other within a 5% tolerance. If the measurements do not agree within 5% a load cell shall be added at the dead end and if force measurements agree within 5% between the gauge at a live end and the load cell at the dead end, the elongation agreement may be waived with permission from the Engineer.

After an initial force has been applied to the tendon, reference points for measuring elongation due to additional tensioning forces shall be established.

Calculations for elongation and gauge readings must include appropriate allowances for friction in the jacking system, strand seating, movement of abutments, bed shortening if under load, thermal corrections, and any other compensation for the setup. Copies of all calculations shall be made available to the Engineer.

Hydraulic gauges, load cells, or other devices for measuring the stressing load shall be graduated so they can be read within a tolerance of $\pm 2\%$. Gauges, jacks, and pumps shall be calibrated as a system in the same manner as they are used in tensioning operations. Calibrations shall be performed by an approved testing laboratory, calibration service, or under the supervision of a licensed professional engineer, and a certified calibration curve shall accompany each tensioning system. Pressure readings can be used directly if the calibration determines a reading is within a $\pm 2\%$ tolerance of actual load. Calibrations shall be performed at any time a tensioning system indicates erratic results and, in any case, at intervals not greater than six months.

Those producers using multiple strand tensioning systems may use a "Master Gauge" monitoring system for ongoing calibration of their systems after an initial calibration as a total system. The producer shall have a master gauge calibrated every six months by an approved testing laboratory, calibration service or under the supervision of a licensed professional engineer. Production gauges shall be checked by plumbing the master gauge adjacent to the production gauge and recording pressures shown on both gauges throughout the normal operating range. Should the difference in gauge pressures exceed 2%, the production gauge shall be taken out of service. This check shall be performed at any time a tensioning system indicates erratic results and, in any case, at intervals not greater than 6 months.

Pressure gauges or other measuring devices, such as digital readout, shall have a full range of measurement of 1 1/2 to 2 times their normal working pressure, whether for initial or final load.

Tensioning methods employing hydraulic gauges shall have appropriate bypass valve snubbers and fittings so that the gauge pointer will not fluctuate but will remain steady until the jacking load is released.

In all methods of pretensioning, the load shall be applied in two increments. An initial load is applied to the individual strands to straighten them, eliminate slack, and provide a starting or reference point for measuring elongation. The final load is then applied for which elongation of strands is computed and measured. This method of operation shall be mandatory except as noted below in multiple strand tensioning.

Initial tensioning shall not exceed 15% of the specified tensioning force, or 3,000 pounds (13.3 kilonewtons), whichever is greater. In single-strand tensioning, the initial and final loads may be applied in immediate succession on each strand.

At the completion of initial tension, reference marks shall be established from which elongation by final tensioning forces can be measured. Elongations shall then be accurately measured from these reference points. Elongations shall be measured as outlined hereinafter.

Elongation measurement shall take into account all operational losses and compensations in the tensioning system.

Final Stressing of Straight Strands:

1. Single-strand tensioning: After application of the initial load and establishment of reference marks for measuring elongation, the full strand load shall be applied. Loads indicated by gauging systems shall control the tensioning, with elongation checked on every strand. An exception is the case of a completely open bed with no headers or other possible sources of friction. In such instances, strand elongation shall be checked on only the first and last strands and 10% of all others.

2. Multiple-strand tensioning: Following application of initial stress and seating of each strand on the anchorage header, reference marks shall be established for measuring elongation and slippage.

Reference marks for slippage shall be made by marking a straight line across the strands in each row along the face of the anchorage. For uniform application of load to strands, the face of anchorage at final load must be in a plane parallel to its position under initial load. Parallel movement shall be verified by measurement of movement on opposite sides of the anchorage and a check of its plumb position before and after application of the final load.

Final Stressing of Draped Strands: Draped pretensioning strands may be finally stressed by one of the following methods:

1. Partial stressing and subsequent strains: In this method, the strands shall be tensioned in a straight position or one a partially draped trajectory to a predetermined, intermediate stress value between initial and final stress. The final stress shall be induced by strains resulting from lifting or depressing strands at all other points of change in strand alignment. Final position and stress shall be offset symmetrically about the center of the setup to distribute friction evenly. Stress and elongation shall be measured as specified for the intermediate stress value. Suitable stress measurements at each anchorage at each end of the bed shall verify calculated strand stresses within 5%.

2. Final stressing in draped position: In this method the strands are stressed to final value in their draped position for the full length of the bed. The strands shall pass over devices which effectively minimize friction at all deflection points. Stress and elongation shall be measured as specified.

When final stressing is done by jacking strands from one end of the bed, even when that tensioning is within tolerance, the force shall be measured on at least two strands at the far end. This force shall not be below the theoretical values by more than 5%. If the theoretical elongation has not been attained at one end of the bed when the force, as indicated by pressure gauge or load cell, is exceeded by 5%, the strand shall be jacked from the other end of the bed to the theoretical elongation. If this requires an overstress as indicated by the gauge in excess of 5% overload, the number of deflection points on the bed shall be reduced until the elongation can be attained with not more than 5% overload or the hardware shall be improved to reduce friction. Remaining deflection points shall then be achieved as outlined.

If elongation is not obtained within 5% tolerance when theoretical force has been applied, the strand may be temporarily overstressed to overcome friction. Overstress shall not exceed 80% of the specified tensile strength of the strand. Strands shall not be seated in this overstress condition. Provision shall be made to reduce the force on the strand before anchorage. Anchorage by seating of strand into chucks shall be done within 5% tolerance of theoretical force.

Stress shall not be transferred to pretensioned members until concrete strength, as indicated by test cylinders or any other properly calibrated nondestructive test technique, is in accordance with specified transfer strength.

If concrete has been heat-cured, detensioning shall be performed immediately following the curing period while the concrete is still warm and moist.

In all detensioning operations, the prestressing forces shall be kept nearly symmetrical about the vertical axis of the member and shall be applied in a manner that will minimize sudden shock or loading. Maximum eccentricity about vertical axis of the member shall be limited to 10% of the strand group. Limitation of vertical axis eccentricity shall be at the initial cutting of strands at the ends of the bed and as strands are cut between members in the setup. For unusual shapes and heavily stressed shapes, production drawings shall show detensioning procedures.

Forms, ties, inserts, or other devices that would restrict longitudinal movement of the members along the bed shall be removed or adequately loosened. Hold-downs shall be removed at the appropriate time for the product and setup. Alternately, detensioning shall be performed in such a manner sequence that longitudinal movement is precluded.

In a single strand detensioning, both ends of the bed shall be released simultaneously and symmetrically to minimize sliding of members.

The sequence used for detensioning strands shall be according to an approved pattern and schedule that keeps the stresses nearly symmetrical about the vertical axis of the members as specified above.

In multiple strand detensioning, strands shall be released simultaneously by hydraulic de-jacking. The total force shall be taken from the header by the jack, then released gradually.

The overstress required to loosen lock nuts or other anchoring devices at the header shall not exceed the force in the strand by 5%.

The maximum permissible time for holding tensioned strands in the bed before starting concrete placement is 36 hours.

Prestressing details that have been approved by the Engineer shall not be deviated from unless details of such deviations are approved in advance of use. The approval by the Engineer of any proposed method, materials, or equipment shall not relieve the Contractor of full responsibility for successfully completing the prestressing operations in accordance with the requirements of these specifications.

3. Forms: The forms for the beams and deck units shall be of substantial construction. A firm compressible material as indicated on the approved shop drawings, shall form the bottom of the casting bed near the ends of the beams in order that cracking and chipping of the beams will be minimized at the time of load transfer. A minimum concrete cover of 1 1/2 inches (40 millimeters) must be maintained for prestressing strands by the use of approved spreaders or by bundling in areas adjacent to openings, cavities, or inserts. Stirrups and ties shall have a minimum cover of 1 inch (25 millimeters) at these locations.

Side forms carrying no load may be removed after 24 hours with the permission of the Engineer or after the concrete has reached the strength required at time of transfer (f'_{ci}).

4. Placing Concrete: Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the prestressing elements and reinforcing steel, including all other cast-in-place components, and has given his approval thereof.

Concrete shall not be deposited into the forms when the ambient temperature is below 40°F (5°C) or above 100°F (37°C), unless adequate heating or cooling procedures have been previously approved by the Engineer. The concrete temperature shall be 60°F to 90°F (16°C to 32°C) at the time of placement. At no time will truck-mixed or transit-mixed concrete be allowed.

Production during the winter season, from November 15 to March 15 inclusive, will be permitted only on beds located in a completely enclosed structure of suitable size and dimension that provides a controlled atmosphere for the protection of the casting operation and the product.

Outside concreting operations will not be permitted during rainfall unless the operation is completely under cover.

Void forms shall be held in place against uplift or lateral displacement during the pouring and vibrating of the concrete by substantial wire ties or other satisfactory means as approved by the Engineer.

The concrete shall be vibrated internally, or externally, or both, as ordered by the Engineer. The vibrating shall be done with care in such a manner as to avoid displacement of reinforcing steel, prestressing elements, voids, forms, or other components. There shall be no interruption in the pouring of any of the members. Concrete shall be carefully placed in the forms and vibrated sufficiently to produce a surface free from imperfections such as honeycombing, segregation, cracking, or checking. Any deficiencies noted in the members may be cause for rejection.

5. Finishing: Prestressing elements shall be recessed 1/8 inch to 1/4 inch (3 millimeters to 6 millimeters) into the member. The recess shall be patched with material approved by the Engineer. When the patch material has cured, it shall be coated with a waterproof material approved by the Engineer. Special care shall be given to the finishing of exposed surface areas. The surface area of all shear keys shall be blast cleaned. Additional finishing of members shall be as shown on the plans or as otherwise directed by the Engineer.

Formed surfaces shall not be finished in any manner unless permitted by the Engineer. Top surfaces shall be finished as follows:

Beams: The laitance shall be removed from the top of the beams. After the concrete has set sufficiently to prevent tearing loose of coarse aggregate, the top surface shall be transversely raked.

Deck Units: Deck units to be used in structures having a bituminous concrete wearing surface shall be given a float finish on the top surface as specified in Article 6.01.03-21. Where the deck units are used with a concrete deck, the top surface of the units shall be finished in accordance with the above requirements for beams.

6. Test Cylinders: During the casting of each prestressed member, the Contractor shall make test cylinders under the supervision of a representative of the Department. The dimensions, type of cylinder mold and number of cylinders shall be specified by the Engineer. At least four test cylinders shall be cured by the same methods employed for the curing of the member and shall be used to verify the (f'_{ci}) required for transfer of the prestressing load. The remaining test cylinders shall be used to determine when the required 28-day strength (f'_c) has been achieved.

Failure of any of the 28-day test cylinders to meet 90% of the minimum compressive strength or failure of the average to meet the full minimum compressive strength requirement may be cause for rejection.

7. Curing: Unless otherwise shown on the plans or indicated in the special provisions, prestressed concrete members shall be cured in accordance with the latest edition (including Interim Specifications) of "AASHTO Standard Specifications for Highway Bridges, Division II."

8. Patching: No patching of the complete members will be allowed unless permitted by the Engineer. The Contractor's proposal for methods and materials to be used in the patching operation shall be submitted to the Engineer for his approval. Failure to do so may be cause for rejection.

9. Joining Deck Units: The transverse tie strands shall be installed and tensioned to the total force shown on the plans. When the required length of the transverse tie strand is greater than 13 feet (4 meters), the strands shall be checked after a period of 36 hours and retensioned if necessary to the required force. After the check and required retensioning, the longitudinal shear keys between the adjacent deck units and the recesses at the ends of the transverse tie strands shall be filled with non-shrink grout conforming to the requirements of Subarticle M.03.01-12.

Before the non-shrink grout is placed, the key spaces and recesses shall be thoroughly cleaned. If Portland cement non-shrink grout is used, the key areas shall be thoroughly wetted prior to placement of the grout. The Portland cement grout shall be mixed and placed as directed by the Engineer. If premixed non-shrink grout is used, the key areas shall be prepared and the grout mixed and placed as recommended by the grout manufacturer's directions. Where the top surfaces of the adjacent deck units do not match, the grout shall be sloped to form a smooth transition.

No superimposed dead or live loads shall be applied to the adjacent deck units until the non-shrink grout in the longitudinal shear keys and recesses has cured.

The curing time for Portland cement non-shrink grout shall be seven days. The curing time for premixed non-shrink grout shall be considered the time when the grout has attained a compressive strength of 4,500 psi (31 megapascals) and as recommended by the grout manufacturer.

10. Quality Control: Quality control shall be the responsibility of the fabricator. Quality assurance shall be the prerogative of the State. At no expense to the State, there shall be provided a separate office building or room having an area of at least 80 square feet (7.5 square meters), with the least dimension to be 6 feet (2 meters). This office shall be equipped with a suitable heating system capable of maintaining a minimum temperature of 65°F (18°C). It shall be clean and free of extraneous material and equipment. Sufficient light and ventilation shall be provided. During the summer months, the office temperature shall not exceed the ambient temperature. A desk and chair shall be provided for the inspector, and a telephone shall be within audible range of the office.

The quality of fabrication and construction and the dimensional tolerance of the prestressed members shall conform to the limits specified in the "Manual for Quality Control for Plans and the Production of Precast Prestressed Concrete Products (MNL-116-Latest Edition)" published by PCI, unless otherwise specified herein, except that: 1. The tolerance for horizontal alignment shall be measured from a straight line intersecting the ends of beam at either or both faces of top and bottom flanges. 2. The tolerance for beam seat bearing area shall apply to the entire width of the member. Deviations in excess of the permissible tolerances will be cause for rejection.

11. Marking: Beams and deck units shall be identified as to project, structure, casting date, and position in the structure by means of a non-corrosive metal tag embedded permanently in the bottom of the members at the mark end.

12. Inspection: The provisions of Article M.06.02-13 shall apply to the steel items, and the pertinent requirements contained herein shall apply equally to the work performed in the plant producing the precast concrete products.

13. Lifting Hooks: The number and location of lifting hooks shall be as shown on plans.

14. Special Considerations: Before erection, the Contractor shall recess, clean, patch and paint ends of strands in a neat and workmanlike manner. Projecting fins and surface imperfections shall be removed.

The bearing area at the bottom ends of the beams and deck units must lie in the same plane as the grade of the beam or deck units in their final erected position after application of full dead load. Prior to erection, any deviations of the bearing area from a true plane shall be remedied by grinding, by applying an approved epoxy mortar, or by a combination of both as approved by the Engineer.

15. Handling and Storage: Care shall be taken during storage, transporting, hoisting, and handling of all prestressed members to prevent cracking or damage. Members damaged by improper storing, transporting, or handling shall be replaced by the Contractor at his expense. All storage and handling operations shall be as directed by the Engineer.

After erection, any marking, chipping, or spalling sustained by the member shall be removed or repaired in a neat and workmanlike manner as directed by the Engineer.

16. Methods and Equipment: The Contractor shall be solely responsible for the adequacy of his erection scheme and for all details of plant, falsework, and other equipment and material necessary to carry it out. The Contractor's responsibility includes the investigation of erection stresses. The results of this investigation, including computations, shall be submitted to the Engineer upon request.

5.14.04--Method of Measurement: This work will be measured for payment by the actual number of linear feet (meters) of prestressed beams or deck units installed and accepted. Measurement will be made along the center line of each member.

5.14.05--Basis of Payment: Payment for this work will be made at the contract unit price per linear foot (meter) for Prestressed Beams--Pretensioned, Type () and Prestressed Deck Units, (size) as shown on the plans, completed and accepted, including all materials, equipment, tools, and labor incidental thereto, and without differentiation as to interior or exterior members.

Pay Item	Pay Unit
Prestressed Beams--Pretensioned, Type ()	l.f. (m)
Prestressed Deck Units (size)	l.f. (m)

SECTION 5.21
ELASTOMERIC BEARING PADS

5.21.01—Description: Work under this item shall consist of furnishing and installing elastomeric bearing pads and all other necessary materials and equipment to complete the work as shown on the plans.

5.21.02—Materials: Elastomeric bearing pads and adhesive for bonding the pads to steel shall conform to the requirements of Article M.17.01.

5.21.03—Construction Method:

1. Shop Drawings: Before fabricating any materials, the Contractor shall submit drawings to the Engineer for approval in accordance with Subarticle 1.05.02-3. These drawings shall include but not be limited to the following information: The name of the manufacturer, complete details of the pads and pertinent material designations.

2. Setting the bearing pads: The Contractor shall set the elastomeric bearing pads in accordance with the following requirements:

(a) Concrete bearing areas: The bearing areas of the masonry upon which the elastomeric bearing pads are to rest shall be carefully finished, by grinding if necessary, to a smooth, even level surface of the required elevation, and shall show no variations from a true plane greater than 1/16 inch (1.5 millimeter) over the entire area upon which the elastomeric bearing pads are to rest.

(b) Metal bearing areas: The elastomeric bearing pads shall be bonded to steel masonry plates or to steel sole plates or girders where indicated on plans or when directed by the Engineer.

3. There shall be uniform bearing between the bottom of the beam or steel sole plate and the elastomeric bearing pad and between the elastomeric bearing pad and the concrete seat or steel base plate, after application of full dead load. Also after application of full dead load, there shall be uniform deflection of the elastomeric bearing pad.

4. The elastomeric bearing pads shall be bonded to the steel plates or beams as shown on contract plans or where directed. All contact surfaces to which the adhesive is to be applied shall be free of oil, paint, lacquer, galvanizing, mill scale, and rust. Primer, if required, and adhesive shall be applied in strict accordance with the manufacturer's printed instructions. The prefabricated pads shall be pressed to the steel plate under sufficient pressure to provide full intimate contact until the adhesive has set.

5. The adhesive shall be mixed in strict accordance with the manufacturer's printed directions.

5.21.04—Method of Measurement: This work will be measured for payment by the number of cubic inches (cubic decimeters) of elastomeric bearing pads, installed and accepted.

5.21.05—Basis of Payment: This work will be paid for at the contract unit price per cubic inch (cubic decimeter) of "Elastomeric Bearing Pads", complete in place, which price shall include all materials, equipment, tools and labor incidental thereto, including all the cost of furnishing test pads.

Pay Item	Pay Unit
Elastomeric Bearing Pads	c.i. (cu. dm)

SECTION 5.22
ELASTOMERIC COMPRESSION SEAL

5.22.01—Description: Under this item the Contractor shall furnish and install elastomeric compression seal with a lubricant-adhesive in joints as shown, dimensioned and detailed on the plans, or as ordered by the Engineer.

5.22.02—Materials: The materials for this work shall conform to the requirements of Article M.17.02.

5.22.03—Construction Methods: The Contractor shall arrange to have a representative of the manufacturer knowledgeable in the methods of installation present at the time of the first installation. The Contractor shall also arrange to have the representative of the manufacturer present at such other times as the Engineer may require.

Shop Drawings: Before fabricating any materials, the Contractor shall submit shop drawings to the Engineer for approval in accordance with Subarticle 1.05.02-3. These drawings shall include but not be limited to the following information: The complete details of the method, materials and equipment proposed to be used in the installation operation. These drawings shall also indicate the name of the manufacturer, complete details of the compression seal and method of notching at bends where necessary. Notching details shall show length and depth of notch.

Joint Preparation: Where the concrete has spalled, cracked or chipped adjacent to the joint, the Contractor shall make the necessary repairs with an approved material to the satisfaction of the Engineer and at no additional cost to the State. Immediately before placing the compression seal, the entire joint shall be thoroughly cleaned of all scale, loose concrete, dirt, dust and foreign matter to the satisfaction of the Engineer. The portion of the joint outside of the traveled way, including the mall and all curb areas shall be masked sufficiently on each side of the joint to prevent the lubricant-adhesive from coming in contact with the exposed surfaces.

Installation: The compression seal shall be furnished and installed continuous in length for the full length of the transverse joint as shown on the plans. Cutting shall be performed in accordance with the methods and procedures as indicated on the shop drawings.

The compression seal shall be installed by special hand or machine tools in the joint with the lubricant-adhesive after the concrete in curb areas adjacent to the joint has cured. The lubricant-adhesive shall be applied to the sides of the joint or to the sides of the compression seal or to both such that the full area in contact between the compression seal and the joint shall be covered with the lubricant-adhesive.

Immediately prior to installation, the compression seal shall be wiped with a suitable solvent to remove any dirt, dust, protective coating or any foreign matter. The compression seal shall be installed in a compressed condition and shall at all times be recessed to the depth indicated on the plans. The sides of the compression seal shall be fully in contact with the sides of the joint and the "V" section of the top of the compression seal shall be folded so that it projects inwards towards the inner web sections. Any lubricant-adhesive on the top of the compression seal shall be removed immediately.

Any compression seal that is punctured or ruptured shall be removed in its entirety and replaced by the Contractor at no additional cost to the State.

5.22.04—Method of Measurement: This work will be measured for payment by the actual number of linear feet (meters) of elastomeric compression seal, of the various widths, installed and accepted.

5.22.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Elastomeric Compression Seal" of the various widths, complete in place, which price shall include all material including lubricant-adhesive, splicing, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
(Size) Elastomeric Compression Seal	l.f. (m)

**SECTION 6.01
CONCRETE FOR STRUCTURES**

6.01.01--Description

6.01.02--Materials

6.01.03--Construction Methods

6.01.04--Method of Measurement

6.01.05--Basis of Payment

6.01.01--Description: This item shall include concrete for use in bridges and culverts, walls, catch basins, drop inlets and other miscellaneous construction as required. The concrete shall be composed of Portland cement, fine and coarse aggregate, admixtures if ordered, and water, prepared and constructed in accordance with these specifications, at the locations and of the form dimensions and class shown on the plans, or as directed by the Engineer.

The concrete shall be of three classes, Class "A," "C" and "F". The class to be used shall be as shown on the plans or designated herein, or as directed.

The use of truck-mixed or transit-mixed concrete is permitted for all Class "A," "C" and "F" concrete.

6.01.02--Materials: The materials for this work shall conform to the requirements of Article M.03.01.

6.01.03--Construction Methods:

1(a) Equipment: All equipment and tools used in the handling of materials, trucks used for transporting the batched material, the batching equipment, and concrete mixers used for the mixing of concrete shall comply with the requirements of Article 4.01.03. When permitted by the Engineer, mixers of the batch type design with a minimum rated capacity of a 2-bag batch, may be used.

(b) Truck Mixed and Transit Mixed Concrete:

Definitions: Truck mixed concrete shall be construed to mean concrete mixed completely in a truck mixer after its arrival at the point of placement. Transit mixed concrete shall be construed to mean concrete mixed completely in a truck mixer while en route to the point of placement.

General Requirements: The location and capacity of the batch plant and complement of truck mixers for truck or transit mixed concrete shall be adequate for continuous placement of concrete in the forms.

If in the opinion of the Engineer, undue delay in deliveries do occur, and concrete already in place takes initial set, all such material in place may be rejected.

The batch plant, truck mixers and related equipment will be inspected by the Engineer; and these, as well as all methods of operation related thereto, shall be approved before the concrete is batched.

The concrete shall be discharged within one and one-half hours from the time the dry aggregates are loaded into the truck mixer; otherwise the concrete shall be disposed of by the Contractor at his expense.

With each delivery of concrete, the Contractor shall furnish a ticket indicating the proportionment of the batch and stamped by an approved time clock indicating the time the batch is placed in the truck mixer. This ticket shall be presented to the Engineer or his authorized representative before discharge of the concrete will be permitted.

After each time the drum of any mobile mixer is washed, the Contractor shall, at his own expense, add one-half cubic foot (0.02 cubic meter) mixture of sand and cement for each cubic yard (cubic meter) of concrete being placed in the drum of the mixer. The same proportions as specified for the concrete shall be used, and the mixture shall be introduced immediately before or at the time of batching.

Truck Mixers: The capacity of truck mixers shall be in accordance with the manufacturer's ratings, except that the maximum permissible capacities, expressed as percentages of the total volume of the drum or container, shall not exceed 63.25%.

Each truck mixer shall have an attached metal standard rating plate on which are stated the capacities, in terms of volume, of mixed concrete, for the various uses applicable to the equipment. When the manufacturer's ratings of capacity are less than the limit indicated above, the manufacturer's ratings shall govern. Further, truck mixers shall be equipped with a suitable means by which the number of revolutions of the drum or blades may be readily verified.

Truck mixers shall be of standard type, size and manufacture and shall be either of the horizontal axis revolving-drum type, the inclined axis revolving-drum type, or the open-top revolving blade or paddle type.

Truck mixers must be inspected and approved by the Engineer.

Loading, Water and Transportation: The mix shall be in the proportions required for the work and placed in the drum of the mixer. Water shall be added to the mix, and the mixing conditions shall be in accordance with one of the following methods:

Truck-Mixed Concrete: Water shall be introduced into the mixing drum only after arrival at a level area on the site where the concrete is to be placed and under the supervision of the Engineer. The water shall be measured accurately by volume or mass by an approved adjustable measuring device which shall measure the required quantity under all operating conditions within a tolerance of 1 quart (1 liter) or 1%, whichever is greater. The device shall be such that the flow of water shall be stopped automatically when the required quantity has been delivered. The mixer shall be equipped with an approved device which shall record the number of revolutions of the drum or blades during mixing. The mixing procedures shall be carried out at the site as hereinafter specified.

Transit-Mixed Concrete: Water shall be introduced into the mixing drum while the mixer is at the batch plant. The water shall be measured and controlled as specified above. The mixing procedure shall be carried out during transportation as hereinafter specified. Each truck mixer shall be equipped with a readily visible device that will record accurately the number of revolutions of the drum or blades at mixing speed from the moment of batching. This equipment shall be set into operation only at the batch plant by the inspector and shall be so constructed as to show evidence of any tampering or misoperation.

Any one of the following shall be sufficient cause for the rejection of any load of truck-mixed or transit-mixed concrete: when the elapsed time exceeds that which is permitted, when the mixing revolutions exceed 100, when the recording device has been tampered with or misoperated after the batching, when, at the time of placing, the air content or slump are not within specified ranges, when there is evidence of segregation or when initial set has taken place.

Mixing Procedure and Delivery: When the truck mixer is loaded in excess of 50% of the gross volume of the drum or container, the mixing period shall consist of not less than 60 revolutions of the drum or blades at mixing speed, after the water is added; if loaded to not more than 50%, the mixing period shall consist of not less than 40 revolutions of the drum or blades at mixing speed.

For the revolving drum type mixers the mixing speed shall be not less than 4 revolutions per minute of the drum or greater than a speed which will produce a peripheral velocity of the drum of 225 feet per minute (1.14 meters per second). For the revolving blade type mixers the mixing speed shall be not less than 4, nor more than 16, revolutions per minute of the mixing blades.

Agitating speed for both the revolving drum and revolving blade type of mixers shall be not less than 2, nor more than 6, revolutions per minute of the drum or the blades.

In no case shall mixing exceed 100 revolutions at mixing speed. Mixing beyond 100 revolutions shall be done at agitating speed.

In discharging truck mixers, the direction of rotation of drum or blades shall be manipulated so as to avoid segregation.

Slump: When the slump does not meet the specification requirements, modification of the concrete mix may be permitted if, in the opinion of the Engineer, no harmful effect upon the structural qualities or appearance of the concrete will result. If permitted by the Engineer, modifications shall be limited to the addition of not more than 50 pounds (30 kilograms) of Portland cement per cubic yard (cubic meter) of concrete to decrease the slump or to the addition of water to increase the slump. The amount of water or cement added shall be further limited to the minimum needed to meet slump requirements. The cost of additional material and the work connected with each modification shall be borne by the Contractor. The addition of cement or water, or both, for the purpose of re-tempering concrete will not be permitted.

(c) **Vibrators:** Not less than two vibrating units, including source of power, shall be available on the work and shall be of the mechanical immersion type, in good operating condition at each pouring of concrete in order to insure satisfactory and uninterrupted vibration during placing. They shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4,500 impulses per minute. Vibrators shall be used only when directed by the Engineer.

(d) **Trucking Equipment:** Trucks used for the transporting of the batched material from the batcher plant to the mixer shall conform to the requirements of Subarticle 4.01.03-E.

2. Falsework and Centering: All falsework and centering required shall be adequate for the type of construction involved. Details of this construction shall be proposed by the Contractor and unless otherwise authorized shall be submitted to the Engineer for his information before construction is started. Approval of the plans or methods proposed for such construction shall not serve to relieve the Contractor of any of his responsibility for the successful completion of the project.

Suitable provision shall be made to secure the permanent camber required in the superstructure, and means of adjustment shall be provided so as to correct any possible settlement or deflection during construction. The method of adjustment shall be such as to permit the gradual lowering of the falsework or centering when these

are to be removed. Falsework and centering shall remain in place for a period as stated in Subarticle 6.01.03-20. No falsework or centering shall be removed without the permission of the Engineer.

3. Forms: Forms shall be built true to lines and grades designated, shall be strong, stable, firm, mortar-tight and adequately braced or tied, or both. They shall be designed and constructed to withstand all loads and pressures including those imposed by plastic concrete, taking full account of the stresses due to the rate of pour, effect of vibration and conditions brought about by construction methods. Where necessary, forms shall be constructed to compensate for variations in camber of supporting members and allow for deflections.

Internal voids may be formed by the use of heavy paper or fiber forms especially made for this purpose, or with an alternate acceptable to the Engineer. These forms must be of substantial construction and adequately waterproofed in order to maintain their shape during the entire construction cycle. The end caps shall also be of similar construction. These forms shall be held in place against uplift or lateral displacement during the pouring and vibrating of the concrete by substantial wire ties or other satisfactory means. Before incorporating the forms in the work, a sample 4 feet (1 meter) in length with end caps shall be furnished the Engineer for approval. These forms shall not be incorporated in the work until the Engineer has approved the sample submitted.

If requested, form work plans shall be submitted to the Engineer by the Contractor before form work is started. The furnishing of such plans, however, shall not serve to relieve the Contractor of any of his responsibility for the successful completion of the work.

Forms shall be filleted at all sharp corners, unless otherwise ordered or permitted, and shall be given a slight bevel or draft in the case of projections to insure satisfactory removal.

Materials for forms and their supports, ties and bracing, shall be of the type, quality and strength to achieve the foregoing requirements without impairment to the structural qualities or appearance of the concrete structure. Form material in contact with concrete shall be of a quality to provide the hereinafter required concrete surface smoothness; and, unless otherwise authorized, the contact surface shall be oiled with a light, clear paraffin base oil which will not damage, discolor or adhere to the concrete; or, as an alternate, the form may be lined with an approved composition form lining.

Materials and workmanship for forms for concrete to remain exposed in the finished work shall be such as to provide a smooth concrete surface of good appearance and texture, free of voids, indentations, protrusions or bulges and within tolerances consistent with good trade practices. If panels are used, they shall be evenly placed in columns or rows if their positioning is to be visible after the concrete is finished. These same requirements shall apply to forms for concrete not to remain exposed in the finished work except that minor irregularities where form boards or panels join and variations in form pattern will be acceptable.

Metal ties and anchors to hold the forms in alignment and location shall be so constructed that the metal work can be removed to a depth of at least 2 inches (50 millimeters) from the concrete surface without damage to the concrete. All cavities resulting from the removal of metal ties shall be filled with cement mortar of the same proportions used in the body of the work and the surface finished smooth and even, and if exposed in the finished work, shall conform to the texture and color of adjacent surfaces. With permission of the Engineer, the Contractor need not remove from the underneath side of bridge decks portions of metal devices used to support reinforcing steel providing such devices are of material, or are adequately coated with material, that will not rust or corrode.

Date of Completion: The year in which each structure is completed shall be shown in at least two places on each concrete superstructure unless otherwise ordered by the Engineer. Usually the date shall be placed in diagonally opposite ends of the bridge parapets adjacent to traffic. The numerals will be furnished by the Contractor. They shall be carefully set by the Contractor; and their subsequent removal after the concrete is placed and the finishing shall be carefully done so that the impression of the numerals in the concrete is clear and sharp, with no broken edges or other imperfections.

Ornament or Reverse Moulds: Ornamental work, when so noted on the plans, shall be formed by the use of reverse moulds. These moulds shall be produced by a qualified manufacturer approved by the Engineer. They shall be carefully built by the most approved modern methods and in accordance with the general dimensions shown on the plans. Additional details necessary to construct the moulds shall be worked out by the manufacturer and shall be such as to produce ornaments having the appearance indicated on the plans. The manufacturer shall prepare all detailed drawings that he may require for his guidance, and all such drawings as well as all models or carvings that he may prepare shall be approved by the Engineer before the moulds are made.

Moulds shall be carefully handled, shipped and stored so as to prevent all damage to the ornaments. They shall be delivered at the site of the work completely assembled and of the required size and shape in order to

facilitate their proper placing. The Contractor shall be responsible for their condition at all times, and he will be required to remove and replace any damaged or defective moulds at his own expense.

The moulds shall be fitted into the surrounding form work so that they will act as a substitute for the ordinary forms which would be required in the area.

The surfaces of the moulds shall be given a coating of grease or lubricant to prevent the adherence of concrete. Any material which will adhere to or discolor the concrete shall not be used.

Utility Installations: On any structure where it becomes necessary to install any public utility, i.e., telephone, electric light or power conduits; gas, water or sewer pipes; pneumatic, oil or any other lines, the utilities concerned will furnish, delivered at the site, all material necessary for such installation.

Unless specifically otherwise ordered, the Contractor shall erect or install such equipment or material as shown on the plans; or if not shown thereon, he shall comply with the Engineer's instructions.

Whether or not the presence of any public utilities is mentioned on the plans or in the special provisions, the Contractor shall, by any means at his disposal, apprise himself of the location of any and all of them. He shall use every effort to protect them from damage of any nature whatsoever, which might result from carelessness or negligence in any of his operations. He shall be held solely and strictly responsible for any damage resulting from such negligence or carelessness.

In cases where any utilities are to be installed on, under or within the construction limits of any structure--and the Contractor does not participate actively in the work--he shall arrange his operations as to cause no inconveniences or interruption to the progress of such installation. The Contractor shall extend his fullest cooperation to the construction forces of any utility company which may be operating within the limits of the contract.

4. Handling Material: The requirements of Subarticle 4.01.03-B shall apply.

5. Composition: The requirements of Subarticle 4.01.03-A shall apply except for the proportionment of the concrete mix which shall be in accordance with Article M.03.01, and the air content for Class "C" or Class "F," as the case may be, used for bridge decks, including curbs, sidewalks and railings attached thereon or attached thereto. This concrete shall contain not less than 5% nor more than 7% entrained air at the time the concrete is deposited in the forms. For pumped concrete, the percentage of entrained air shall be determined at the placement end of the pump line.

Unless otherwise directed by the Engineer, all concrete for bridge decks shall contain a retarder admixture which the contractor shall add to the concrete mix in predetermined amounts varying with the temperature and other working conditions.

On any one structure, the admixture for a specific purpose shall be the particular product of one manufacturer only. When admixtures for different purposes are used together, the Contractor shall submit proof of their compatibility prior to use.

6. Consistency: The consistency shall be determined by the AASHTO Method T 119. A uniform consistency shall be continuously maintained. When Class "A" and Class "C" concrete is not to be vibrated, the allowable range of slump shall ordinarily be not less than 2 or more than 4 inches (50 millimeters or more than 100 millimeters). When Class "A" and Class "C" concrete is to be consolidated by vibration, the slump shall be not more than 2 1/2 inches (60 millimeters); and for Class "F" concrete, the slump shall be not more than 3 inches (78 millimeters). Slumps outside these limits shall be used when, in the opinion of the Engineer, conditions are such that satisfactory workability cannot be obtained within such limits. Concrete mixes designed by the Contractor so as to be pumpable, shall not be subject to the above conditions. The desired slump shall be indicated on the mix design submitted for approval. The slump shall be determined at the placement end of the pump line.

7. Mixing Concrete: Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

The mixing time requirements shall be in accordance with the recommendations of the manufacturer of the mixer. If a mixing time of less than 60 seconds is recommended, the Contractor shall furnish test data acceptable to the Engineer, verifying that the reduced mixing time will produce uniform concrete conforming to the provisions of AASHTO M157.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic

feet (cubic meters), as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

Failure of the water measuring device or of the timing device shall result in suspension of mixing until correction has been made, except that, with prior approval of the Engineer, operations may be allowed to continue for the balance of the day if secondary controls can be demonstrated.

Truck mixed or transit mixed concrete may be used with the written permission of the Engineer for limited amounts or other exceptional cases. If its use is so allowed, the provision of Section 6.01 relating to truck mixers and truck mixed and transit mixed concrete shall fully apply.

The first batch of concrete materials placed in the mixer shall contain an additional quantity of sand, cement, and water sufficient to coat the inside surface of the drum without diminishing the mortar content of the mix. Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned.

Hand mixing shall not be permitted except in cases of emergency and with the permission of the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform, and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least 6 times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixed batches shall not exceed 1/2 cubic yard (0.5 cubic meters) in volume. Hand mixing will not be permitted for concrete to be placed under water.

8. Placing Concrete: Concrete, except for central plant-mix, truck or transit-mixed, shall be placed in the forms immediately after mixing; and in no case shall concrete be used which does not reach its final position in the forms within 60 minutes after the time that water is first added to the mix, except that the Engineer reserves the right to alter this time by as much as one-half when necessary to achieve the requirements related to set and plasticity.

The use of long chutes and troughs for conveying concrete from the mixing plant to the forms will be permitted only on authority from the Engineer. If such conveyors are allowed and the quality of concrete as it reaches the forms or the method of placing or working it therein are not satisfactory, the Engineer may order their use discontinued and the substitution of a satisfactory method of placing. Where steep slopes are required, chutes and troughs shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete. Open troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

During placing operations, the concrete shall not come in contact with any aluminum.

Unless permission is obtained from the Engineer, concrete shall not be dropped a distance of more than 5 feet (1.5 meters); and special care shall be taken to fill each part of the forms by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and the concrete forced around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred; and no strain shall be placed on the ends of projecting reinforcement.

Concrete shall be placed in horizontal layers. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding layer has taken initial set, to prevent injury to the green concrete and to avoid surfaces of separation between the layers.

Concrete shall be compacted by continuous working with suitable tools or by vibrating as ordered by Engineer. The number and type of vibrators required, the length of the vibrating period and the location of the vibrators shall be as required by the Engineer.

Special care shall be taken in placing and compacting concrete around ornamental moulds, and vibrating equipment shall be used with caution. The vibrator shall not touch the moulds at any time. A gentle vibration shall be used, sufficient to assure the proper flow of the materials and to bring the mortar into complete contact so that all contours of the ornaments will be sharp. Tarpaulins or heavy paper shall be hung over the moulds, the bottom of which shall be kept constantly immersed in the fresh concrete, in order to prevent splashing the surfaces of the moulds.

When the placing of concrete is temporarily discontinued, the necessary keys or joints shall be formed as shown on the plans or as ordered, and the concrete after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete.

Joints shall be formed only in the locations shown on the plans or as permitted by the Engineer. Feathered edges at construction joints will not be permitted.

Immediately following the discontinuance of the placing of concrete, all accumulations of mortar splashed upon reinforcing steel and the surface of the forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If accumulations are not removed prior to the concrete becoming set, care shall be taken not to injure or break the concrete-steel bond, at and near the surface of the concrete, while cleaning the reinforcing steel.

9. Concrete for Bridge Decks: Unless otherwise indicated on the plans or in the Special Provisions, concrete for use in bridge decks, including curbs, safety curbs, sidewalks, parapets and concrete railings placed thereon or attached thereto, shall be Class "F" concrete.

At least 15 days before the erection of the screed rails, the Contractor shall submit his screed erection plans, grades and sequence of concrete pours and proposed rate of placing concrete for review by the Engineer. These plans shall include details of equipment to be used in the placement and finishing of the concrete, including the number and type of personnel who will be engaged in placing the deck concrete. The personnel shall consist exclusively of persons with skill and experience appropriate to their working assignments.

When setting screed rails for mechanical finishing, the Contractor shall take into consideration and make proper allowances for the deflection of the bridge superstructure due to all operations.

(a) **Composition:** The composition shall be as specified in Subarticle 6.01.03-5.

(b) **Placing Concrete:** Bridge decks shall be finished using a mechanical finisher or other method as approved by the Engineer.

The completed surface shall be constructed in accordance with grades and cross slopes shown on the plans. When tested with a 10-foot (3-meter) straightedge, the surface shall not vary more than 1/8 inch in 10 feet (3 millimeters in 3 meters). Variances greater than this, which, in the opinion of the Engineer, may adversely affect the riding qualities of the surface shall be corrected; and this shall be done at the expense of the Contractor.

The Contractor shall notify the Engineer at least 24 hours in advance of his intention to place concrete.

All concrete shall be placed during daylight, and the placing of concrete shall not be started unless the intended pour can be completed and finished during daylight hours; except that when an adequate and approved lighting system is provided beforehand, the Engineer may waive this requirement.

Concrete shall be deposited in such a manner that the total deflection or settlement of supporting members, and the final finishing of the surface, shall have occurred before the initial set of the concrete takes place.

When construction joints are shown on the plans, or approved by the Engineer, all concrete between consecutive joints shall be placed in a continuous operation.

In order to allow for shrinkage, concrete shall not be placed against the second side of the construction joints for at least 12 hours after that on the first side has been placed, unless otherwise authorized or ordered by the Engineer.

Workmen will not be permitted to walk in the fresh concrete after it has been screeded. All finishing work, including the application of the fog spray and placement of the curing mats, shall be performed from bridges supported above the deck surface. A minimum of 2 bridges shall be available for the various operations.

Concrete shall be placed in a uniform manner across the entire width being poured, and only 2 passes of the transverse screed will be allowed over a given deck area, except as otherwise permitted by the Engineer.

After the concrete has been consolidated and brought to the proper elevation by the screed machine, it shall be further smoothed by use of a longitudinal float of suitable and approved design. The float shall be worked from a bridge with a dragging motion while held in position parallel to the centerline and passed gradually from one side of the deck to the other.

During finishing operations, water shall not be applied to the concrete surface for purposes of re-tempering.

(c) **Finishing:** The deck shall be given a final transverse-tined texture in cases where the membrane waterproofing is omitted.

The texturing shall be applied to the plastic surface of the concrete using a mechanical self-propelled device designed to ride the screed rails. The texturing operation shall be performed in two stages:

- (1) Dragging with Burlap. The burlap shall be at least 3 feet (1 meter) wide and of a length 2 feet (1 meter) greater than the distance between rails. The burlap shall not have frayed edges and shall be kept wet and clean of accumulations of dried concrete particles or other foreign materials, which might leave

distinctive undesirable marks. The burlap shall be drawn longitudinally along the surface in a slow manner so as to leave an even texture. When not in use, the burlap shall not be allowed to rest on the pavement.

- (2) **Texturing with Metal Tines.** As soon as possible, after the pavement surface has been dragged with burlap, mechanical equipment shall be used to texture the surface with deep transverse grooves. The equipment shall consist of a self-propelled mechanical rig capable of applying a textured finish transverse to the centerline of the bridge. The texturing shall be accomplished with metal tines 0.03 inch (0.75 millimeter) thick, 0.08 inch (2.0 millimeter) wide and 4 inches to 6 inches (100.0 millimeters to 150.0 millimeters) in length with an average spacing of 1/2 inch (12.0 millimeters) on centers.

The transverse grooving shall be performed when the condition of the concrete is optimum. This condition will prevail when the grooves can be formed to a maximum depth of 3/16 inch (5.0 millimeter) with relative ease and without the walls of the grooves closing in on each other.

The tined grooving shall extend across the pavement to within 1 foot (300 millimeters) of the edge of the pavement on each side. The tining mechanism shall be aligned so as to prevent overlapping of grooves in any two successive transverse passes. The depth of the grooves formed in the surface by the tines shall be checked randomly with a tire tread depth-measuring gage furnished by the Contractor to ensure compliance with the required limits of 1/8 to 3/16 inch (3.0 to 5.0 millimeters). The original surface of the concrete before tining shall serve as the datum for the depth measurements.

Prior to starting work, the Contractor shall submit for approval a plan to protect the concrete in case of adverse weather. All materials required by the approved plan must be on hand at the time of concrete placement.

After completion of the placing and finishing operation--and for at least 12 hours after the concrete has set--the Contractor shall not operate any equipment in the immediate vicinity of the freshly placed concrete if the tare weight (mass) of the equipment exceeds 2,500 pounds (1150 kilograms). The immediate vicinity is defined as any distance within which the operation of equipment would, in the opinion of the Engineer, cause excessive vibration, movement or deflection of the forms.

(d) Curing: All concrete shall be kept constantly moist and protected against any drying action and cured for no less than 7 days after the placing of the concrete, and shall be accomplished in the following manner:

- (1) **Fog Spray:** Curing of the concrete shall begin by the application of a water fog spray immediately after the initial set. Fog spraying shall continue until such time as the moist cotton mats are placed. The amount of fog spray shall be strictly controlled so that accumulations of standing or flowing water on the surface of the concrete shall not occur. There shall be a sufficient amount of spray to keep up with the placing operations.

Should atmospheric conditions render the use of fog spray impractical, the Contractor shall use plastic covers of suitable thickness and securely fastened down, but not directly in contact with the deck concrete. The covers shall be used only until the initial set has taken place, whereupon moist cotton mats shall be placed immediately thereafter and kept wet for the duration of the curing period.

On the windward side of the panel being cured, the Contractor shall erect barriers of suitable height, when necessary, to protect the curing concrete from the direct force of the wind.

- (2) **Moist Curing:** When the concrete has set sufficiently, moist curing conforming to Subarticle 4.01.03-F.7(b) shall be substituted for the fog spray. The concrete shall be immediately covered with the moist cotton mats upon discontinuance of the fog spray. The mats shall be kept saturated by means of soaker hoses, garden spray, or other approved methods and remain in place for the required curing period.

Particular attentions shall be given to horizontal construction joints in parapet, curb, sidewalks and median areas to assure that the moist mats are in contact with the concrete surface.

10. Depositing Underwater Concrete: Concrete shall not be exposed to the action of water before setting, or deposited in water, except with the approval of the Engineer and under his immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated.

The Contractor shall design and submit to the Engineer a concrete mix that he proposes to use. The mix shall be designed in accordance with the applicable sections of ACI 211 and ACI 318.

During placing operations, the concrete shall not come in contact with any aluminum.

Concrete deposited under water shall be carefully placed in a compacted mass in its final position by means of a tremie, a bottom dump bucket or other approved method and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water, and all form work designed to retain concrete under water shall be watertight. The consistency of the concrete shall be carefully regulated, and special care shall be exercised to prevent segregation of the

materials. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Concrete deposited under water shall be placed continuously from start to finish whenever possible, and each succeeding layer shall be placed before the preceding layer has taken initial set.

When a tremie is used, it shall consist of a suitable hopper and a tube having a diameter of not less than 10 inches (254 millimeters). If the tube is constructed in sections, it shall have watertight couplings. The means of supporting the tremie shall be such as to permit the free movement of the discharge end over the area of the work and shall be such as to permit it to be rapidly lowered when necessary to choke off or retard the flow. The discharge end shall be plugged at the start of the work to prevent water from entering the tube. It shall be entirely sealed at all times, and the tremie tube kept full of concrete to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The flow shall be continuous until the work is complete.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than one cubic yard (0.8 cubic meters). The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised very slowly as the concrete is discharged, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

Before placing substructure concrete, all laitance or other unsound material shall be removed from the surface of the underwater concrete.

11. Concrete Exposed to Sea Water: Concrete structures so located as to be subject to the action of sea water shall be constructed to provide a maximum resistance to its disintegrating action.

The concrete shall be mixed not less than 2 minutes. The water content shall be carefully controlled and so regulated as to produce concrete of maximum impermeability. In placing concrete, care shall be exercised to avoid the formation of stone pockets; and the concrete shall be thoroughly compacted to the satisfaction of the Engineer. The original surface of the concrete shall be left undisturbed. In order to secure a thick and dense surface film, the surfaces of the forms shall be heavily coated with shellac or an approved form oil.

The range of possible disintegration of the concrete from an elevation below that of extreme low tide to an elevation above that of extreme high tide shall be determined by the Engineer; and except with his special permission, no construction joints shall be located within this range. In the determination of this range, due consideration shall be given to wave action, ice formation and other conditions affecting the extreme limits of possible deterioration and disintegration.

12. Concreting in Cold Weather: During the period from October 15 to April 15 of the subsequent year, cold-weather concreting procedures shall be employed by the Contractor, unless otherwise directed by the Engineer. Cold-weather concreting practices shall include taking measures to ensure that the temperature surrounding the structure is kept above 60°F (16°C) for a period of 5 days after placing the concrete, and above 40°F (5°C) for an additional nine days. The temperature shall then be gradually lowered to that of the surrounding atmosphere. Concrete test specimens prepared during the period noted shall be cured in the same manner as the structure that they represent, in accordance with ASTM C 31 (AASHTO T 23). If tests performed on the specimens indicate that sufficient strength has been achieved, the Engineer may reduce the amount of time that the structure must be protected and heated.

Sufficient heating apparatus of the kind approved by the Engineer, such as stoves, salamanders, or preferably steam equipment, and fuel to furnish all required heat, shall be supplied. All water used for mixing concrete shall be heated, but shall not exceed a temperature of 150°F (65°C).

The temperature of the mixed concrete shall not be less than 60°F (16°C) at the time of placing in the forms.

If aggregates are heated either by steam or by dry heat, the temperature of the aggregate shall be not less than 50°F (10°C), nor more than 100°F (37°C). The heating apparatus shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will burn the material. There will be no additional compensation for the use of such heating equipment, but the cost thereof must be included in the cost of the concrete.

In case of extreme weather conditions, the Engineer may at his discretion vary the temperature limitations for water, aggregate and mixed concrete.

Except for deck slabs and thin wall sections, form insulation may be substituted for a heated enclosure, provided it can be demonstrated to the satisfaction of the Engineer that the insulation material proposed for use will keep the concrete within the above specified temperature limits for the specified periods of time. When the use of form insulation is permitted, sufficient provision shall be made by the Contractor so that the surface and interior temperature of the concrete may be determined. If the thermometric readings indicate that the required

temperature is not being maintained, the structure shall be promptly enclosed and heat furnished as provided hereinabove.

When form insulation is substituted for a heated enclosure, forms shall not be stripped until permission is granted by the Engineer.

13. Anchorages: Anchor bolts and similar materials which are to be placed either at the time the substructure is built, or during the erection of the superstructure, shall be carefully and accurately set to the requirements of the plans or as ordered at such time as the Engineer may approve or direct.

(a) **Setting Anchorages at time of Placing Substructure Concrete:** When noted on the plans or ordered by the Engineer, the anchor bolts and similar materials shall be accurately set prior to placing concrete for the bridge seat.

(b) **Setting Anchorages in Formed Holes:** When indicated on the plans, the anchor bolts and similar materials shall be accurately set in formed holes in accordance with details and dimensions shown.

The space around the anchorage material shall be completely filled with non-shrink, non-staining grout conforming to the requirements of Subarticle M.03.01-12.

(c) **Setting Anchorages in Drilled Holes:** When the Contractor is not required to set anchorages at the time of constructing the substructure, he may set the anchorages as in (a) and (b) above, or he may drill holes having a diameter of 4 inches (100 millimeters) and a depth suitable to receive the bolts in the correct locations perpendicular to the plane of the bridge seat. Anchor bolts shall be grouted into clean drilled holes in accordance with the requirements of "Setting Anchorages in Formed Holes." When anchorage material is to be furnished by the Contractor for the superstructure and placed by the Contractor of the substructure, the necessary material shall be fabricated and delivered to the site of the work at such times as it may be required for proper inclusion in the substructure construction.

In locating anchor bolts in relation to slotted holes in expansion shoes, due consideration shall be given to the temperature at the time of erection.

Anchor bolt holes shall be clean and free of dirt, moisture or other foreign materials at the time of setting anchor bolts. Precaution shall be taken to prevent damage to concrete due to freezing of water in anchor bolt holes.

14. Preparation of Bearing Areas: The areas of masonry upon which the bases, pedestals or shoes are to rest shall be carefully finished by grinding if necessary to a smooth, even surface of the required elevation, and shall show no variations from a true plane greater than 1/16 inch (1.5 millimeters) over the entire area upon which the shoes are to rest.

15. Placing Superstructure: No superstructure load shall be placed upon any finished pier or abutment without the approval of the Engineer.

16. Placing Pipes and Conduits: Pipes and conduits which are to be carried by the structure as shown on plans or as ordered shall be placed by the Contractor during construction. Such pipe and conduits will be delivered to the Contractor, unless otherwise noted on plans or in the Special Provision, at the site of the work, by the Department or by others for whose use they are intended.

17. Construction Joints: Construction joints other than those shown on the plans will not be permitted without prior approval of the Engineer. When the placing of concrete is to be interrupted and a construction joint formed, provision shall be made for interlocking with the succeeding layer by roughening the surface and providing keyways, dowels or similar construction shown on the plans or as ordered.

In joining fresh concrete to concrete that has already set, the work already in place shall have its surface cut over thoroughly with a suitable tool to remove all loose and foreign material. This surface shall then be washed and scrubbed with wire brooms and thoroughly drenched with water until saturated. It shall remain saturated until the new concrete is placed. Immediately prior to the placing of the new concrete, all forms shall be drawn tight against the concrete already in place.

In construction joints exposed to view or in other construction joints where seepage of water is particularly objectionable, a baffle strip of copper, zinc, sheet lead or other approved materials shall be inserted. This strip shall be placed not less than 3 inches (80 millimeters) from the face of the concrete and shall extend into each section of the concrete a distance of not less than 2 inches (50 millimeters).

18. Expansion Joints: Expansion joints shall be built in the locations and to the dimensions and details shown on the plans.

Sliding surfaces of metal shall be planed true and smooth, the marks of the plane paralleling the movement of the joint. Expansion plates shall be well anchored as shown on the plans. All sliding surfaces of expansion plates shall be thoroughly coated with graphite or other approved lubricant just before being placed in position and special care taken to avoid placing concrete in such manner as to interfere with their free action.

Open joints shall be placed at locations designated on the plans and shall be formed by the insertion and subsequent removal of templates of wood, metal or other suitable material. The templates shall be so constructed that their removal may be readily accomplished without injury to the work.

Filled joints shall be made with a joint filler, the materials for which shall conform to the requirements of the plans and of these specifications.

Mortise joints shall be as shown on the plans and, in general, shall consist of a tenon of concrete or metal sliding in a suitable concrete or metal socket or mortise. The construction shall be such as to permit freedom of movement and such as to be, as far as possible, watertight and rust proof. Metal flashing shall be used as shown on the plans or when ordered by the Engineer.

Special types of expansion joints shall conform to the dimensions and details shown on the plans.

19. Curing Concrete: Concrete surfaces exposed to conditions causing premature drying shall be protected by covering, within 2 hours of placing. Concrete shall be cured as specified in Subarticle 4.01.03-F.7 except Liquid Membrane-Forming Curing shall not be used. Other means of curing may be used provided that by either field or laboratory demonstration it can be shown that the material, or method used, sufficiently supplies necessary moisture to the concrete or causes the concrete to retain moisture, is not injurious to concrete and is not toxic.

Curing shall continue for a period of not less than 7 days after placing the concrete. Other precautions to insure the development of strength or to prevent injury shall be taken as the Engineer may direct.

20. Removal of Forms: The forms for any portion of the structure shall not be removed until the concrete is strong enough to avoid possible injury from such removal. Forms and their supports shall not be removed without the approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to take up the stresses due to its own mass uniformly and gradually.

If field operations are controlled by flexural-strength tests, the flexural strength of the concrete in the structure shall be monitored by the penetration-resistance tests, except in cases where the Engineer directs the use of third-point loading of test beams or splitting-tensile tests of cylinders. In this case, the Engineer shall be guided by the following considerations: penetration-resistance tests will be valid only for concretes containing coarse traprock aggregate with a top size to 1 1/2 inches (38 millimeters); beam tests will be valid for concrete containing all types and sizes of coarse aggregates; and, splitting-tensile tests will be valid for concrete containing any size of traprock aggregate.

If field operations are controlled by cylinder tests, the removal of forms, supports and housing and the discontinuance of heating and curing may be begun when the strengths reach the values which shall be fixed by the Engineer.

If field operations are not controlled by one of the above tests, the following period, exclusive of days when the temperature is below 40°F (5°C), may be used as a guide for the removal of forms:

Arch Centers	14 to 28 days
Centering Under Beams	14 to 28 days
Floor Slabs	7 to 14 days
Walls	24 hours to 4 days
Columns	2 to 7 days

To facilitate finishing, side forms carrying no load may be removed after 24 hours with the permission of the Engineer, but the curing process must be continued for seven days.

Ornament moulds shall be removed in the same manner as the usual form work. In case a portion of the plaster work remains in the concrete after the mold is removed, this material shall be carefully removed with a wood chisel, wood mallet or wire brush, using a chipping action wherever possible, and taking care that no damage is done to the concrete. No work of this nature shall be started until at least ten days after the forms have been removed.

21. Surface Finish: The external surface of all concrete shall be thoroughly worked during the operation of placing by means of tools of an approved type. The working shall be such as to force all coarse aggregate from the surface and thoroughly work the mortar against the forms to produce a smooth finish free from water and air pockets, segregated materials, or honeycomb. Unless otherwise authorized by the Engineer, the surface of the hardened concrete shall be finished immediately after the removal of the forms. All voids and honeycomb on the surface shall be filled and finished to conform to the surrounding concrete surface immediately after the

forms are removed and before the finishing process is started. The finish shall be governed by the "Table of Finishes" shown elsewhere herein.

Float Finish: This finish shall be formed by placing an excess of material in the form and removing or striking off of such excess with a template, forcing the coarse aggregate below the mortar surface. There shall be created no concave surfaces in which water will be retained. After the concrete has been struck off as above described, the surface shall be thoroughly worked and floated with a wooden, canvas or cork float, the operation to be performed by skilled and experienced concrete finishers. Before this last finish has set, the surface shall be lightly stripped with a fine brush to remove the surface cement film, leaving a fine grained, smooth, but sanded texture. Curing, as specified elsewhere, shall follow.

Grout Clean-Down Finish: As soon as all cavities have been filled as required elsewhere and the cement mortar has set sufficiently, grout clean-down shall be performed as follows:

- (1) All burrs, unevenness, laitance, including that in air holes, and any other material which will adversely affect the bond of the grout to the concrete, shall be removed by approved methods. This cleaning shall be done from the top or uppermost part of the surface to be finished to the bottom.
- (2) A mixture of a fine aggregate and Portland cement shall be thoroughly blended while dry. The proportions shall be such that when mixed with the proper amount of water, the color will match that of the concrete to be finished. The proportions shall be determined by trial panels. Water shall be added to this mixture in an amount which will bring the grout to a workable thick paint-like consistency.
- (3) The surface to be treated shall be thoroughly wetted with a sufficient amount of water to prevent the absorption of water from the grout. Grout shall then be applied to the wetted surface before setting of the grout occurs. Grout which has set, shall not be re-tempered and shall be disposed of by the Contractor at his expense.

The grout shall be uniformly applied by brushes, spray gun, or sponge rubber float over the entire surface, completely filling all air bubbles and holes. Immediately after applying the grout, the surface shall be floated with a cork, or other suitable float, scouring the surface vigorously. While the grout is still plastic, the surface shall be finished with a sponge rubber float, removing all excess grout but without removing grout from holes or depressions.

- (4) The surface shall be allowed to dry thoroughly, and shall then be rubbed vigorously with burlap to remove completely any dried grout. No visible film of grout shall remain after this rubbing. Operations (3) and (4) shall be completed in one and the same day for the area treated.
- (5) Curing of the concrete so treated shall then be resumed as specified elsewhere or, if completed, for at least 1 more day.

Rubbed Finish: The entire surface shall be thoroughly wet with a brush and rubbed with a No. 16 carborundum stone or an abrasive of equal quality, bringing the surface to a paste. The rubbing shall be continued sufficiently to remove all form marks and projections, producing a smooth, dense surface without pits or irregularities. The paste formed by the rubbing as above described may be finished by carefully stripping with a clean brush, or it may be spread uniformly over the surface and allowed to reset. After the concrete has set for 7 days or such period as the Engineer may direct, the surface shall be rubbed again, with a carborundum stone, until a uniform even color is obtained. No mortar shall be used during this second rubbing. Curing, as specified elsewhere, shall be completed in all cases.

TABLE OF FINISHES

STRUCTURE		TYPE OF FINISH			
	PART	AREA	FLOAT	GROUT CLEAN DOWN	RUBBED
BRIDGE	Abutment	Exposed		X	
	Wings	Top	X		
		Exp. Sides			X
	Piers	Top	X		
		Exp. Sides			X
	Parapets	Top	X		
		Sides			
		& Fascia	X		
	Seat		X		
	Bearing Areas *		X		
	Sidewalks	Top	X		
Curbs	Top	X			
	Sides				X
BOX CULVERT	Wings	Top	X		
		Exp. Sides		X	
	Curbs	Top	X		
		Sides			
	Ends	Exp.		X	
	Median		X		
	Parapets	Top	X		
& Fascia		Sides			X
CATCH BASINS **		Exp.			X
CURBING			X		
DROP INLETS **		Exp.			X
ENDWALLS		Top	X		
		Exp.		X	
GUTTERS		Exp.	X		
PRECAST PILES ***		Exp.			X
RETAINING WALLS		Top	X		
		Exp.		X	
SHOTCRETE		Exp.	X		
SLOPE PAVING		Exp.	X		
STEPS & COPING		Top	X		
		Exp. Sides			X

* See Subarticle 6.01.03-14 for finish following floating.

*** When required by special provisions.

** Precast units excepted; See Subarticle M.08.02-4.

22. Testing Apparatus and Test Specimens:

- (a) The flexural strength of the concrete for structures shall be monitored by the evaluation of compressive strength cylinders. The compressive strength specimens shall be cast and cured in the field in accordance with AASHTO T 23. After proper curing, these cylinders shall be transported to the Division of Materials Testing for strength evaluation.
- (b) Cylinders for 28-Day Compressive Strength: The concrete necessary to cast several cylinders for 28-day compressive-strength determinations shall be furnished by the Contractor from each day's pour. The necessary personnel and forms for casting these specimens will be furnished by the Department and the number of specimens required will be specified by the Engineer. These cylinders shall be cured in an approved concrete cylinder box, or boxes, as described in Section 6.12.

23. Opening to Traffic: Vehicular traffic shall be excluded from the structure until the concrete has developed a compressive strength of 4,000 psi (28 megapascals), or until the Engineer authorizes its opening to traffic. Use of equipment applying loads greater than the design capacity of the bridge or structure shall not be allowed.

24. Joint Seal: The Contractor shall seal joints where shown on the plans and elsewhere where directed by the Engineer.

Before placement of the sealing material, the joints shall be thoroughly cleaned of all scale, loose concrete, dirt, dust or other foreign matter. Projections of concrete into the joint space shall be removed. The joint shall be clean and dry before the sealing compound is applied.

The joint sealant shall be prepared and placed in accordance with the manufacturer's directions and with the equipment prescribed by the manufacturer. Any material improperly mixed or likely to set up before placement into the joints will be rejected and shall be replaced at the Contractor's expense.

The joints shall be sealed in a neat and workmanlike manner, free from all dust and foreign matter.

When the work is completed, the joints shall effectively seal against infiltration of moisture and water.

The sealing compound shall be flush with, or not more than 1/8 inch (3 millimeters) above the adjacent surface of concrete. Where directed by the Engineer, the joint shall be smoothed and leveled to the adjacent surface by cutting off all excess compound after the application. Any joint material which does not adhere or bond with the concrete surface of the joint shall be immediately removed and replaced at the Contractor's expense.

6.01.04--Method of Measurement: This work will be measured for payment as follows:

1. Concrete: The quantity of concrete shall be the actual volume in cubic yards (cubic meters) of the several classes, with the exception of underwater concrete, completed and accepted within the neat lines as shown on the plans or as ordered by the Engineer.

When a concrete footing is to be constructed on bedrock, that quantity of concrete actually placed down to--but not exceeding 6 inches (150 millimeters) below the plan or revised plan footing grade--will be included for payment.

No deduction will be made for panels less than 1 1/2 inches (38 millimeters) in depth, nor for the volume of reinforcing bars or structural steel shapes when used as reinforcing, nor for pile heads. Also there will be no deduction made for the volume occupied by culvert and drainage pipes, scuppers, weep holes, public utility structures or any other opening, unless the surface area of any such single opening is 9 square feet (1 square meter) or more.

Concrete for bridge decks, including curbs, sidewalks, railings, placed thereon or attached thereto, will be classified as Class "F" Concrete unless otherwise indicated on the plans.

In the case of culverts or drainage pipes, the computation of the surface area shall be based on the nominal diameter of the pipe, disregarding the thickness of the shell.

Underwater concrete when specified will be measured by the volume in cubic yards (cubic meters), completed and accepted within the horizontal limits of the cofferdam shown on the plans in which it is placed, and between the elevations established by the Engineer. When underwater concrete is not originally specified but is required, it will be measured by the volume in cubic yards (cubic meters), completed and accepted within the actual horizontal limits of the cofferdam in which it is placed and between the elevations established by the Engineer.

2. Joint Filler: This material will be measured by the area in square feet (square meters) of the joint filler, of the type and thickness specified, actually installed and accepted.

3. Miscellaneous Material: Miscellaneous material such as metal flashing and metal used in expansion joints and bearings will be measured in accordance with the dimensions shown on the plans or as ordered by the Engineer.

6.01.05--Basis of Payment: Payment for this work will be made as follows:

1. Concrete: This material will be paid for at the contract unit price per cubic yard (cubic meter) for "Class A," "Class C" and "Class F Concrete," respectively, complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto, including heating, all admixtures and joint sealer.

2. Underwater Concrete: When this class of concrete is constructed, it will be paid for at the contract unit price per cubic yard (cubic meter) for "Underwater Concrete," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

When no item for "Underwater Concrete" appears in the proposal, and is required, it will be paid for at 80% of the contract unit price for "Class A Concrete," which price shall include all materials, equipment, tools, labor, and work incidental thereto.

3. Ornament or Reverse Moulds: This material will be paid for at the contract lump sum price for "Ornament Moulds" complete in place, including furnishing, setting, removal and all incidental expense.

4. Joint Filler: Expansion joint filler will be paid for at the contract unit price per square foot (square meter) for "Joint Filler for Bridges" of the type and thickness specified, complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

5. Miscellaneous Material: Metal flashing, metal in expansion joints and bearings, etc., will be paid for at the contract unit prices for the class of material in question.

No direct payment will be made for the work of testing the concrete in structures, any testing equipment, the instruction of its use, or for the concrete in or curing of the required test beams and cylinders as specified, or for completion dates set in the forms; but, the cost of this work shall be considered as included in the general cost of the work. The work of transporting and testing these beams and cylinders will be done by the Department without expense to the Contractor.

There shall be no direct payment for the cost of forming keys or construction joints, but the cost thereof shall be considered as included in the cost of the concrete items. Where steel dowels are used, this material will be paid for under the reinforcement item.

There shall be no direct payment for forming weep holes through the wall or for the pipe necessary for this purpose, but the cost thereof shall be considered as included in the general cost of the work.

There shall be no direct payment for the work of placing anchor bolts and similar material that is furnished to the Contractor at the site of the work.

Unless covered by specific contract items, any work performed by the Contractor in connection with utilities installations will be paid for as extra work.

The above provision shall not apply where the installation of equipment for the construction or support of utilities is included in the contract items.

Pay Item	Pay Unit
Concrete (Class A, C, F)	c.y. (cu. m)
Underwater Concrete	c.y. (cu. m)
Ornament Moulds	l.s. (l.s.)
(Thickness and Type) Joint Filler for Bridges	s.f. (s.m)
Metal Flashing	lb. (kg)

SECTION 6.02 REINFORCING STEEL

6.02.01—Description

6.02.02—Materials

6.02.03—Construction Methods

6.02.04—Method of Measurement

6.02.05—Basis of Payment

6.02.01—Description: Work under this item shall consist of furnishing and placing reinforcing steel and splicing materials, of the type and size designated, as shown on the plans, as directed by the Engineer and in accordance with these specifications.

6.02.02—Materials: The materials for this work shall conform to the requirements of Article M.06.01.

6.02.03—Construction Methods:

1. Shop Drawings: Prior to fabricating any materials, the Contractor shall submit shop drawings of the reinforcing steel and splicing materials, with material lists, material designations, placement diagrams, bending diagrams and manufacturer's literature for mechanical connections, for review and approval, in accordance with Article 1.05.02. Any expenses incidental to the revision of materials furnished in accordance with shop drawing and order lists to make them comply with the requirements of the plans, specifications or special provisions shall be borne by the Contractor.

2. Fabrication:

(a) Cutting and Bending: Bar reinforcement shall be cut and bent to the shapes shown on the plans. Fabrication tolerances shall be in accordance with the requirements of ACI 315. All bars shall be bent cold, unless otherwise permitted.

Coated bars shall not be field cut, unless permitted by the Engineer. Field cutting of coated bars should be performed using hydraulic-powered cutters or friction cutting tools to minimize coating damage and field touch-up. Flame cutting of coated bars will not be permitted. Field cut coated bars shall be repaired immediately.

Bars partially embedded in concrete shall not be field bent, except as shown on the plans or permitted by the Engineer.

(b) Hooks and Bend Dimensions: The dimensions of hooks and the diameters of bends measured on the inside of the bar shall be as shown on the plans. When the dimensions of hooks or the diameter of bends are not shown, they shall be in accordance with the ACI 318, "Building Code Requirements for Reinforced Concrete" as amended by ASTM A767M for galvanized bars.

(c) Identification: Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the CRSI "Manual of Standard Practice".

3. Handling, Storing and Surface Condition of Reinforcement: Steel reinforcement shall be stored above the surface of the ground on platforms, skids, or other supports and shall be protected as far as practical from mechanical injury and surface deterioration caused by exposure to conditions producing rust.

Epoxy-coated and galvanized reinforcing steel shall be handled and stored by methods that will not damage the coating. All systems for handling coated reinforcement shall have adequately padded contact areas wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong back, multiple supports, or platform bridge so as to prevent bar-to-bar abrasion from sags in the bar bundle. Bars or bundles shall not be dropped or dragged. Coated reinforcing steel shall be transported and stored on wooden or padded supports. Epoxy-coated reinforcing steel, stored at the job site, shall be protected by covering with opaque polyethylene or other suitable protective material. Provisions shall be made for adequate ventilation to prevent condensation under the covering. Since the epoxy coating is flammable, the epoxy coated reinforcing shall not be exposed to any fire or flame.

Prior to placement of concrete, all reinforcement shall be free from dirt, loose rust or scale, mortar, paint, grease, oil, or other materials that would reduce bond. Reinforcement shall be free from injurious defects such as cracks and laminations. Bonded rust, surface seams, surface irregularities, or mill scale will not be cause for rejection, provided the minimum dimensions, cross section area, and tensile properties of a hand wire brushed specimen meet the physical requirements for the size and grade of steel specified.

4. Placing and Fastening

(a) General: Steel reinforcement shall be accurately placed as shown on the plans and firmly held in position during the placing and setting of concrete. Bars shall be tied at all intersections except where the spacing is less than 12 inches (300 millimeters) in each direction when alternate intersections shall be tied.

Bars shall be tied at all intersections around the perimeter of each mat.

Bundled bars shall be tied together at not more than 6-foot (1800-millimeter) centers. Lap splices shall have a minimum of 2 ties or be tied 12 inches (300 millimeters) apart for the length of the splice, whichever requires the greater number of ties. For epoxy-coated reinforcement, tie wires and metal clips shall be epoxy, plastic or nylon coated. For galvanized reinforcement, tie wires and metal clips shall be plastic coated or galvanized.

With the exception of tie down bars, welding (tack welding) will not be permitted for assembly of reinforcement, unless shown on the plans. Tie down bars shall be placed as shown on the plans and a top longitudinal reinforcing bar tied to these bars. When welding coated bars an appropriate protective mask must be worn, safety equipment used and suitable ventilation provided.

If wire fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

(b) Support Systems: Reinforcing steel shall be supported in its proper position by use of precast mortar blocks, wire bar supports, supplementary bars (tie-down bars), side form spacers or other approved devices. Such devices shall be sufficiently strong and properly placed at frequent intervals so as to maintain the cover between the reinforcing and the surface of the concrete. The reinforcing steel cover shall be no less than that shown on the plans and no greater than that shown plus 1/4 inch (6 millimeter).

Platforms for the support of workers and equipment during concrete placement shall be supported directly on the forms and not on the reinforcing steel.

(c) Precast Mortar Blocks: Precast mortar blocks shall have a compressive strength not less than that of the concrete in which they are to be embedded. The face of the blocks in contact with forms for exposed surfaces shall not exceed 2 inches x 2 inches (50 millimeters x 50 millimeters) in size and shall have a color and texture that will match the concrete surface. Precast mortar blocks shall not be used on exposed surfaces of precast concrete members. When used on vertical or sloping surfaces, such blocks shall have an embedded wire for securing the block to the reinforcing. When used in slabs, either such a tie wire or, when the weight of the reinforcing is sufficient to firmly hold the blocks in place, a groove in the top of the block may be used. For epoxy-coated bars, such tie wires shall be epoxy, plastic or nylon coated. For galvanized bars, such tie wires shall be plastic coated or galvanized.

(d) Wire Supports: Wire bar supports, such as ferrous metal chairs and bolsters, shall conform to industry practice as described in the CRSI "Manual of Standard Practice of the Concrete Reinforcing Steel Institute." All bolsters or chairs which bear against the forms for exposed surfaces shall be equipped with snug fitting, high density, polyethylene tips which provide 1/2-inch (12-millimeter) minimum clearance between the metal and any exposed surface. For epoxy-coated reinforcement, all wire bar supports and bar clips shall be epoxy or plastic coated. For galvanized reinforcement, chair and bar supports shall be hot-dip galvanized, after fabrication, in accordance with ASTM A123.

The maximum spacing of slab bolster rows and high chair rows for concrete deck slabs shall be 4 feet (1200 millimeters) unless otherwise directed by the Engineer.

(e) Repair of Coated Reinforcing Steel:

Epoxy-coated Reinforcing Steel - In addition to the requirements of ASTM D3963M, all damage (i.e., scratches, nicks, cracks) to the epoxy coating of the bar reinforcement, visible to the unaided eye with corrective vision, caused during shipment, storage or placement shall be repaired by the Contractor at the job site with approved patching material. Ends of bars that have been sheared, saw cut or cut by other means shall be coated with approved patching material. The areas on the bars and tie down bars damaged by welding shall be repaired with approved patching material.

Patching of damaged areas shall be performed in accordance with the patching material manufacturer's recommendations. Any singular damaged surface area (prior to repair with approved patching material), shall not exceed 2% of the total surface area of the bar. The total bar surface area covered by patching material shall not exceed 5% of the total surface area of the bar. Should either of these limits be exceeded the bar shall be removed from the work and replaced with an acceptable bar. All patching material shall be fully cured prior to placing concrete.

The patching material shall be compatible with the epoxy coating, inert in concrete, and suitable for repairs in the field. The patching material shall be prequalified, as required for the coating material, and shall be either identified on the container as meeting the requirements of Annex A1 of ASTM D3963M or shall be accompanied by a Materials Certificate certifying that the material meets the requirements of said Annex A1.

Galvanized Reinforcing Steel - All damage (i.e. scratches, nicks, cracks) to the galvanized coating on bar reinforcement, visible to the unaided eye with corrective vision, caused during shipment, storage or

placement shall be repaired by the Contractor at the job site in accordance with ASTM A780, Annex A2 - "Repair using Zinc-Rich Paints". Ends of bars that have been sheared, saw cut or cut by other means shall be coated with zinc-rich paint. The area on the bars and tie down bars damaged by welding shall be repaired with zinc-rich paint.

Field coating of damaged areas shall be performed in accordance with the zinc-rich paint manufacturer's recommendations. The zinc-rich paint shall conform to FS TT-P-641, Type 1 and shall be brush applied to achieve a dry film thickness from 3 - 6 mils. All touchup paint shall be fully cured prior to placing concrete.

5. Splicing of Bars:

(a) **General:** All reinforcement shall be furnished in the full lengths indicated on the plans unless otherwise permitted. Except for splices shown on the plans, splicing of bars will not be permitted without written approval of the Engineer. Splices shall be staggered as far as possible.

(b) **Lapped Splices:** Lapped splices shall be of the lengths shown on the plans.

In contact lap splices, the bars shall be placed in contact and tied together in such a manner as to maintain the minimum distance to the surface of the concrete shown on the plans.

In non-contact lap splices, the bars shall be placed as shown on the plans and tied to adjacent bars in such a manner as to maintain the minimum distance to the surface of the concrete shown on the plans.

(c) **Welded Splices:** Welded splices shall be used at the locations shown on the plans. Welding shall conform to AWS publication "Structural Welding Code, Reinforcing Steel, AWS D1.4" and applicable special provisions.

Welded splices shall not be used on epoxy-coated or galvanized bars. No welding shall be performed close enough to epoxy-coated or galvanized bars to cause any heating of the coating.

(d) **Splices made with Dowel Bar Mechanical Connections:** Splices made with dowel bar mechanical connections shall be used at the locations shown on the plans. The minimum size of the bars and the length of the lap splices for the dowel bar mechanical connections shall be as shown on the plans.

The mechanical connections shall be installed in accordance with the manufacturers recommendations. All tools and equipment required to install and field inspect the connections shall be provided by the Contractor. The Contractor shall take all measures necessary to prevent concrete from adhering to the threaded portions of the mechanical connections.

After installing the coated mechanical connectors, all damaged areas on the coated connectors shall be repaired in accordance with 6.02.03-4(e).

6. Splicing of Welded Wire Fabric: Welded wire fabric reinforcement shall be lap spliced as shown on the plans.

7. Substitutions: Substitution of different size bars will be permitted only when authorized by the Engineer. The substituted bars shall have an area equivalent to or larger than the area shown on the plans.

8. Inspection: Reinforcement in any member or component shall be placed, inspected and approved by the Engineer before placing of concrete begins. Concrete placed prior to approval of the reinforcement may be rejected and its removal required.

6.02.04—Method of Measurement:

1. General: No measurement will be made for payment for any clips, wire, separators, wire chairs, precast mortar blocks and other material used for fastening and supporting the reinforcement in the correct position.

2. Bar Reinforcement: Uncoated, epoxy coated, galvanized and weldable bar reinforcement shall be classified as "Deformed Steel Bars", "Deformed Steel Bars - Epoxy Coated", "Deformed Steel Bars - Galvanized" and "Deformed Steel Bars - Weldable" respectively.

This work will be measured for payment by the number of pounds (kilograms) of bar reinforcement installed and accepted.

The weight (mass) of reinforcing steel shall be computed using the values tabulated in Subarticle M.06.01.02. No allowance shall be made for the weight (mass) of the epoxy or galvanized coatings.

Tie down bars will not be measured for payment.

In case short bars are used when full length bars might reasonably be required, only the amount which would be obtained if full length bars were used will be measured for payment. No allowance will be made for lap splices not contemplated by the plans unless approved by the Engineer.

If bars are substituted upon the Contractor's request and as a result more reinforcing steel is used than specified, only the amount specified will be included.

3. Welded Wire Fabric: This work will be measured for payment by the number of pounds

(kilograms) of welded wire fabric installed and accepted.

The weight (mass) of welded wire fabric will be computed from the values published in the CRSI "Manual of Standard Practice".

4. Dowel Bar Mechanical Connections: Uncoated, epoxy coated and galvanized dowel bar mechanical connections shall be classified as "Dowel Bar Splicer System", "Dowel Bar Splicer System - Epoxy Coated" and "Dowel Bar Splicer System - Galvanized" respectively.

This work will be measured for payment by the number of dowel bar mechanical connections installed and accepted.

6.02.05—Basis of Payment: Payment for this work will be made as follows:

1. Bar Reinforcement: This work will be paid for at the contract unit price per pound (kilogram) for "Deformed Steel Bars", "Deformed Steel Bars - Epoxy Coated" or "Deformed Steel Bars - Galvanized" and "Deformed Steel Bars - Weldable" complete in place and accepted, including shop drawings, furnishing, fabricating and placing reinforcing steel, welding splices and all materials, equipment, tools, labor and work incidental thereto.

2. Welded Wire Fabric: This work will be paid for at the contract unit price per pound (kilogram) for "Welded Wire Fabric", complete in place and accepted, including shop drawings, furnishing, fabricating and placing welded wire fabric and all materials, equipment, tools, labor and work incidental thereto.

3. Dowel Bar Mechanical Connections: This work will be paid for at the contract unit price each for "Dowel Bar Splicer System", "Dowel Bar Splicer System - Epoxy Coated" and "Dowel Bar Splicer System - Galvanized" complete in place and accepted, including shop drawings, furnishing, fabricating and placing dowel bar mechanical connections and all materials, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Deformed Steel Bars	lb. (kg)
Deformed Steel Bars - Epoxy Coated	lb. (kg)
Deformed Steel Bars – Galvanized	lb. (kg)
Deformed Steel Bars - Weldable	lb. (kg)
Welded Wire Fabric	lb. (kg)
Dowel Bar Splicer System	ea. (ea.)
Dowel Bar Splicer System - Epoxy Coated	ea. (ea.)
Dowel Bar Splicer System - Galvanized	ea. (ea.)

SECTION 6.03 STRUCTURAL STEEL

6.03.01—Description

6.03.02—Materials

6.03.03—Construction Methods

6.03.04—Method of Measurement

6.03.05—Basis of Payment

6.03.01—Description: This item shall consist of furnishing, fabricating, transporting, erecting, surface preparation and painting structural steel, rivet and eyebar steel, steel forgings, wrought iron, steel castings, gray iron castings, malleable castings and phosphor bronze of the kind and size designated, in conformity with the requirements of the plans or as ordered and in accordance with these specifications.

Structural steel, regardless of its source, will be fabricated in the United States.

6.03.02—Materials: The materials for this work shall conform to the requirements of Section M.06 and Article M.07.02.

6.03.03—Construction Methods:

1. Shop Drawings: Before fabricating any material, with the exception of structural steel for side-mounted sign supports, the Contractor shall submit shop drawings to the Engineer for approval in accordance with Article 1.05.02-3. These drawings shall include erection plans, material lists and material designations.

2. Camber for Stringer Spans and Floor Beam-Girder Systems: Camber shall be interpreted as the convexity induced into a member to provide for vertical curvature of grade and to offset the anticipated deflections indicated on the plans when the member is in its erected position in the structure. Cambers shall be measured in this erected position, and failure to meet the required amount of camber may be cause for rejection of the member. Unless otherwise noted on the plans, the camber shall approximate a smooth circular curve for the length of the member or between designated points. Compound or reverse cambers may be required for special designs as shown on the plans.

Rolled, plated-rolled and fabricated sections shall be cambered to the total amount specified on the plans and within the camber deviation tolerances permitted for welded beams and girders, as indicated in the ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

Additional camber required to compensate for loss of camber caused by shrinkage due to welding of the members and shear connectors shall be determined by the fabricator.

Camber for rolled and plated-rolled sections shall be produced by local heating. Rolled sections requiring shop welding shall be heat-cambered to the total amount required after such welding has been completed. Improper heating or cooling which might affect the grain structure, strength or ductility of the metal may be cause for rejecting the member.

Correction of errors in camber in welded beams and girders of A514M/A517M material shall be done only under rigidly controlled procedures, each application subject to approval of the Engineer.

3. Workmanship and Finish: The workmanship and finish shall be equal to the best general practice in modern bridge shops.

Weathering steel, particularly within the limits designated on the plans or in the specifications to be blast-cleaned, requires a higher than normal degree of workmanship and finish. Mismatched sections, gouges, scratches, dents and grinding marks other than those permitted by ASTM A6M will be cause for rejection by the Engineer. The repair of defects, as permitted by ASTM A6M, shall be performed by qualified welders using low hydrogen electrodes which provide deposited weld metal meeting the special requirements of the base metal for chemistry, oxide color and atmospheric corrosion resistance in conformity with Article M.06.04.

Where a choice of plates is available for the various weathering steel girders, the best plates shall be reserved for the fascia girders.

4. Storage of Materials: Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids or other supports. It shall be kept free from dirt, grease and other foreign matter and shall be protected, as far as practicable, from corrosion.

Weathering steel shall be stored in such a manner as to allow free drainage and promote the development of the oxide coating in order to develop an early uniform appearance.

5. Fabrication: Unless otherwise shown on the plans or indicated in the Special Provisions, Structural Steel shall be fabricated in accordance with the latest edition (including interim specifications) of

AASHTO Standard Specifications for Highway Bridges, Division II, Section 11.

6. Welding: Unless otherwise shown on the plans or indicated in the special provisions, welding of structural steel shall be done in accordance with "ANSI/AASHTO/AWS D1.5 Bridge Welding Code, latest edition."

(a) Qualification testing of welders, welding operators and tackers shall be carried out under the supervision of the Engineer except that at his discretion, he may approve qualification under other supervision satisfactory to him.

If a welder, welding operator or tacker on any project has not been engaged in welding operations on a Department project or a project acceptable to the Department for a period of six months or more, or if he cannot produce a suitably approved welding certificate dated not more than twelve months previously from a welding agency acceptable to the Engineer, he shall be required to requalify through examination.

Updating of Department welder certification cards shall be performed by personnel from the Division of Materials Testing.

The Department will maintain a listing of approved agencies that are authorized by the State of Connecticut to administer Welder Certification tests. The cost of these tests shall be borne by the Contractor. The Contractor shall furnish without cost all welding appurtenances necessary to perform the test, welding protective equipment, and filler metal for the test welding.

When the coupons or welded specimens pass all the required tests, the welder, welding operator or tacker will be issued a dated certificate of qualifications specifying the weld position and type of weld for which he has been certified; and he shall perform only those operations for which he is certified. The welding certificate shall be valid for a period of two years, after which time the welder may apply for a new certificate. This renewal shall be issued at no cost to the welder if the welder certificate has been properly maintained in accordance with the requirements contained herein. Any discrepancies in the proper maintenance and use of this welder certificate shall be grounds for immediate revocation. If the coupons or welded specimens fail to pass any or all of the required tests, the welder, welding operator or tacker will be so notified; and he may apply for reexamination at any time without prejudice.

The Engineer shall require requalification in the case of those welders, welding operators or tackers whose quality of work he has specific reason to question.

(b) Inspection and Testing of Shop Welds: Magnetic particle, radiographic or ultrasonic testing inspection, whichever is specified, shall be made of all shop weld areas designated on the plans, special provisions or by the Engineer. Such inspection shall be made for the fabricator by an established and approved laboratory whose equipment shall have a rated capacity sufficient for the work to be done.

Each test shall be witnessed by an authorized representative of the Department. Three copies of certified reports of these inspections shall be sent by the Contractor to the Assistant Manager, Materials Testing Section, Department of Transportation, Materials Testing Laboratory, Rocky Hill, Connecticut for his examination. Each certified report shall be identified as to structure, member and location of weld or welds and shall also list all the defective welds, the number of times defective welds were corrected, and the amount of additional inspection required.

The member will be accepted for placement in the structure only when all corrections have been made, and the copies of the certified report shall state that the welds have been inspected and are free from any type of imperfection hereinafter noted for the type of inspection specified, or the entire piece shall be rejected as determined by the Engineer. Upon completion of the work, the Contractor shall send to the Assistant Manager, Materials Testing Section, all radiographs or magnetic particle plates or transfers properly identified. These records shall be one of the documents required under Article 1.08.14—
Acceptance of Contract.

Inspection of Weld Areas not Designated in the Contract: The Engineer shall have the right to require radiographic inspection, magnetic particle inspection or ultrasonic testing inspection of shop weld areas not designated in the contract. In such cases, if the inspection shows the shop weld to be defective, the cost of such inspection shall be borne by the Contractor; but if the inspection shows the weld to be satisfactory, the Contractor will be paid by the Department for the actual cost of the inspection.

Visual inspection and nondestructive testing of welds (shop and field welds) in all steels other than ASTM A514M/517M may begin immediately after they are completed. Welds in A514M/517M steel shall be visually inspected and nondestructively tested not less than 48 hours after they are completed.

Cost of Inspection: Except as stated herein above, there will be no direct payment made for any work required in connection with the inspection of shop welds, but the cost thereof shall be included in the contract lump sum price for "Structural Steel (Site No.)" as identified by number or at the contract unit

price per hundred weight (kilogram) for "Structural Steel" or "Structural Steel (Low Alloy)," whichever is indicated on the proposal form. The payment for tests as stated in Articles 1.05.10 and 1.06.02 shall not apply to the inspection of shop welds for "Structural Steel (Site No.)," "Structural Steel," "Structural Steel (Low Alloy)," or "Structural Steel (Quenched or Tempered)."

7. General: If the substructure and superstructures are built under separate contracts, the Department will provide the substructure, constructed to correct lines, dimensions and elevations and properly finished and will establish the lines and elevations required for setting steel.

The Contractor shall erect the structural steel, remove the temporary construction, and do all work required to complete the construction included in the contract in accordance with the plans and specifications.

The Contractor shall take the reasonable precautions to protect all components of the substructure from stains due to rusting. Stains caused by rusting shall be removed by the Contractor at his own expense.

8. Plans: The Contractor shall submit erection plans prepared by the fabricator, showing a method and procedure of erection compatible with the details of fabrication.

If the fabrication and erection of the structure are done under separate contracts, the Department will furnish detail plans for the bridge or bridges to be erected, including the shop details, camber diagrams, erection diagrams, list of field rivets and bolts and copy of shipping statements showing a list of parts and their weights (masses).

9. Plant: 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.

10. Delivery of Materials: The Contractor shall make all arrangements necessary to unload, handle and store all material and shall unload promptly upon delivery any material which he is required to unload. He shall be responsible for the payment of all demurrage charges.

11. Handling and Storage: Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. If the contract is for erection only, the Contractor shall check the material turned over to him against the shipping lists and shall report promptly in writing any shortage or injury discovered. The Contractor shall be held responsible for any loss of material or for any damage to it, while in his care, occurring prior to its acceptance by the Engineer.

If surfaces which are to be connected by field bolting or that are subject to field welding become rusted or contaminated with any foreign material that would make these connecting procedures unacceptable, the Contractor shall restore these surfaces at no additional cost to the State by scraping, grinding or wire brushing as necessary to remove all foreign material and rust that will interfere with welding and bolting.

12. Falsework: The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor, if required, 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. Falsework shall be adequate to the needs of construction, and adjustment shall be provided so the required camber may be maintained.

13. Methods and Equipment: The Contractor shall be solely responsible for the adequacy of his erection scheme and for all details of plant, falsework and other equipment and material necessary to carry it out. The Contractor's responsibility includes the investigation of erection stresses. The results of this investigation, including computations, shall be submitted upon request of the Engineer for his information.

Before starting the work of erection, the Contractor shall inform the Engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the Engineer. The approval of the Engineer shall not serve to relieve the Contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done until such approval by the Engineer has been obtained.

When the correct location of any part of the structure such as railings, etc., makes it necessary, the Engineer may require that such parts shall not be placed until all floor and paving material has been placed and the structure freed from the falsework. Adequate provision shall be made for the adjustment of such parts. If necessary, all holes for the attachment of such pieces shall be drilled in the field.

If the proposed method of erection requires additional metal in the members, all such additional metal shall be provided at the expense of the Contractor.

14. Anchorages: Anchor bolts and similar materials which are to be placed during the erection of the superstructure shall be carefully and accurately set to the requirements of Subarticle 6.01.03-13.

When anchorage material is to be furnished by the Contractor for the superstructure and placed by the Contractor for the substructure, the necessary material shall be fabricated and delivered to the site of the work at such time as it may be required for proper inclusion in the substructure construction.

In locating anchor bolts in relation to slotted holes in expansion shoes, due consideration shall be given to the temperature at the time of erection.

15. Placement of Bearings: Bearing plates shall have a full and uniform bearing upon the substructure masonry. Bearing plates shall be placed upon bearing areas which are finished according to the requirements of Subarticle 6.01.03-14 "Preparation of Bearing Areas."

Prefabricated pads conforming to the requirements of Article M-12.01 shall be installed unless specifically noted otherwise on the contract plans.

Each piece shall be the same size as the bearing plate it is to support and the holes to accommodate the anchor bolts shall be clearly and accurately punched before setting the pad in place.

In placing expansion bearings, due consideration shall be given to the temperature at the time of erection. The nuts of anchor bolts at expansion bearings shall be adjusted to permit the free movement of the span.

16. Straightening Bent Material: The straightening of plates, angles, other shapes and built-up members, when permitted by the Engineer, shall be done by methods that will not produce fracture or other injury. Distorted members shall be straightened by mechanical means or, if approved by the Engineer, by the carefully planned and supervised application of a limited amount of localized heat, except that heat-straightening of A514M/A517M steel members shall be done only under rigidly controlled procedures, each application subject to the approval of the Engineer. In no case shall the maximum temperature of the A514M/A517M steel exceed 1125°F (607° C), nor shall the temperature exceed 950°F (510° C) at the weld metal or within 6 inches (150 mm) of weld metal. Heat shall not be applied directly on weld metal. In all other steels, the temperature of the heated area shall not exceed 1200°F (648° C) (a dull red) as controlled by temperature-indicating crayons, liquids or bimetal thermometers.

Parts to be heat-straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

17. Assembly Steel: The parts shall be accurately assembled as shown on the plans and any matchmarks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged.

Hammering which will injure or distort the members shall not be 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 proper camber. The blocking shall be left in place until the tension chord splices are fully riveted or bolted and all other truss connections pinned and bolted. Rivets, or permanent bolts in splices or butt joints of compression members, and rivets or permanent bolts in railings, shall not be driven or tightened until the span has been swung. Splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting or bolting with high-strength bolts. Splices and connections carrying traffic during erection shall have three-fourths of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the rivets or high-strength bolts, and cylindrical erection pins shall be 1/32 inch (0.8 mm) larger.

18. Riveting: Pneumatic hammers shall be used for field riveting, except when the use of hand tools is permitted by the Engineer. Rivets larger than 7/8 inch (22 mm) in diameter shall not be driven by hand. Cup-faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes and distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light "cherry red" color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out.

19. Bolted Connections:

(a) **General:** This subarticle covers the field assembly of structural joints using high strength bolts tightened to a specified tension.

(b) **Bolted Parts:** 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 heads, nuts or washers, shall be free of scale, except tight mill scale, and shall also be free of dirt, loose scale, burrs, other foreign material and other defects that would prevent solid seating of the parts.

Except as noted on the plans, contact surfaces within joints designated on the plans as friction type shall be free of oil, paint, lacquer, rust inhibitor, or other foreign material. If protective coating has been applied in accordance with paragraph two of Subarticle 6.03.03-37, it shall be removed prior to making the bolted connection by the use of approved methods to expose joint surfaces as specified above. Joint contact surfaces of members which have been hot-dip galvanized shall be 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.

(c) **Installation:**

(1) Bolt Tension: Each fastener shall be tightened to provide, when all fasteners in the joint are tight, at least the minimum bolt tension shown in Table A for the size and grade of fastener used.

TABLE A
Minimum Bolt Tension ⁽¹⁾ in Pounds

Bolt Size, in inches-	AASHTO M 164 (ASTM A 325) Bolts	AASHTO M 253 (ASTM A 490) Bolts
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	63,600
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.

TABLE A
Minimum Bolt Tension ⁽¹⁾ (kN)

Bolt Diameter mm	AASHTO M 164M (ASTM A 325M) Bolts	AASHTO M 253M (ASTM A 490M) Bolts
16	91	114
20	142	179
22	176	221
24	205	257
27	267	334
30	326	408
36	475	595

⁽¹⁾ Equal to 70 percent of specified minimum tensile strength of the bolts rounded to the nearest kN.

Treaded bolts shall be tightened with properly calibrated wrenches or by the turn-of-nut method. If required because of bolt entering and wrench operation clearances, tightening by either procedure 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.

All fasteners shall have a hardened washer under the element (nut or bolt head) turning in tightening.

- (2) **Calibrated Wrench Tightening:** When calibrated wrenches are used to provide the bolt tension specified in paragraph (c) (1) above, their setting shall be such as to induce a bolt tension 5% to 10% in excess of this value. These wrenches shall be calibrated at least once each working day by tightening, in a device capable of indicating actual bolt tension, not less than three typical bolts of each diameter from the bolts to be installed. Power wrenches shall be adjusted to install or cut-out at the selected calibrating tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to "touch up" bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the prescribed amount.
- (3) **Turn-of-Nut Tightening:** When the turn-of-nut method is used to provide the bolt tension specified in paragraph (c) (1), there shall be enough bolts brought to a "snug tight" condition to insure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall be tightened additionally by the applicable amount of nut rotation specified in Table B with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation, there shall be no rotation of the part not turned by the wrench.

TABLE B
Nut Rotation ¹ from Snug Tight Condition
Disposition of Outer Faces of Bolted Parts

Bolt Length measured from underside of head to extreme end of point	Disposition of Outer Faces of Bolted Parts		
	Both faces normal to bolt axis	One face normal to bolt axis & other face sloped not more than 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters ²	2/3 turn	5/6 turn	1 turn

¹⁻ Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30°; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45°.

²⁻ No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.

(d) Inspection:

- (1) The Engineer shall determine that the requirements of paragraphs (2) and (3) following are met in the work. When the calibrated wrench method of tightening is used, the Engineer shall have full opportunity to witness the calibration tests prescribed in paragraph (c) (2) above. When calibrated wrenches are used, the Contractor shall furnish a calibrated inspection wrench, including a device capable of indicating actual bolt tensions.
 - (2) The Engineer shall observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and shall determine that all bolts are tightened.
 - (3) The following inspection shall be used unless a more extensive or different inspection procedure is specified.
 - (A) Either the Engineer, or the Contractor in the presence of the Engineer, shall use an inspecting wrench which may be either a torque wrench or a power wrench that can be accurately adjusted in accordance with the requirements of paragraph (c) (2) above.
 - (B) Three bolts of the same grade, size* and condition as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. There shall be a washer under the part turned in tightening each bolt.
 - (C) When the inspecting wrench is a torque wrench, each bolt specified in paragraph (d) (3) (B) shall be tightened in the calibration device by any convenient means to the minimum tension specified for its size in paragraph (c) (1). The inspecting wrench then shall be applied to the tightened bolt; and the torque necessary to turn the nut or head 5 degrees (approximately 1 inch at 12-inch radius (25 mm at 305 mm) radius) in the tightening direction shall be determined. The average torque measured in the test of three bolts shall be taken as the job inspecting torque to be used in the manner specified in paragraph (d) (3) (E).
- *Length may be any length representative of bolts used in the structure.
- (D) When the inspecting wrench is a power wrench, it shall be adjusted so that it will tighten each bolt specified in paragraph (d) (3) (B) to a tension at least 5 but not more than 10 percent greater than the minimum tension specified for its size in paragraph (c) (1). This setting of wrench shall be taken as the job inspecting torque to be used in the manner specified in paragraph (d) (3) (E).
 - (E) Bolts represented by the sample prescribed in paragraph (d) (3) (B), which have been tightened in the structure, shall be inspected by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to 10 percent of the bolts, but not less than two bolts, selected at random, in each connection. If no nut or bolthead is turned by this application of the job inspecting torque, the connection shall be accepted as properly tightened. If any nut or bolthead is turned by the application of the job inspection torque, this shall be applied to all bolts in the connection; and all bolts, whose nut or head is turned by the job inspecting torque, shall be tightened and reinspected; or alternately, the fabricator or erector, at his option, may retighten all of the bolts in the connection and then resubmit the connection for the specified inspections.

20. Pin Connections: Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge. 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.

21. Welded Connections:

(a) **General:** This subarticle covers the field assembly of structural joints using welding processes conforming to the requirements of Subarticle 6.03.03-6.

(b) **Dimensional Tolerances:** Ends of members fabricated by welding which are to be field connected by welding shall be shop assembled or assembled to a template and conform to the following requirements. Abutting parts to be joined by butt welds shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, an offset not exceeding 10 percent of the thickness of the thinner part joined, but in no case more than 1/8 inches (3 mm) may be permitted as a departure from the theoretical alignment. In correcting misalignment in such cases, the parts shall not be drawn in to a greater slope than 1/2 inch in 12 inch (41.67 mm/m). Measurement of offset shall be based upon center line of parts unless otherwise shown on the drawing.

(c) **Requirements of Minimum Preheat and Interpass Temperature:** The minimum requirements for preheat and interpass temperature tabulated hereinafter, shall apply except that the requirements of Subarticle 6.03.03-6(b) shall take precedence.

**MINIMUM PREHEAT AND INTERPASS
TEMPERATURE DEGREES F(C)(1), (3)**

Thickness of Thickest Part at Point of Welding-Inches (mm)

Welding Process (Base Metal)	To 3/4 in. Incl. (19.1)	Over 3/4 in. to 1 1/2 in. Incl. (19.1 to 38.2)	Over 1 1/2 in. to 2 1/2 in. Incl. (38.2 to 63.5)	Over 2 1/2 in. (63.5)
Shielded Metal-Arc Welding with Low Hydrogen Electrodes; Submerged Arc Welding; Gas Metal-Arc Welding; or Flux Cored Arc Welding (ASTM A 36 (2); A 572; Grade 50; A 588)	50(10)	70(21.1)	150(65.6)	225(107.2)
Shielded Metal-Arc Welding with Low Hydrogen Electrodes; Submerged Arc Welding with Carbon or Alloy Steel Wire, Neutral Flux; Gas Metal- Arc Welding; or Flux Cored Arc Welding (ASTM A 514/517)	50(10)	125(51.7)	175(79.4)	225(107.2)
Submerged Arc Welding with Carbon Steel Wire, Alloy Flux (ASTM A 514/517)	50(10)	200(93.3)	300(148.9)	400(204.4)

**MINIMUM PREHEAT AND INTERPASS
TEMPERATURE DEGREES °C (1), (3)**

**Thickness of Thickest Part at Point
of Welding- mm**

Welding Process (Base Metal)	To 19	Over 19 to 38	Over 38 to 63.5	Over 63.5
Shielded Metal-Arc Welding; Submerged Arc Welding; Gas Metal-Arc Welding; or Flux Cored Arc Welding (ASTM A 36M (2); A 572M, Grade 345; A588M)	10	20	65	110
Shielded Metal-Arc Welding; Submerged Arc Welding; Gas Metal-Arc Welding; or Flux Cored Arc Welding (ASTM A514M/517M)	10	50	80	110

(1) When the base metal is below the temperature listed for the welding process being used and the thickness of material being welded, it shall be preheated (except as otherwise provided) in such manner that the surfaces of the parts on which weld metal is being deposited are at or above the specified minimum temperature for a distance equal to the thickness of the part being welded, but not less than 3 inches (76 mm) both laterally and in advance of the welding. Preheat and interpass temperatures must be sufficient to prevent crack formation. Temperature above the minimum shown may be required for highly restrained welds. For ASTM A514M/A517M steel the maximum preheat and interpass temperature shall not exceed 400°F (205° C) for thicknesses up to 1 1/2 inches (38 mm) inclusive, and 450°F (230° C) for greater thicknesses. Heat input when welding ASTM A514M/A517M steel shall not exceed the steel producer's recommendation. Welding shall be carried continuously to completion or to a point that will insure freedom from cracking before the joint is allowed to cool below the minimum specified preheat and interpass temperature.

(2) For A36M steel to one inch (25.4 mm) thickness, inclusive, when welded with other than low-hydrogen electrodes, the minimum preheat and interpass temperature shall be 150°F (65.6° C).

(3) In joints involving combinations of base metals, preheat shall be as specified for the higher strength steel being welded.

(d) Inspection and Testing of Field Welds: Visual inspection of welds shall be performed by the Contractor in accordance with the requirements of 6.03.03-6 prior to nondestructive testing of welds. The Department will make magnetic particle inspection, radiographic testing inspection or ultrasonic testing inspection of field welds when so required by the plans, special provisions or Engineer. Each test shall be witnessed by an authorized representative of the Department.

Welds or sections of welds containing imperfections and judged unacceptable by the Department shall be removed and rewelded by the Contractor at his expense. Welds so removed and replaced will be reinspected by the Department by the same method of inspection and judged by the same criterion, or the entire piece shall be rejected as determined by the Engineer. All costs for the reinspection of defective welds shall be at the expense of the Contractor, and these costs will be deducted from any monies due or which may become due to the Contractor.

The Engineer will schedule the inspection and testing of field welds so as to keep the number of inspection trips to a feasible minimum, and the Contractor shall plan and prosecute the work so that this inspection may be performed in an orderly and efficient manner.

The Contractor shall furnish and properly locate suitable scaffolding, platforms or other means of accessibility to the area where the testing is required. This means of access shall be in position for use by the Department or moved by the Contractor to such position prior to the time it is needed by the Department. The cost of providing, furnishing and moving the means of access will not be paid for directly but shall be included in the structural steel item(s).

22. Misfits: The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will 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 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 inspector and his approval of the method of correction obtained. The correction shall be made in his presence. If the contract provides for complete fabrication and erection, the Contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements.

If the contract is for erection only, the inspector, with the cooperation of the Contractor, shall keep a correct record of labor and materials used; and the Contractor shall render, within 30 days, an itemized bill for the approval of the Engineer.

SURFACE PREPARATION

23. General: Surface preparation shall consist of cleaning surfaces of metals in accordance with the methods listed herein. The cleaned surface shall be approved by the Engineer prior to any painting. The metal surfaces to be painted shall be painted before any rust forms. At no time shall the cleaning and painting of a structure section be done simultaneously without the approval of the Engineer.

Prior to abrasive blast cleaning, all flame cut or sheared corners shall be ground in accordance with ANSI/AASHTO/AWS Bridge Welding Code D1.5, Section 3.2.9. In addition, all rough surfaces shall be ground smooth. Flame-cut edges shall be ground over their entire surface regardless of appearance, so that any hardened surface layer will be removed and subsequent abrasive blast cleaning will produce the specified surface profile depth. All steel surfaces shall then be solvent-cleaned in accordance with SSPC-SP1 "Solvent Cleaning" before being blast cleaned.

Unless otherwise specified, all surfaces which are to be given a first shop coat or a field prime coat shall be prepared in accordance with the requirements of Subarticle 6.03.03-24.

Surface preparation shall be done in accordance with SSPC specifications with the following exceptions:

- (a) Where U.S. Bureau of Mines helmets are specified, other approved helmets may be used.
- (b) Inspection shall be in conformance with Articles 1.05.09, 1.05.10 and 1.05.11.
- (c) Abrasive blast cleaning shall be done with 16/35 grade mesh or finer sand, or other approved abrasive which will produce a maximum height of profile of 1.9 mils. This exception applies to surfaces to be painted only.
- (d) The surface for "Near-White Blast Cleaning" shall conform to SSPC-SP 10 and SSPC-VIS 1.
- (e) All field blast cleaning shall be performed using techniques approved by the Engineer that will contain and collect all removed paint and blast debris. The collected paint and debris shall be disposed of by the Contractor in a safe and environmentally acceptable method.

When erection work is completed, including field connections and straightening of bent metal, all surfaces to be painted which are unpainted, have rusted or developed defects in the prime coat, or which are otherwise considered unsatisfactory by the Engineer, shall be cleaned in conformance with the requirements of the system used in the original surface preparation. Before any rust forms, the Contractor shall apply one coat of field touch-up repair primer.

All foreign matter such as oil, grease and cement spatter shall be cleaned from the surfaces in accordance with the requirements of SSPC-SP 1 "Solvent Cleaning" before the next field coat of paint is applied.

24. Blast Cleaning: All surfaces shall be blast cleaned in strict conformance with provisions of SSPC-SP 10 "Near-White Blast Cleaning." Unless otherwise noted on the plans or in the special provisions, the metal surfaces of hardware, railings, plates and other similar materials to be painted may be cleaned in conformance with the provisions of SSPC-SP 8 "Pickling" as a substitute for the requirements of "Blast Cleaning" prior to painting.

Surfaces which are to be blast cleaned before fabrication shall be given a coat of zinc silicate primer conforming to M.07.17 at a dry film thickness of .5 to 1.5 mils. Surfaces receiving this treatment may be welded without removal of the primer.

25. Pickling for Painting: Where noted on the plans or in the special provisions, the members to be cleaned by pickling shall be cleaned in strict conformance with the provisions of SSPC-SP 8 "Pickling."

26. Other Methods of Surface Cleaning: Where noted on the plans or in the special provisions or where directed by the Engineer, surfaces shall be cleaned in conformance with the provisions of SSPC-SP 2 "Hand Tool Cleaning." Cleaning in accordance with the provisions of SSPC-SP 3 "Power Tool Cleaning," SSPC-SP 4 "Flame Cleaning of New Steel" or SSPC-SP 7 "Brush-Off Blast Cleaning" may be used in lieu of SSPC-SP 2 for all or part of the surfaces to be cleaned. Where these methods of surface cleaning are

specified as the primary method of cleaning, all weld areas shall be neutralized before cleaning is begun in accordance with the provisions of SSPC-SP 1 "Solvent Cleaning," Article 3.1.6.

27. Cleaning for Weathering: Weathering steel shall be blast-cleaned within the limits of the following areas:

1. The outside face of fascia girder including exposed surfaces of top flange; web; top, sides and bottom of bottom flange.
2. Sides and bottom of bottom flanges of all interior girders, cross frames, and horizontal connection plates.

Additional areas of weathering steel shall be blast-cleaned within the limits shown on the plans or as directed by the Engineer. At the option of the Contractor, all weathering steel may be blast-cleaned. Blast cleaning shall be executed in accordance with the requirements of SSPC-SP 6 "Commercial Blast Cleaning" before or immediately after fabrication. Areas not to be blast-cleaned shall have all foreign matter removed in accordance with the requirements of SSPC-SP 2 "Hand Tool Cleaning," SSPC-SP 3 "Power Tool Cleaning" or SSPC-SP 7 "Brush-Off Blast Cleaning."

Weathering steel shall be kept free and clean of all foreign matter. Any foreign matter which gets on the steel after it has been cleaned, such as paint, grease, oil, welding slag and spatter, chalk and crayon marks, dirt, etc., that may affect its natural oxidation shall be removed in accordance with the aforementioned specifications as soon as possible. Concrete spatter shall be washed off immediately.

Identification markings shall be on faying surfaces or the top of the top flange, and shall be stenciled with permanent ink. The use of steel die stamps, or marking with paint, will not be allowed.

All weld areas, excepting those to be blast-cleaned, shall be cleaned by power tool in accordance with the requirements of SSPC-SP 3 "Power Tool Cleaning," to remove welding flux, slag and spatter.

All weathering steel shall be fabricated and handled carefully and treated with the care and concern accorded any finished architectural product. The Contractor shall provide all necessary protection for the steel during concreting operations or other work where soiling might occur.

After the structure is completed, if the weathering steel has not developed a uniform appearance due to soiling, imperfections or improper procedures, any foreign material which gets on the steel is to be removed as soon as possible with the proper solvent according to the requirements of the SSPC Surface Preparation Specification "No. 1 Solvent Cleaning," SSPC-SP 1. Where soilage is too severe to be removed by solvent cleaning, it shall be removed according to the requirements of the SSPC Surface Preparation Specification "No. 2 Hand Cleaning," SSPC-SP 2. Where soilage is too severe to be removed by hand cleaning, the soiled areas shall be cleaned according to the SSPC Surface Preparation Specification "No. 3 Power Brush Cleaning," SSPC-SP 3 or "No. 7 Brush-off Blast cleaning," SSPC-SP 7.

28. General: The painting of metal structures shall include, unless otherwise provided in the contract, the preparation of the metal surfaces as specified hereinbefore the application, protection and drying of the paint coatings and the supplying of all tools, tackle, scaffolding, labor and materials necessary for the entire work. Weathering steel shall not be painted.

29. Paint: The paint used shall conform to the requirements as stated herein and shall be as specified on the plans or in the special provisions.

30. Vacant

31. Mixing of Paint: Paint shall be factory mixed except as provided herein. All paint shall also be thoroughly field mixed before applying in order to keep the pigments in uniform suspension.

32. Weather Conditions: Paint shall not be applied when the air temperature is below 40°F (5° C) or when the air is misty, or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work. It shall not be applied upon damp or frosted surfaces.

Material painted under cover in damp or cold weather shall remain under cover until dry or until weather conditions permit its exposure in the open. Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

33. Application: Painting shall be done in a neat and workmanlike manner. Paint shall be applied with hand brushes, except as hereinafter provided for shop painting and inaccessible surfaces. By whatever method applied, the coating of paint shall be smoothly and uniformly spread so that no excess paint will collect at any point.

(a) **Brushing:** The paint shall be so manipulated under the brush as to produce a smooth, uniform, even coating in close contact with the metal or with previously applied paint, and shall be worked into all corners and crevices.

(b) **Inaccessible Surfaces:** On all surfaces which are inaccessible for paint brushes, the paint shall be

applied by spraying as hereinafter described or with sheepskin daubers to insure thorough covering.

(c) **Spraying:** Power spraying equipment shall apply the paint so as to secure uniform coverage in a fine, even spray without the addition of any thinner. In cool weather, the paint may be warmed by approved methods to reduce viscosity for use.

(d) **Rollers:** The use of rollers will be allowed only for the application of the finish coat—Provided that the completed finish coating meets all the specification requirements as to coverage, appearance and film thickness. Prior to the use of the rollers, the finish coat on edges of plates or shapes, rivet and boltheads, and on any angular or welded areas shall be applied by brushing.

(e) **Film Thickness:** The dry film thickness will be measured by means of a calibrated film thickness gage applied at such random locations as the Engineer may select. Areas found to be deficient in dry film thickness shall be corrected by the Contractor at his expense by the application of additional paint in a manner acceptable to the Engineer.

34. Removal of Paint: If the surface is unsatisfactory to the Engineer, the paint shall be removed by abrasive blast cleaning and the metal thoroughly cleaned and repainted.

35. Thinning Paint: Paint as delivered in containers is ready for use when the components are thoroughly mixed. If it is necessary to thin the paint so that it can spray or spread more freely, it shall be done up to the maximum thinning requirements of the coating manufacturer, by approved methods and only with the permission of the Engineer.

36. Painting Galvanized Surfaces: Galvanized surfaces which are required to be painted shall be treated as follows:

For the purpose of conditioning, the painting of galvanized surfaces shall be deferred as long as possible in order that the surfaces may weather.

Before painting galvanized surfaces, they shall be treated as follows:

In one gallon (3.785 L) of soft water dissolve 2 ounces (59.1 ml) each of copper chloride, copper nitrate and sal ammoniac, then add 2 ounces (59.1 ml) of commercial muriatic acid. This should be done in an earthen or glass vessel, never in tin or other metal receptacle. Apply the solution to the galvanized surface with a wide flat brush when it will assume a dark almost black color which, on drying, becomes a grayish film.

37. Shop Painting: Unless otherwise specified, steel work shall be brushed or sprayed with one coat of approved paint after it has been accepted by the inspector and before it is shipped from the plant.

Surfaces not in contact with other steel surfaces, but inaccessible after assembly, shall be coated prior to assembly. Field contact surfaces shall be protected by an application of zinc silicate primer conforming to Article M.07.17 except application of the coating shall be within the range of 2.5 to 3.5 mils dry film thickness.

Structural steel which is to be welded shall be coated after welding is completed. If it is to be welded only in the fabricating shop and subsequently erected by bolting or riveting, it shall be fully coated after shop welding is completed, except that contact surfaces within friction-type joints shall be free of contaminants, as indicated below. Steel which is to be field welded shall receive .5 to 1.5 mils dry film thickness of zinc silicate primer conforming to Article M.07.17, after shop welding and shop fabrication are completed.

Surfaces of iron and steel casting, either milled or finished, shall be given one coat of paint.

With the exception of abutting joints and base plates, machine-finished surfaces shall be coated, as soon as practicable after being accepted, with corrosion protective compound conforming to MIL-C-11796B, Class 1, before removal from the shop.

Contact surfaces within friction-type joints, as indicated on the plans, shall be free of contaminants. A coat of zinc silicate primer conforming to Article M.07.17 shall be applied on contact surfaces of friction-type joints, except application of the coating shall be within the range of 2.5 to 3.5 mils dry film thickness and shall be removed prior to making the bolted connection by use of approved methods to expose the joint surfaces in accordance with Subarticle 6.03.03-19(b).

Erection marks for the field identification of members and weight (mass) marks shall be painted upon surface areas previously painted with the shop coat.

Freshly painted material shall not be loaded for shipment or be moved outside to dry during inclement weather, but shall remain in the shop until the paint is thoroughly dry and, in any case, not less than 24 hours after the paint has been applied.

38. Field Painting: When the erection work is completed, including all connections and straightening of bent metal, all adhering rust, scale, dirt, grease and other foreign material shall be removed as specified under "Surface Preparation."

As soon as the inspector has examined and approved all field connections and any surfaces from which the shop or first coat of paint has been worn or has otherwise become defective, these surfaces shall be cleaned and thoroughly covered with shop paint. All shipping and erection marks shall also be cleaned and thoroughly covered with shop paint.

Surfaces which will be inaccessible after erection shall be painted with such field coats as are called for on the plans or authorized, before being erected.

When the paint applied for retouching the shop coat has thoroughly dried and the field cleaning has been satisfactorily completed, such field coats as are called for on the plans or are authorized shall be applied. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film.

The following provisions shall apply to the application of both field coats. To secure a maximum coating on edges of plates or shapes, rivet heads and other parts subject to special wear and attack, the edges shall first be striped with a longitudinal motion and the rivet heads with a rotary motion of the brush, followed immediately by the general painting of the whole surface, including the edges and rivet heads.

If, in the opinion of the Engineer, traffic produces an objectionable amount of dust, the Contractor shall allay the dust for the necessary distance on each side of the bridge and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

The application of the field coats shall be deferred until adjoining concrete work has been placed and finished. If concreting operations have damaged surfaces to be painted, they shall be thoroughly cleaned before painting is started.

The Contractor shall protect property, pedestrians, vehicular and other traffic upon, underneath, or in the vicinity of the bridge, and also all portions of the bridge superstructure and substructure against damage or disfigurement from spatters, splashes, smirches or spray of paint or paint materials.

Contact surfaces within friction-type joints as indicated on the plans shall be free of oil and other contaminants.

6.03.04—Method of Measurement: Payment under this item will be at the contract lump sum price per each complete bridge structure or shall be based on the net mass of metal in the fabricated structure, whichever method appears on the proposal form.

When payment is based on a lump sum basis, the work will not be measured for payment.

When payment is based on the net weight (mass) of metal in the fabricated structure, it shall include rivet heads, high tensile strength boltheads, nuts, stickthrough and washers required. This net weight (mass) shall be determined by computation as described in Subarticle 6.03.04-1, unless it is provided that it be determined by scale weighing (a scale), as described in Subarticle 6.03.04-2.

1. Computed Weight (Mass): The weight (mass) of the metal works to be paid for under the item of structural steel shall be computed on the basis of the net finished dimensions of the parts as shown on the approved shop drawings, deducting for copes, cuts, clips and all open holes, except rivet and bolt holes, and on the following basis:

(a) The weight (mass) shall be computed on the basis of the following weights per cubic foot (densities (kg/m³)):

Aluminum, cast or wrought	173.0	(2770)
Brass	530.0	(8490)
Bronze, cast	536.0	(8590)
Copper-alloy	536.0	(8590)
Copper, sheet	558.0	(8940)
Iron, cast	445.0	(7130)
Iron, malleable	470.0	(7530)
Iron, wrought	487.0	(7800)
Lead, sheet	707.0	(11325)
Steel, cast, copper bearing, carbon		
silicon, nickel and stainless	490.0	(7850)
Zinc	450.0	(7210)

(b) The weights (masses) of rolled shapes shall be computed on the basis of their nominal weights (masses) per meter, as shown on the drawings or listed in the handbooks.

The weight (mass) of plates shall be computed on the basis of the nominal weight (mass) for their width

and thickness as shown on the drawings, plus an estimated overrun computed as one-half of the "Permissible Variation in Thickness" (Table A1.1) and "Permissible Variations in Weight (Mass)" (Table A1.2) as tabulated in ASTM A6M. The estimated overrun shall be applied to the net finished dimensions of the plate as shown on the approved shop drawings.

(c) The weight (mass) of castings shall be computed from the dimensions shown on the approved shop drawings, deducted for open holes. To this weight (mass) shall be added 5 percent allowance for fillets and overrun. Scale weights (masses) may be substituted for computed weights (masses) in the case of castings or small complex parts for which accurate computations of weight (mass) would be difficult.

(d) The weight (mass) of temporary erection bolts, shop and field paint, galvanization, boxes, crates and other containers used for shipping, and materials used for supporting members during transportation and erection, shall not be included.

(e) The weight (mass) of all rivet heads, both field and shop, and high strength boltheads, nuts, stickthrough and washers shall be included on the basis of the following weights (masses):

Weight per 100 (in pounds)		
Nominal diameter of H.S. Bolt or rivet	Rivet heads	Bolthead, nut, 1 washer and stickthrough
1/2	4	22
5/8	7	33
3/4	12	55
7/8	18	84
1	26	120
1 1/8	36	169
1 1/4	48	216

Mass per 100 (kg)		
Nominal diameter of H.S. Bolt or rivet (mm)	Rivet heads	Bolthead, nut, 1 washer and stickthrough
16	2	17
20	3	26
22	5	39
24	8	50
27	12	60
30	16	73
36	22	122

- (f) The weight (mass) of weld metal shall be computed on the basis of the theoretical volume from dimensions of the welds.
- (g) The weight (mass) of railings shall be measured and paid for as structural steel only if so specified in the special provisions.
- (h) Steel grid floor shall be measured and paid for as structural steel only if so specified in the special provisions.
- (i) The weight (mass) of steel or brass shims shall be included. The weight (mass) of brass shims shall be calculated on the basis of the density of brass.
- (j) No deduction shall be made for trepanned or drilled in recesses in self-lubricating bearings or bearing plates.

2. Scale Weight (Mass): The weight (mass) of metal in the fabricated members shall be determined on scales, approved by the Department, in the presence of the inspector. The Contractor shall supply such scales and shall perform all work involved in handling and determining the weight (mass) of the various parts. If shop paint has been applied to the completed member, 0.4 of 1 percent of the weight (mass) of the member shall be deducted from the scale weight (mass) to compensate for the weight (mass) of the paint. If galvanization has been applied to the completed member, 2 percent of the weight (mass) of the member shall be deducted from the scale weight (mass) to compensate for the weight (mass) of the galvanization. The weight (mass) of field rivets shall be based on the approved shipping list. No payment will be made for any weight (mass) in excess of 1 1/2 percent above the computed net weight (mass) of the whole item.

If the scale weight (mass) of any member is less than 97 1/2 percent of the computed weight (mass), the member may be rejected.

6.03.05—Basis of Payment: The structural steel and metal of the various other types covered by this section, incorporated in the completed and accepted structure, will be paid for at the contract lump sum price for "Structural Steel (Site No.)," or at the contract unit price per hundred weight (kilogram) for "Structural Steel," "Structural Steel (Low Alloy)" or "Structural Steel Sign Support," whichever is indicated on the proposal form.

Payment under either method shall be for structural steel, complete in place, which price shall include furnishing, fabricating, transporting, erecting, surface preparation, painting, galvanizing and all materials, equipment, tools and labor incidental thereto.

Unless otherwise provided, such items as bronze plates, castings, etc., will be paid for at the same unit price as for the structural steel, even though consisting of other materials.

Unless otherwise provided, bridge railing, if required, will be paid for as separate items as provided hereinafter.

Full size tests of eyebars and other members will be paid for as specified hereinbefore.

Wrought iron will be paid for at the contract unit price per pound (kilogram) for "Wrought Iron," incorporated in the completed structure, complete in place, which price shall include furnishing, fabricating, transporting, erecting, surface preparation, painting and all materials, equipment, tools and labor incidental thereto.

No direct payment will be made for setting anchor bolts and anchorage material, preparing bearing areas, furnishing and placing materials under shoes and setting shoes, but the cost thereof shall be included in the general cost of the work.

Anchorage materials furnished by the Contractor for the superstructure and placed by the Contractor for the substructure will be included as part of the superstructure contract.

Pay Item	Pay Unit
Structural Steel (Site No.)	l.s. (l.s.)
Structural Steel	cwt. (kg)
Structural Steel (Low Alloy)	cwt. (kg)
Wrought Iron	lb. (kg)
Structural Steel Sign Support	cwt. (kg)

SECTION 6.05 MASONRY FACING

6.05.01—Description

6.05.02—Materials

6.05.03—Construction Methods

6.05.04—Method of Measurement

6.05.05—Basis of Payment

6.05.01—Description: This item shall consist of a surface course or facing of masonry of the hereinafter specified quality, applied to the exposed surfaces of the concrete structures as a protection or ornamentation. It shall be constructed to the dimensions indicated on the plans or as ordered and in accordance with these specifications.

6.05.02—Materials: The materials for this work shall conform to the requirements of Article M.11.01 for masonry facing stone, Article M.11.04 for mortar and Article M.06.01 for metal dowels and ties.

6.05.03—Construction Methods: Each grade of masonry facing stone shall be constructed in the location and to the dimensions shown on the plans or as ordered and shall be built in conjunction with concrete backing. The backing shall not be placed until the masonry facing and any required dowels or ties have been properly placed. The work shall be carried on in successive layers or lifts as permitted by the Engineer. Care must be taken to prevent any movement of the masonry already in place while placing and compacting the concrete. When required by the Engineer, the facing stone shall be supported by such bracing and form work as may be necessary to prevent movement.

All stone shall be set by competent and experienced masons.

1. Dressing Stone: All stones shall be dressed to the required size and shape before being laid and, except in the case of granite, shall be cut to lie on their natural beds. The bottom bed shall be the full size of the stone, and no stone shall have an overhanging top. In rock-faced work the exposed surface of any stone shall not present an excessively undercut contour adjacent to its bottom arris giving a top heavy, unstable appearance when laid.

Beds and joints of dimensioned masonry stone, except for rock-faced surface finish stone, shall be fine finished a full 2 inches (50 millimeters) from the pitch line of the face from which point the bottom bed may fall under the square 1 inch in 12 inches (80 millimeters in 1 meter); the top bed 1 1/2 inches in 12 inches (125 millimeters in 1 meter); and the joints 2 inches in 12 inches (165 millimeters in 1 meter); but all beds must have a reasonable area of bearing spots back of the face. They shall be free from large depressions which might impair the stability of the work. On rock-faced stone, the beds shall be sawn or dressed full for at least the specified minimum width of the stone; beyond that the beds may fall under the square not in excess of 3 inches in 12 inches (250 millimeters in 1 meter). The joints shall be cut full and square for at least 2 inches (50 millimeters) back of the pitch lines from which point they may fall away not over 3 inches in 12 inches (250 millimeters in 1 meter). Headers, if called for, shall have a back dimension not less than 2/3 of the corresponding face dimension unless otherwise shown on the plans.

Beds and joints of ashlar stone shall be rough finished for a depth of not less than 2 inches (50 millimeters) in from the arris lines, and the balance of the stone shall not fall off more than 1/4 of the minimum dimension of the piece.

Holes for dowels or ties or for handling stone shall not be permitted to show in exposed surfaces.

2. Mixing Mortar: The mortar shall be hand or machine mixed as may be directed by the Engineer. In the preparation of hand mixed mortar, the fine aggregate, cement and lime, if used, shall be thoroughly mixed together in a clean, tight mortar box until the mixture is of uniform color, after which water shall be added in such quantity as to form a stiff paste. Machine mixed mortar shall be prepared in an approved mixer and shall be mixed not less than 1 1/2 minutes.

Mortar shall be used before obtaining initial set. Re-tempering of mortar will not be permitted.

3. Laying Stone: Stone shall not be laid when the air temperature in the shade and away from artificial heat is 40°F (5°C) or below and falling, except with the permission of the Engineer and subject to such conditions as he may impose.

Dimensioned stone masonry shall be carefully and accurately constructed in accordance with the provisions of the approved plans.

Ashlar stone masonry shall be so constructed as to produce the general effect shown on the plans. As an aid in determining the required appearance, the Contractor shall lay up a sample section of wall, under the direction of the Engineer, which when approved, shall be accepted as representing the appearance to be

obtained in the construction.

Each stone shall be cleaned and thoroughly saturated with water before being set. Stone shall not be dropped on or slid over the wall, but shall be carefully set without jarring stone already laid and shall be handled with a lewis or other appliance which shall not cause disfigurement. All stones shall be well bedded in freshly made mortar and settled in place with a suitable wooden maul before the setting of the mortar. Whenever possible the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of about 2 inches (50 millimeters) before mortar has set. The face surfaces of stone shall not be smeared with the mortar forced out of joints or that used in pointing. No hammering, rolling or turning of stones will be allowed on the wall. Precautions shall be taken to prevent seepage of moisture, through or from the beds and joints, which may cause discoloration of the exposed surfaces.

For rock-faced stone, the course heights may vary from 2 feet to 3 feet 2 inches (0.6 meter to 1.0 meter) with the higher courses at the bottom. Face bond shall be not less than 12 inches (300 millimeters).

Headers shall be placed in the masonry only if so specified. They shall then be placed in each course and shall have a face length of not less than the rise of the stone. They shall bond with the core or backing not less than 12 inches (300 millimeters). A minimum face bond of not less than 12 inches (300 millimeters) shall be maintained. In no case shall a joint occur over or under a header. Approximately 1/5 of the area of the wall shall consist of headers.

Beds and joints in dimensioned stone masonry, unless otherwise specified, shall be not less than 3/8 inch (10 millimeters) nor more than 3/4 inch (20 millimeters) in thickness and shall present a uniform appearance. Abrupt changes in the thickness of beds and joints will not be permitted.

Beds and joints in ashlar masonry shall have an average thickness of not more than 1 inch (25 millimeters).

4. Dowels and Ties: Metal dowels and ties of the type called for on the plans or as ordered shall be installed during the placing of the stone and before the backing is placed.

5. Resetting: In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.

6. Concrete Backing: Before concrete backing is poured, the backs of all beds and joints shall be pargeted with not less than 1/2 inch (13 millimeters) of setting mortar. No concrete shall be poured until the pargeting mortar has set. In general, horizontal construction joints produced by successive pours of the backing concrete shall be located not less than 6 inches (150 millimeters) below the top or above the bottom bed of any course of masonry.

7. Joints: Joints shall be pointed or raked as called for on the plans or in the special provisions.

8. Pointing: Pointing shall not be done in freezing weather or when the stone contains frost.

Joints not pointed at the time the stone is laid shall be thoroughly cleaned out, wet with water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool to produce the type of joint shown on the plans or required by the Engineer. The wall shall be kept wet while pointing is being done; and in hot or dry weather, the pointed masonry shall be protected from the sun and kept wet for a period of at least three days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition. The use of acid for cleaning will not be permitted.

6.05.04—Method of Measurement: This work will be measured for payment as follows:

1. Masonry Facing: The quantity of masonry facing shall be the actual number of square yards (square meters) of the face area of accepted masonry facing, completed within the neat lines as shown on the plans, or as ordered by the Engineer.

When the masonry facing is backed with concrete, the quantity to be paid under the concrete item shall be determined by assuming that the facing has the average thickness stated on the plans.

2. Metal Dowels or Ties: Metal dowels or ties will be measured for payment by the number of pounds (kilograms) of metal actually incorporated in the completed and accepted work in accordance with the provisions of Article 6.02.04.

3. Pointing: Unless otherwise specified, all pointing shall be included in the cost of the masonry facing. When the item of "Pointing" appears as a Contract item, measurement will be made according to the gross area of the surface to receive this treatment.

6.05.05—Basis of Payment: This work will be paid for as follows:

1. Masonry Facing: Masonry facing will be paid for at the contract unit price per square yard (square meter) for "Dimension Stone Masonry" or "Ashlar Stone Masonry," as the case may be, complete in place,

which price shall include all equipment, tools and labor incidental thereto and all materials except metal dowels or ties. The cost of drilling holes for dowels or ties shall be considered as included in the general cost of the work.

2. Metal Dowels or Ties: Metal dowels or ties will be included with and paid for at the Contract unit price per pound (kilogram) for "Deformed Steel Bars" in accordance with the provisions of Article 6.02.05.

3. Pointing: Where the item of pointing appears, pointing will be paid for at the contract unit price per square yard (square meter) for "Pointing" which shall include all materials and all other expense incidental thereto.

Pay Item	Pay Unit
Dimension Stone Masonry	s.y. (s.m)
Ashlar Stone Masonry	s.y. (s.m)
Pointing (Kind)	s.y. (s.m)

SECTION 6.06
CEMENT RUBBLE MASONRY

6.06.01—Description

6.06.02—Materials

6.06.03—Construction Methods

6.06.04—Method of Measurement

6.06.05—Basis of Payment

6.06.01—Description: This item shall consist of approved stone, laid in full mortar beds, constructed in such shapes and at such places as indicated on the plans or where directed, and in accordance with these specifications.

6.06.02—Materials: The materials for this work shall conform to the requirements of Article M.11.02 for rubble masonry stone and Article M.11.04 for mortar.

6.06.03—Construction Methods: The masonry shall be constructed in the location and to the dimensions shown on the plans or as ordered.

1. Dressing Stone: All necessary dressing or shaping shall be done before the stone is laid in the wall. No dressing or hammering which will loosen the stone will be permitted after it is placed. Stone at angles or at ends of walls shall be roughly squared and dressed to the required lines.

2. Laying Stone: Stone shall not be laid when the air temperature in the shade and away from artificial heat is 40°F (5°C) or below and falling, except with the approval of the Engineer and subject to such conditions as he may impose.

The masonry shall be laid to line and in courses roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones; and all courses shall be laid with bearing beds parallel to the natural bed of the material.

Each stone shall be cleaned and thoroughly saturated with water before being set. Stone shall not be dropped or slid over the wall but shall be carefully set without jarring stone already laid. All stone shall be well bedded in freshly made mortar. The mortar joints shall be full and the stones carefully settled in place before the mortar has set. No spalls will be permitted in the beds. Joints and beds shall have an average thickness of not more than 1 1/2 inches (38 millimeters).

Headers shall be placed in each course and shall have a width of not less than 1 1/2 times their thickness. They shall bond with the core or backing not less than 12 inches (300 millimeters); and in walls 2 feet (600 millimeters) or less in thickness, they shall extend entirely through the wall. Headers shall occupy not less than 1/5 of the face area of the wall and shall be evenly distributed.

Whenever possible the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of about 2 inches (50 millimeters) before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joints or that used in pointing.

The vertical joints in each course shall break joints with those in adjoining courses at least 6 inches (150 millimeters). In no case shall vertical joints be so located as to occur directly above or below a header.

In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.

3. Pointing: Pointing shall not be done in freezing weather or when the stones contain frost.

Joints not pointed at the time the stones are laid shall be thoroughly wet with water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done; and in hot or dry weather, the pointed masonry shall be protected from the sun and kept wet for a period of at least three days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workman-like condition.

Cofferdams shall be so maintained that the masonry is not exposed to the action of running water until such time as the mortar has attained a strength sufficient, in the opinion of the Engineer, to prevent injury to the work from such exposure.

6.06.04—Method of Measurement: This work will be measured for payment as follows:

1. Cement Rubble Masonry: The quantity of cement rubble masonry shall be the actual number of cubic yards (cubic meters), completed and accepted, within the neat lines as shown on the plans or as ordered by the Engineer. No deduction will be made for the volume occupied by culvert or drainage pipes having an exposed surface area of less than 9 square feet (1 square meter) for each opening. The

computation of the surface area shall be based on the nominal diameter of the pipe, disregarding the thickness of the shell.

6.06.05—Basis of Payment: This work will be paid for as follows:

1. Cement Rubble Masonry: Cement rubble masonry will be paid for at the contract unit price per cubic yard (cubic meter) for "Cement Rubble Masonry" complete in place which price shall include all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Cement Rubble Masonry	c.y. (cu. m)

SECTION 6.07
DRY RUBBLE MASONRY

- 6.07.01—Description**
- 6.07.02—Materials**
- 6.07.03—Construction Methods**
- 6.07.04—Method of Measurement**
- 6.07.05—Basis of Payment**

6.07.01—Description: This item shall consist of approved stone, laid without the aid of mortar, so as to fit neatly and firmly, constructed in such shapes and at such places as indicated on the plans or where directed, and in accordance with these specifications.

6.07.02—Materials: The materials for this work shall conform to the requirements of Article M.11.02 for rubble masonry stone.

6.07.03—Construction Methods: The masonry shall be constructed in the location and to the dimensions shown on the plans or as ordered.

1. Dressing Stone: All necessary dressing or shaping of stone shall be done before the stone is laid in the wall. No dressing or hammering which will loosen the stone will be permitted after it is placed. Stones at angles or at ends of walls shall be roughly squared and dressed to the required lines.

2. Laying Stones: The masonry shall be laid to line in courses, roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones, and all courses shall be laid with bearing beds parallel to the natural bed of the material. Face joints shall have a width of not more than 1 1/2 inches (38 millimeters).

In laying rubble masonry, care shall be taken that each stone takes a firm bearing at not less than three separate points upon the underlying course. Open joints, both front and rear, shall be chinked with spalls, fitted to take firm bearing upon their top and bottom surfaces, for the purpose of securing firm bearing throughout the length of the stone.

6.07.04—Method of Measurement: The quantity of dry rubble masonry shall be the actual number of cubic yards (cubic meters), completed and accepted, within the neat lines of the structure as shown on the plans or as ordered by the Engineer. No deduction will be made for the volume occupied by culvert or drainage pipes having an exposed surface area of less than 9 square feet (1 square meter) for each opening. The computation of the surface area shall be based on the nominal diameter of the pipe, disregarding the thickness of the shell.

6.07.05—Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for "Dry Rubble Masonry," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Dry Rubble Masonry	c.y. (cu. m)

**SECTION 6.09
REPOINTED MASONRY**

6.09.01—Description

6.09.02—Materials

6.09.03—Construction Methods

6.09.04—Method of Measurement

6.09.05—Basis of Payment

6.09.01—Description: This item shall consist of repointing existing masonry walls where indicated on the plans or as directed, in accordance with these specifications.

6.09.02—Materials: The mortar for this work shall conform, as regards materials, proportions and mixing, to the pointing mortar specified in Article M.11.04.

6.09.03—Construction Methods: Pointing shall not be done in freezing weather or when the stone contains frost. The joints in the existing masonry shall be thoroughly raked out and cleaned of all loose mortar, dirt, or other foreign material to a depth of about 2 inches (50 millimeters) or as ordered. The joints shall be thoroughly wet with water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done; and in hot or dry weather, the pointed masonry shall be protected from the sun and kept wet for a period of at least three days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.

6.09.04—Method of Measurement: The quantity of repointed masonry shall be the actual number of square yards (square meters) completed and accepted within the neat lines as shown on the plans or as ordered.

6.09.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Repointed Masonry" which price shall include all materials, equipment, tools and labor incidental thereto.

Pay Item

Pay Unit

Repointed Masonry

s.y. (s.m)

SECTION 6.11 SHOTCRETE

6.11.01—Description

6.11.02—Materials

6.11.03—Construction Methods

6.11.04—Method of Measurement

6.11.05—Basis of Payment

6.11.01—Description: This item shall consist of a surface coating of Portland cement mortar applied to the reinforcement by means of pneumatic equipment, built in the locations and to the dimensions and details shown on the plans and in conformity with these specifications.

6.11.02—Materials: The materials for mortar for this work shall conform to the requirements of Article M.11.04.

Reinforcement shall be of the type called for on the plans and shall conform to the requirements of Article M.06.01.

6.11.03—Construction Methods: The preparation and application of shotcrete shall be done under the supervision of experienced foremen, using only experienced men as machine and nozzle operators.

1. Preparation of Bonding Surface: The bonding surface to receive the shotcrete shall be rough and clean. Loose particles, dust and dirt shall be removed by the use of wire brushes or other approved means. Steel members to be protected with shotcrete shall be cleaned thoroughly of all loose rust, scale, grease, dirt, paint and any foreign material that will prevent or lessen the bond between the shotcrete and the steel.

The bonding surface shall be maintained constantly wet for a minimum of one hour prior to the application of the shotcrete. After wetting, a sufficient time shall elapse or special means shall be used, to remove all surplus surface water and to produce a damp surface that is slightly absorptive. The shotcrete shall be applied when this condition is attained. In no case shall shotcrete be applied to a dry surface.

2. Placing Reinforcement: Reinforcement shall be placed in accordance with the requirements of the plans; and where dowels or anchor bolts are specified, the reinforcement shall be securely fastened to them. When wire fabric reinforcement is used, adjoining sections shall be lapped not less than 4 inches (100 millimeters). Fabric around the top flanges of beams and girders carrying concrete slabs shall be placed before the slab is poured and shall extend at least 5 inches (130 millimeters) below the bottom of the slab and be so located as to properly lap the web reinforcement. Exposed reinforcement in existing structures that are to be repaired or altered shall be thoroughly cleaned. No reinforcement shall be located closer than 3/4 inch (20 millimeters) from any finished surface.

3. Composition: Shotcrete shall be mixed in the proportions of 1 part Portland cement to not more than 3 1/2 parts of fine aggregate, by dry, loose volume. Due consideration shall be given to the bulking effect of any moisture contained in the fine aggregate.

4. Placing: Shotcrete shall be placed by pneumatic pressure through a suitable machine, with the proper amount of water for hydration applied in the mixing nozzle. No shotcrete shall be placed when the air temperature is below 40°F (5° C) or against surfaces containing frost.

Portland cement and fine aggregate shall be premixed dry in a batch mixer and screened through a 1/4-inch (6.3-millimeter) screen before being placed in the hopper of the machine. The sand so used shall have only a normal moisture content of 3% to 8%.

Water pressure in the delivery pipe shall be maintained at a pressure of 10 to 20 psi (70 to 140 kilopascals) above the air pressure in the machine.

A uniform pressure of not less than 35 psi (240 kilopascals) shall be maintained in the placing machine. Where the length of the hose between the placing machine and the point of application exceeds 100 feet (30 meters) horizontally or 25 feet (7.5 meters) vertically, the pressure shall be increased so as to secure a satisfactory velocity at the nozzle.

Shooting strips shall be employed to insure square corners, straight lines and the required thickness of shotcrete. These shooting strips shall be so placed that they will not trap rebound.

When "shooting" any surface, the stream of material flowing from the nozzle shall impinge as nearly as possible at right angles to the surface being covered. All deposits of loose sand shall be removed prior to "shooting." Should any such deposit be covered with shotcrete, it shall be cut out and removed by the Contractor at his own expense.

Shotcrete shall be applied in two or more coats, the next to the last coat being screeded to remove irregularities after which the final or "flash" coat shall be applied. This coat shall not be troweled or

screeded but shall be left without further finish except that outside exposed surfaces shall be given a "float" finish as specified in Article 6.01.03.

5. Curing: Shotcrete shall be cured and protected in accordance with the requirements of Article 6.01.03.

6.11.04—Method of Measurement: This work will be measured for payment as follows:

1. Shotcrete: When shotcrete is applied to new or repair work, the measurement for work under this item shall be based on the actual number of 94-pound net weight (42.64-kilogram) bags of cement used to cover the exposed surface area to the full depth required within the neat lines as shown on the plans or as ordered and accepted by the Engineer.

2. Reinforcement: Reinforcement will be measured in accordance with the provisions of Article 6.02.04.

6.11.05—Basis of Payment: Payment for this work will be made as follows:

1. Shotcrete: This work will be paid for at the contract unit price per bag for "Shotcrete," complete in place, which price shall include all equipment, tools, labor and all materials except reinforcement.

2. Reinforcement: This material will be paid for at the contract unit price per pound (kilogram) for "Deformed Steel Bars" and per square yard (square meter) for "Wire Fabric" complete in place, which price shall include all materials, equipment and labor incidental thereto.

Pay Item	Pay Unit
Shotcrete	bag (bag)

**SECTION 6.12
CONCRETE CYLINDER CURING BOX**

6.12.01--Description: This item shall consist of furnishing an approved box for curing concrete cylinders for test purposes. The box shall remain the property of the Contractor. The box shall be constructed in accordance with these specifications and delivered to the location on the Project as directed by the Engineer.

6.12.02--Materials: The curing box shall be constructed with double walls separated by 2 inches (50 millimeters) of rigid foam insulation and shall have minimum internal dimensions of 42 inches (1050 millimeters) long by 18 inches (450 millimeters) wide by 19 inches (480 millimeters) deep. The top of the box shall be an insulated lid hinged at the back with a lock at front and shall provide a moisture-proof seal between the lid and the box. The box shall be constructed so that the required temperature and humidity within the box can be supplied by an immersible heater (minimum 1,000 watts) when immersed in a pool of water approximately 4 inches (100 millimeters) in depth at the bottom of the box. The heating elements shall be automatically controlled so that the temperature within the box will be maintained within the range stated below. The cylinders shall be supported so that they will not come in direct contact with the pool of water and that there will be free circulation of air over the water and around the cylinders.

A bimetallic thermometer shall be installed which measures the internal temperature of the curing box and can be read from the outside without opening the box. The curing box shall maintain an internal temperature of 72°F + 5°F (22°C + 3°C).

6.12.03--Construction Methods: The Contractor shall keep his curing box in good repair and shall provide and maintain all necessary unit connections to operate the curing box.

6.12.04--Method of Measurement: The furnishing of concrete cylinder curing box will be measured for payment by the number of boxes required for testing purposes or as ordered by the Engineer.

6.12.05--Basis of Payment: This work will be paid for at the contract price each for "Concrete Cylinder Curing Box," ordered and accepted on the project, which price shall include all materials, tools, equipment and labor incidental thereto, also all maintenance of all unit connections to operate the curing box.

Pay Item	Pay Unit
Concrete Cylinder Curing Box	ea. (ea.)

SECTION 6.51 CULVERTS

6.51.01--Description: This item shall consist of furnishing and installing new pipe culverts, new pipe-arch culverts and relaying existing pipe and pipe-arch culverts of the type, size and length called for on the plans or as ordered, at the locations and to the lines and grades designated on the plans, or as directed by the Engineer, and in conformity with these specifications. This item shall also consist of furnishing and installing slotted drain pipes to the dimensions, details and of the size, length and location shown on the plans or ordered by the Engineer.

This item shall also include furnishing and installing culverts, either circular or arched, composed of structural plates, fabricated in the field in accordance with the details shown on the plans, or as ordered. Substructures and incidental construction shall comply with the requirements of the specifications for the various items which constitute the completed structure.

This item shall further include the furnishing and installing of corrugated metal pipe elbows of the type and size shown on the plans, at the location, to the lines and grade designated, or as ordered by the Engineer and in conformance with these specifications.

6.51.02--Materials: The materials for this work shall conform to the following:

Pipes of the type indicated on the plans, joint sealant and bedding material shall conform to the requirements of Article M.08.01. Gravel fill shall conform to the requirements of Article M.02.01.

6.51.03--Construction Methods: Unless otherwise directed by the Engineer, all new or re-laid pipe culverts, including culverts composed of structural plates, shall be installed in pipe bedding in accordance with the details as shown on the plans and in conformance with these specifications.

Pipe with an internal diameter of less than 48 inches (1200 millimeters) and pipe-arch of an equivalent horizontal span shall be installed in a Type I installation, and pipe of 48 inches (1200 millimeters) internal diameter or more, including pipe-arch of equivalent horizontal span shall be installed in a Type II installation.

Type I installation shall consist of installing the pipe, or pipe-arch, in bedding material with a thickness directly under the pipe of 4 inches (100 millimeters) and pre-shaped to a height of 10% of the total height of the pipe. After the pipe has been installed, the trench shall be backfilled with bedding material to a height 25% of the total height of the pipe.

Type II installation shall consist of installing the pipe or pipe-arch in bedding material, with a thickness directly under the pipe of 4 inches (100 millimeters) and pre-shaped to a height of 10% of the total height of the pipe. After the pipe has been installed, the trench shall be backfilled with bedding material to a height of 12 inches (300 millimeters) above the top of the pipe.

Methods of backfilling shall be in conformance with the pertinent sections of Article 2.05.03.

Where pipe is to be laid below the ground line, a trench shall be excavated to the required depth, the bottom of which shall be graded to the elevation of the bottom of the bedding material or to afford a uniform firm bearing for the pipe throughout its entire length, whichever the case may be. When rock is encountered, it shall be excavated to not less than 12 inches (300 millimeters) below the bottom of the pipe; and this depth shall be refilled with bedding material which shall be thoroughly tamped.

Where pipe is to be laid in a fill area, the embankment shall be placed and compacted to an elevation 12 inches (300 millimeters) above the top of the proposed pipe, whereupon the trench excavation shall be made and the pipe installed.

Where the nature of the foundation is poor, the culvert shall be relocated in firm material if possible. Where this cannot be done, the poor material shall be removed and replaced with a layer of gravel fill of such depth as the Engineer may direct; or special construction of the character shown on the plans, special provisions or as ordered by the Engineer, may be employed.

Normally, the placement of pipe shall start at the downstream end and progress upstream. All pipes shall be carefully laid, true to the lines and grades given, hub ends upgrade and with the spigot ends fully entered into the adjacent hubs.

Joints in concrete and vitrified clay pipe shall be sealed with cold-applied bituminous sealer, preformed plastic gaskets or flexible, watertight, rubber-type gaskets conforming to the requirements of Article M.08.01. Portland cement mortar shall not be used for sealing pipe joints except by permission of the Engineer, and if permitted shall conform to the requirements of Article M.11.04.

When cold-applied bituminous sealer is used, the bell and spigot or tongue and groove pipe shall be wiped clean and dry before applying the bituminous sealer to the pipe joint. Before the pipes are placed in contact with each other, the spigot or tongue end shall be completely covered with an excess of bituminous sealer; then the

pipe shall be laid to line and grade so the inside surface of the abutting pipes are flush. The joints shall be completely filled with bituminous sealer. All excess joint sealant shall be removed from inside of the pipe.

Metal pipe and pipe-arches shall be carefully jointed and firmly clamped together by approved connecting bands, which shall be properly bolted in place before any backfill is placed.

Bituminous fiber and asbestos cement pipe shall be joined by use of coupling bands of the same material as the pipe.

Corrugated structural plate pipe, plate-arches and plate pipe-arches shall be constructed in conformity with the plans, or as ordered, shall be true to lines and grades given, and shall have a protective bituminous coating applied by an approved method on the inside and outside of the plates. The coating material shall meet the requirements of Subarticle M.08.01-5. Before applying the coating, the metal shall be cleaned to the extent possible of all dust, dirt, oil, unbonded or incompatible paint, grease, acids, alkalies or other foreign matter.

If so ordered by the Engineer, any pipe which is not in true alignment, or which shows any settlement or distortion after laying, shall be taken up and re-laid or corrected, to the satisfaction of the Engineer without additional compensation.

Where indicated on the plans or directed by the Engineer, existing pipe culverts shall be taken up and re-laid or extended and renewed in the same manner as specified herein for new pipe culverts.

Where shown on the plans or directed by the Engineer, the Contractor shall connect the proposed drainage system with existing drainage structures or pipes. This work shall be performed in a workmanlike manner.

Where shown on the plans or directed by the Engineer, the Contractor shall plug existing pipes with cement masonry.

For Slotted Drain Pipe: All slotted drain pipe and related fittings shall be handled and assembled in accordance with the manufacturer's instructions except as modified in the contract documents or as ordered by the Engineer.

Placement of concrete shall conform to Article 6.01.03. The Contractor shall ensure all voids are filled with the concrete.

Care shall be taken in placing concrete backfill immediately adjacent to the interceptor drain pipes to avoid damage to the pipe and to prevent pipe misalignment. The concrete shall be thoroughly consolidated using internal vibrators. Sufficient hold-downs shall be provided by the Contractor to prevent the interceptor drain from floating during concrete placement.

The Contractor shall make sure the surface of the concrete shall be sloped towards the slotted drain pipe detailed in the contract documents. The Contractor shall provide a suitable cover for the wall openings to prevent the concrete backfill or any other foreign debris from entering the pipe or sealing the opening during the installation and subsequent curing periods.

Transverse contraction joints shall be either formed or sawed in the concrete backfill at 20-foot (6-meter) intervals unless the concrete abuts concrete curbs. In this case, the transverse joints shall be 3/8 inch (9 millimeters) wide and 2 1/2 inches (65 millimeters) deep. Sawing shall be done within 24 hours after placement. Care shall be taken not to saw into the interceptor drain pipe.

One expansion joint shall be provided in the concrete backfill for every 500 feet (150 meters) of continuous interceptor drain pipe installed or at every location where the concrete backfill abuts a drop inlet, manhole, or other similar structure. This joint shall be formed for the full depth of the backfill concrete and shall be a minimum of 3/4 inch (19 millimeters) in width.

A longitudinal joint shall be provided if the concrete backfill is placed adjacent to a concrete pavement. This joint shall be either formed or sawed, 1/4 inch (6 millimeters wide), and 2 1/2 inches (65 millimeters) deep. Finish of concrete will be similar to burlap drag finish.

After curing, the transverse, expansion, and longitudinal joints shall be thoroughly cleaned to remove any contaminants or laitance remaining from forming or saw cutting. Before sealing, a backer rod bond breaking material such as closed cell polyurethane rod shall be placed so that a sealer width to depth ratio of 1:1 will be achieved. The joints shall then be sealed with an elastomeric polymer sealer. The methods and materials used to construct the various joints shall be chosen by the Contractor subject to the approval by the Engineer.

Movement of construction equipment and all other vehicles and loads over and adjacent to any slotted drain pipe shall be done at the Contractor's risk. Any pipe or backfill which becomes damaged or disturbed through any cause shall be replaced or repaired as directed by the Engineer at the expense of the Contractor and at no cost to the State. Suitable temporary crossovers consisting of steel plate or other materials approved by the Engineer shall be employed for a minimum of 7 days following concrete backfill operations in all areas where vehicular traffic must be maintained or until such time as the pipe installation will withstand loading without damage. All concrete surfaces shall receive a protective coating.

End cap installation shall be as recommended by the manufacturer.

6.51.04--Methods of Measurement: This work will be measured for payments as follows:

1. New and Re-laid Pipe Culverts and Pipe-Arch Culverts will be measured for payment by the actual number of linear feet (meters) of pipe or pipe-arch of the various sizes and types, completed and accepted and measured in place along the invert. Coupling bands and fittings for culvert pipe and pipe-arches will not be measured for payment.

Corrugated Metal Pipe Elbows (of the type and size specified) will be measured for payment by the actual number of linear feet (meters) of pipe elbows completed and accepted, based on 6 linear feet (2 meters) per elbow, as shown on the plans. Coupling bands for elbows will not be measured for payment.

2. Corrugated Structural Plate Pipe will be measured for payment by the actual number of linear feet (meters) of pipe of the diameter specified, completed and accepted and measured in place along the invert.

3. Corrugated Structural Plate Arches and Pipe-Arches, being paid for on a lump sum basis, will not be measured for payment.

4. Excavation for Trench will be measured for payment in accordance with Article 2.05.04.

5. Gravel Fill will be measured for payment in accordance with Article 2.13.04.

6. Bedding Material will be measured for payment by the actual number of cubic yards (cubic meters) completed and accepted, measured within the payment lines as shown on the plans or as ordered by the Engineer. The volume of the pipe will not be included in the measurement.

7. There will be no measurement for payment for the cost of connecting proposed drainage systems with existing systems, but the cost thereof shall be included in the contract unit price per linear foot (meter) for the size and type of pipe being installed. Excavations necessary for such work will be considered as trench excavation and will be measured for as such.

8. There will be no measurement for payment for the cost of plugging existing pipes.

9. Slotted Drain Pipe or Temporary Slotted Drain Pipe shall be measured in linear feet (meters) along the top centerline, including elbow, as designated on the plans or as directed by the Engineer.

6.51.05--Basis of Payment: This work will be paid for as follows:

1. New Pipe Culverts and Pipe-Arch Culverts will be paid for at the contract unit price per linear foot (meter) for pipe or pipe-arch of the type and size specified, complete in place, including all materials, equipment, tools and labor incidental thereto.

Corrugated Metal Pipe Elbows will be paid for at the contract unit price per linear foot (meter) for "Corrugated Metal Pipe Elbow" of the type and size specified, complete in place, including all materials, equipment, tools and labor incidental thereto.

2. Re-laid Pipe Culverts and Pipe-Arch Culverts will be paid for at the contract unit price per linear foot (meter) for re-laid pipe or pipe-arch of the type and size actually re-laid, complete in place, including all materials, equipment, tools, labor and work incidental thereto.

3. Corrugated Structural Plate Pipe will be paid for at the contract unit price per linear foot (meter) for pipe of the size specified, complete in place, including all material, protective coating, equipment, tools, labor and work incidental thereto.

4. Corrugated Structural Plate Arches and Pipe-Arches will be paid for at the contract lump sum price for "Corrugated Structural Plate Arch" or "Corrugated Structural Plate Pipe-Arch" of the dimension specified, complete in place, including all materials, protective coating, supporting channels, equipment, tools, labor and work incidental thereto. Excluded therefrom shall be work and materials entering into the construction of masonry foundations.

5. Trench Excavation will be paid for in accordance with Article 2.05.05 at the contract unit price per cubic yard (cubic meter) for "Trench Excavation" of the applying depth.

6. Gravel Fill will be paid for in accordance with Article 2.13.05.

7. Bedding Material will be paid for at the contract unit price per cubic yard (cubic meter) for "Bedding Material," complete in place, which price shall include all materials, tools, equipment and labor incidental thereto.

8. There will be no direct payment for the plugging of existing pipes, but the cost thereof shall be included in the contract unit prices of the drainage and excavation items.

9. Slotted Drain Pipe or Temporary Slotted Drain Pipe will be paid for at the contract unit price per linear foot (meter) for "Slotted Drain Pipe" or "Temporary Slotted Drain Pipe" of the size specified, complete in place, which price shall include all excavation, pipe, saw cutting, end caps, elbows, concrete, protective coating, grate, and all materials, tools, equipment, and labor incidental thereto.

In addition, if **Temporary Slotted Drain Pipe** is required, as shown on the plans, the contract unit price shall include the removal and disposal of the pipe and concrete backfill, including excavation and all materials, tools, equipment and labor incidental thereto to permit the construction of the permanent structures and/or pavement. The price shall also include any repair of receiving drainage structures subsequent to the removal of the slotted drain pipe outlet.

Pay Item	Pay Unit
(Size and Type) Pipe (Thickness)	l.f. (m)
(Size) C.C.M. Pipe-Arch (Thickness)	l.f. (m)
(Size and Type) Corrugated Metal Pipe Elbow	l.f. (m)
(Size) Corrugated Structural Plate Pipe (Thickness)	l.f. (m)
(Size) Corrugated Structural Plate Arch	l.s. (l.s.)
(Size) Corrugated Structural Pipe-Arch	l.s. (l.s.)
Re-laid Pipe (Type and Size)	l.f. (m)
Re-laid Pipe-Arch (Type and Size)	l.f. (m)
Bedding Material	c.y. (cu. m)
(Size) Slotted Drain Pipe	l.f. (m)
(Size) Temporary Slotted Drain Pipe	l.f. (m)

**SECTION 6.52
CULVERT ENDS**

6.52.01—Description: This item shall consist of furnishing and installing reinforced concrete culvert ends conforming to the details shown on the plans or to commercial details providing equal lengths and a similar shape, and having generally comparable hydraulic characteristics. These reinforced concrete culvert ends shall be placed where and as shown on the plans, or as directed by the Engineer.

This item shall also include furnishing and installing new metal culvert ends at the locations shown on the plans or as directed by the Engineer. These culvert ends shall be of the size, gage and general shape shown on the plans.

6.52.02—Materials: The materials for this work shall conform to Subarticle M.08.01-22 for Reinforced Concrete Culvert End, Subarticle M.08.01-23 for Metal Culvert End, Article M.11.04 for Mortar and Article M.02.01 for Gravel Fill.

6.52.03—Construction Methods: Reinforced concrete culvert ends shall be placed on a prepared bed of the existing ground, or if so directed by the Engineer, on gravel fill and accurately aligned as shown on the plans. The joints shall be sealed as specified in Article 6.51.03.

Metal culvert ends shall be placed on a prepared bed of the existing ground, or if so directed by the Engineer, on gravel fill. After the attachment of the culvert end to the culvert, backfill shall be placed around both sides of the unit up to the prescribed surface, exercising caution to avoid displacement or deformation of the unit.

6.52.04—Method of Measurement: Construction of the culvert ends will be measured as units.

Trench Excavation necessary to place the culvert end will be measured for payment in accordance with Article 2.05.04.

Gravel Fill will be measured for payment in accordance with Article 2.13.04.

If the metal culvert end is shop-riveted to a length of pipe or pipe-arch, this length shall be measured for payment in accordance with Subarticle 6.51.04-1.

6.52.05—Basis of Payment: Reinforced Concrete Culvert Ends and Metal Culvert Ends will be paid for at the contract unit price each for the culvert end of the type and size specified, complete in place, including all materials, equipment, tools and labor incidental thereto.

Necessary trench excavation will be paid for in accordance with Article 2.05.05 at the contract unit price per cubic yard (cubic meter) for "Trench Excavation" of the applying depth.

Gravel Fill will be paid for in accordance with Article 2.13.05.

The shop-riveted length of pipe or pipe-arch will be paid for in accordance with Subarticle 6.51.05-1.

Pay Item	Pay Unit
(Size-Type) Reinforced Concrete Culvert Ends	ea. (ea.)
(Size-Type) Metal Culvert Ends	ea. (ea.)

SECTION 6.53
CLEAN EXISTING DRAINAGE SYSTEM

6.53.01—Description: The work included in this item shall consist of furnishing all equipment, tools, labor, and materials and performing all work necessary for cleaning, removing and disposing of all sludge, dirt, sand, gravel, roots, grease, and other debris from the existing drainage system which includes: culverts, 12 inches to 42 inches (300 millimeters to 1050 millimeters) diameter; culverts, greater than 42 inches (1050 millimeters) diameter; manholes; catch basins; and drop inlets, throughout the project limits, as directed by the Engineer.

6.53.02—Materials: vacant

6.53.03—Construction Methods: Selection of the equipment used shall be based on the condition of the lines at the time the cleaning operations commence and shall be approved by the Engineer.

The sequence of the Contractor's work shall allow for the proper and adequate maintenance of all functional drainage systems.

Precautions shall be taken to protect the drainage systems at all times. All workmen shall be experienced and skilled in the use of the equipment used. The Engineer reserves the right to prohibit use of any equipment or method deemed inappropriate for the intended work.

Any and all debris resulting from the cleaning operations shall be removed from the job site and disposed of by the Contractor. The Contractor shall make every effort to remove all sludge, dirt, sand, gravel, roots, grease, and other debris from the existing drainage systems including discharge points. Washing sludge, dirt, sand, gravel, roots, grease, and other debris downstream shall not be permitted.

6.53.04—Method of Measurement: Catch basins, manholes and drop inlets will be measured for payment by the actual number of units cleaned. Culverts cleaned under this item will be measured for payment by the actual number of linear feet (meters) of culvert cleaned for those 12 inches to 42 inches (300 millimeters to 1050 millimeters) in diameter, and those greater than 42 inches (1050 millimeters) in diameter.

6.53.05—Basis of Payment: This work will be paid for at the contract unit price each for "Clean Existing Catch Basin," "Clean Existing Manhole," "Clean Existing Drop Inlet." Cleaning of culverts will be paid for at the contract unit price per linear foot (meter) for, "Clean Existing Culvert—12 inches to 42 inches (300 millimeters to 1050 millimeters) in Diameter," "Clean Existing Culvert—Greater than 42 inches (1050 millimeters) in Diameter," which price shall include all equipment, tools, and labor incidental to the completion of these items. All costs incidental to the disposal of sludge, dirt, sand, gravel, roots, grease, and other debris will be included in the price above.

Pay Item	Pay Unit
Clean Existing Catch Basin	ea. (ea.)
Clean Existing Manhole	ea. (ea.)
Clean Existing Drop Inlet	ea. (ea.)
Clean Existing Culvert—12" to 42" (300 mm to 1050 mm)	l.f. (m)
Clean Existing Culvert—Greater than 42" (1050 mm)	l.f. (m)

SECTION 7.02 PILES

7.02.01--Description

7.02.02--Materials

7.02.03--Construction Methods

7.02.04--Method of Measurement

7.02.05--Basis of Payment

7.02.01--Description: Piles shall be either timber, steel, precast concrete, prestressed concrete or cast-in-place concrete of the required dimensions, furnished and driven, as shown on the plans or as ordered and in accordance with these specifications.

Test piles shall be piles of the type specified, driven in advance of placing orders for the piles, for the purpose of determining length or bearing capacity of piles.

If specified in the plans or directed by the Engineer, piles shall be tipped, shaped, reinforced or otherwise pointed and strengthened.

7.02.02--Materials: Piles of the type indicated on the plans shall conform to the requirements of Articles M.09.02 and M.14.01.

7.02.03--Construction Methods:

1. Timber Piles: The method of storing and handling timber piles shall be such as to avoid injury to the piles. Special care shall be taken to avoid breaking the surface of treated piles. Cant dogs, hooks, or pike-poles shall not be used. Cuts or breaks in the surface of treated piling shall be given three brush coats of hot creosote oil of approved quality, and hot creosote oil shall be poured into all bolt holes.

2. Steel Piles: The methods of storing and handling steel piles shall be such as to prevent injury to the piles and to protect them from corrosion.

3. Cast-In-Place Concrete Piles: Cast-in-place concrete piles shall be constructed by driving steel shells and filling them with concrete. Shells shall be continuously or incrementally tapered, or cylindrical, or a combination of continuously or incrementally tapered lower sections, which are extended with cylindrical upper sections, unless otherwise provided in the plans or special provisions. The tapered portion of piles shall have a minimum tip diameter of 8 inches (200 millimeters) and shall change in diameter not less than 1 inch in every 12 feet (7 millimeter/meter). Cylindrical piles and the cylindrical extension portions of tapered piles shall have a minimum diameter of 12 inches (300 millimeters). Shells for cast-in-place concrete piles shall be formed by joining sections of the same manufacture, unless otherwise permitted by the Engineer. Composite shell piles, which are piles composed of different thicknesses or of different manufacture, shall not be used unless shown on the plans or approved by the Engineer. Prefabricated driving points or other type tip enclosures shall be subject to the approval of the Engineer.

The Contractor shall furnish shells of a type and gage which can be driven without distortion. Shells which fail, fracture or otherwise distort during driving or after driving shall, unless otherwise directed, be withdrawn or replaced at the Contractor's expense. The metal of shells which are to be driven without a mandrel shall be of sufficient thickness to withstand the driving without failure, fracture or distortion, but in no case shall the thickness be less than No. 7 gage. Shells driven with a mandrel shall have a thickness not less than No. 18 gage. Piles having a shell thickness less than No. 9 gage shall be reinforced as shown on the plans.

Composite shell piles formed by extending lower sections of No. 7 or heavier gage, with upper sections of lighter than No. 7 gage, shall be driven with an internal mandrel in such a manner so as to insure shell alignment and maximum hammer energy transmission throughout the pile shell length. All details concerning compatibility of shell and mandrel construction shall be subject to the approval of the Engineer.

After driving has been completed, the shell shall be inspected and approved before any concrete is placed. The Contractor shall provide suitable lights and other equipment necessary to inspect each shell throughout its length.

All seams, joints and splices in shells shall develop the full strength of the shell and shall be watertight. No payment will be made for any shell which has been improperly driven, is broken, or is otherwise defective. If necessary, any such shell shall be removed and replaced. If removing such a shell is impracticable, it shall be filled with sand and a replacement shell or shells be driven adjacent thereto.

Reinforcement shall be placed in accordance with the requirements of the plans or special provisions.

No concrete shall be placed in a pile until all driving within a radius of 15 feet (5 meters) from the pile has been completed, or until all the shells for any one bent have been completely driven. If this is impracticable, all

driving within the above limits shall be discontinued until the concrete in the last pile cast has set at least 7 days.

Concrete shall be placed continuously in each pile, care being used to fill every part of the shell, and to work concrete around the reinforcement without displacing it. No concrete shall be placed in shells containing an accumulation of water or any foreign material.

Extensions, or "build-ups" on concrete piles, shall be avoided; but when necessary, they shall be made as specified in Subarticle 7.02.03-9.

4. Prestressed Concrete Piles (Pretensioned): The piles shall be manufactured in accordance with the provision of Article 5.14.03, except as follows:

(a) **Forms:** The forms for the piles shall be of substantial construction and shall produce a uniformly smooth surface on all formed sides. A minimum concrete cover of 2 inches (50 millimeters) shall be maintained for prestressing elements by the use of spreaders or by bundling in areas adjacent to openings or inserts. Ties shall also have a minimum cover of 2 inches (50 millimeters) at these locations. Side forms carrying no load may be removed after 24 hours with the permission of the Engineer or after the concrete has reached the minimum transfer strength as required by Subarticle M.09.02-6

(b) **Finishing:** The topside surface of the piles shall be given a uniformly smooth steel trowel finish to match the surface of the formed sides. The prestressing elements shall be cut flush or recessed 1/8 inch (3 millimeters) to the top of the pile. Projecting fins and surface imperfections shall be removed in a workmanlike manner.

Exposed jet pipe connections, inserts or other devices shall be removed or recessed to a depth as directed, and the hole or opening patched with non-shrink grout in a workmanlike manner. The patching material shall have a degree of finish comparable to the adjacent surfaces.

Additional finishing of piles, if required, shall be as shown on the plans or as otherwise directed.

(c) **Handling and Storage:** Care shall be taken during storage, transporting, hoisting and handling of the prestressed piles to prevent cracking or damage. Piles damaged by improper storing, transporting or handling shall be replaced by the Contractor at his expense.

Lifting and support points shall be marked on the piles as required.

(d) **Pile Extensions:** Pile extensions shall normally be fabricated especially for this purpose in accordance with the specifications. However, sound sections of pile cutoffs or sound portions of rejected piles may be used, subject to the approval of the Engineer.

Short pile extensions may, with the permission of the Engineer, be cast-in-place monolithically with the footing or cap.

5. Driving Equipment: Piles shall be driven with an acceptable pile driving hammer or a combination of acceptable hammer and water jet. Sufficient boiler or compressor capacity must be provided at all times to maintain the rated speed of hammer during the full time of driving a pile. The valve mechanism and other parts of the hammer shall be maintained in first-class condition so that the length of stroke for a single-acting hammer and the number of blows per minute for a double-acting hammer, for which the hammer is designed, will be obtained. Any hammer, its connecting hose and source of compressed air or steam (if so supplied) which operates at less than its rated speed or range of speeds, as set forth in the manufacturer's catalog, shall be deemed unsatisfactory and shall be removed from the site.

The size of hammer shall be adapted to the type and size of piles and the driving conditions. Unless otherwise specified, the minimum rated striking energy per blow for hammers used shall be 7000-foot pounds (9500 joules) for driving timber piles; 15,000-foot pounds (20 000 joules) for driving steel piles and for driving shells for cast-in-place concrete piles; and 19,000-foot pounds (25 000 joules) for driving precast concrete piles and for driving prestressed concrete piles. The hammer model used for the driving of test piles shall be used for the driving of service or production piles, unless a change is authorized by the Engineer in writing. Hammers delivering an energy which the Engineer considers detrimental to the piles shall not be used. The hammer used to drive prestressed concrete piles shall be single-acting, and the length of the stroke shall be variable and readily adjustable.

Diesel hammers and vibratory or sonic methods for driving piles, other than prestressed concrete piles, will be permitted subject to the following restrictions:

(a) The Engineer reserves the right to require the Contractor to demonstrate to the satisfaction of the Engineer that such hammers or methods are capable of driving the piles to the penetration, bearing surface or material and resistance required in the plans and specifications, or as determined. Such demonstrations shall consist of a comparison of the performance of one or more piles driven by an acceptable air or steam hammer of adequate size with one or more piles driven by the diesel hammer or vibratory or sonic method. Comparisons

will be based on the results of load tests of each of the piles driven, or check driving of one or more piles driven by diesel hammer or vibratory or sonic method by an adequate air or steam hammer of adequate size, or by evaluation of data derived from the instrumentation of the diesel hammer or vibratory or sonic equipment, or by such combination of these comparisons and evaluations as the Engineer may direct. The piles in the foregoing demonstration will be at locations designated for permanent piles in the structures.

The Engineer reserves the right to require check driving (by means of an acceptable air or steam hammer of adequate size) of piles driven by diesel hammers or vibratory or sonic methods in order to verify final resistance penetration.

(b) Costs: There shall be no direct payment for the cost for tests, check driving and instrumentation carried out for the sole purpose of comparison demonstrations under (a) above. The total length of piles which are accepted in the structure will be paid for at the contract unit price for furnishing and driving piles or at the contract unit price each for test piles, as the case may be.

(c) Instrumentation: Diesel hammers having an enclosed top ram shall be equipped with a calibrated pressure gage which shall register on record chamber pressure at any time during driving. When rebound of ram is unrestricted, hammers shall be equipped with a graduated stroke rod so as to permit observation of the height of stroke at any time during driving.

When required by the Engineer, vibratory or sonic drivers shall be equipped with such instrumentation as will permit an accurate, continuous and simultaneous graphic recording of the rate of penetration of the pile and the energy output of the primary power unit. This graphic recording shall be continuous throughout the driving of piles for demonstration purposes and for test piles.

In case the required penetration is not obtained by use of a hammer complying with the above minimum requirements, the Contractor shall employ such other driving methods as the use of a hammer with a greater mass than that being used, resort to jetting, spudding, pre-holing or a combination of these methods, and perform such other work as may be necessary to obtain the required penetration.

If it becomes necessary and is authorized by the Engineer to resort to jetting, spudding or pre-holing -- and further, if no contract bid price is asked for in the proposal for jetting, spudding, or pre-holing -- such work will be paid for as "extra work" in accordance with Articles 1.04.05 and 1.09.04.

The use of a hammer with a greater mass, or the use of piles manufactured or designed with pile tips of a nature to provide for better penetration such as but not limited to composite shells, tapered sections or H-pile sections, shall not be considered as extra work. Authorized point reinforcement for piles shall be a separate item.

Pile driver leads shall be used for driving all piles, unless written permission to the contrary is given by the Engineer. They shall be constructed in such a manner as to afford freedom of movement to the hammer, and they shall be held in position to assure support and alignment of the piles within the tolerances specified. Except where piles are driven through water, the leads shall be of sufficient length so that the use of a follower will not be necessary. Inclined leads shall be used in driving batter piles.

Piles for exposed pile bents shall be driven with pile driver leads and templates. They shall be of rigid design and construction and shall maintain the required position and alignment of the piles within the tolerances hereinafter specified. Templates shall be anchored or spudded into position, shall be capable of guiding all piles required for the bent and shall remain in place until all the piles in the bent are driven.

The driving of piles with followers shall be avoided if practicable, and shall be done only with the special permission of the Engineer. All test piles shall be driven without a follower.

During driving of precast or prestressed concrete piles, cushion block material shall be used between the driving head and the pile head. This block shall be fabricated of a wood approved by the Engineer. The total thickness of the cushion block shall be varied, based on the driving equipment used and the driving resistance encountered. When necessary, an additional cushion block shall be used between the striking parts and the driving head. Cushion blocks shall be inspected frequently during driving, and no driving shall be done with blocks which have become distressed and unduly compacted with use. Use of cushion block and packing material other than that specified herein may be substituted by the Contractor, subject to the approval of the Engineer. The cushion block and driving head shall not restrain the pile from rotating during driving so as to cause torsion stresses.

When water jets are used, the number of jets and the volume and pressure of water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least 100 pounds psi (700 kilopascals) pressure at two 3/4-inch (19-millimeter) jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn; and the piles shall be driven with the hammer to secure the final penetration. Jetting of piles shall be done only with the special permission of the Engineer.

Other equipment required and not herein described shall be suitable for the use intended and shall be approved by the Engineer.

6. Point Reinforcement for Piles: When directed by the Engineer, the contractor shall point-reinforce piles. Such point-reinforcement shall be in accordance with the plans or as directed.

7. Order Lists and Test Piles: The length of piles to be furnished shall be specified by the Engineer and will be based upon the best information available at the time the order is placed. The lengths shown on the plans or proposal form are approximate only and may be varied to conform to conditions actually encountered.

Before specifying the lengths of piles to be ordered, the Engineer may require the Contractor to furnish and drive one or more test piles of such lengths as stated in the contract and complete such pile loading tests as the Engineer deems necessary. The length or lengths of piles required will be determined by the Engineer, based upon the results obtained in driving the test piles and making the required pile loading tests.

Test piles shall be of the same type, species, manufacture, shell thickness, taper and cross-sectional dimension as the piles to be installed in the finished structure.

8. Driving Piles Piles shall not be driven until after the excavation is complete or the embankment has been completely placed, whichever the case may be. Any material forced up between the piles shall be removed to correct elevation, without expense to the Department, before masonry for the foundation is placed.

When the nature of the driving is such as to unduly injure the heads of piles, they shall be protected by steel caps of approved design. When the area of the head of any timber pile is greater than that of the face of the hammer, a suitable cap shall be provided to distribute the blow of the hammer throughout the cross-section of the pile and thus avoid, as far as possible, the tendency to split or shatter the pile.

Collars or bands to protect timber piles against splitting and brooming shall be provided where necessary.

Piles shall be driven with a variation of not more than 1/4 inch per foot (20 millimeters/meter) from the vertical or from the batter line indicated, except that piles for trestle bents shall be so driven that the cap may be placed in its proper location without inducing excessive stresses in the piles. Upon completion of driving and released from leads, exposed piles such as in bents shall not have a variation of more than 2 inches (50 millimeters) at the cut-off elevation from the position shown on the plans. Unless otherwise permitted in writing by the Engineer, failure to meet this tolerance shall be cause for rejection. Other foundation piles shall not be out of the position shown on the plans more than 6 inches (150 millimeters) after driving.

The Engineer reserves the right to require the Contractor to re-drive any test pile or production pile when the information so derived is necessary for the determination of order lengths or bearing capacity. The period of time between the original driving and the re-driving shall be determined by the Engineer. Payment for such re-driving will be in accordance with the requirement of Article 1.09.04.

Except for incidental upset and minor spalling or cracking, pile heads damaged while driving shall be cut back and repaired as directed before driving is resumed.

Damaged piles that have been rejected by the Engineer shall be removed if there is any interference with proper positioning and driving of the replacement pile.

Open holes vacated by withdrawal of piles shall be immediately filled with sand or sandy material.

Driving equipment, appurtenances and techniques to be used in the installation of prestressed concrete piles shall be in accordance with the recommendations of the pile manufacturer, subject to the approval of the Engineer. Such recommendation shall be prepared by a manufacturer's representative skilled in the installation of prestressed concrete piles, and the Contractor shall certify to the Engineer that this representative will be available to the Contractor to aid and instruct in the installation of piles to obtain results satisfactory to the Engineer. Prior to driving the piles, the Contractor shall submit to the Engineer for written approval complete details of the equipment and appurtenances he proposes to use in the driving operation. Such details shall also outline the driving techniques and sequence of driving to be followed by the Contractor. Driving equipment, appurtenances and techniques shall be subject to the continuing approval of the Engineer throughout the period of pile installation and shall be modified as necessary to achieve the required penetration and to prevent cracking, spalling or other damage to the piles.

9. Splicing Piles and Extensions: Full length piles shall be used when practicable; but if splices cannot be avoided, piles or shells for cast-in-place piles may be spliced in accordance with the requirements of the plans. Piles shall not be spliced except with the approval of the Engineer. Splices in excess of two per pile for timber, steel and cast-in-place concrete piles will not be permitted except with special permission of the Engineer. Only one splice per pile will be permitted in precast concrete or prestressed concrete piles. In the absence of splice details in the plans, piles or shells for cast-in-place concrete piles shall be spliced in accordance with the pile or shell manufacturer's recommendations, subject to the approval of the Engineer. The use of prefabricated

splicing devices and their method of installation shall be subject to the approval of the Engineer. All seams, joints and splices shall develop the full strength of the pile.

After a precast pile is driven, the concrete at the end of the pile shall be cut away, leaving the reinforcing steel exposed for a length of 40 diameters. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the pile shall be securely fastened to the projecting steel, and the necessary form work shall be placed, care being taken to prevent leakage along the pile. The concrete shall be of the same quality as that used in the pile. Just prior to placing concrete, the top of the pile shall be thoroughly wetted and covered with a thin coating of neat cement or other suitable bonding material. The forms shall remain in place not less than 7 days, shall then be carefully removed, and the entire exposed surface of the pile finished as above specified.

For prestressed concrete piles, the end of the pile to be extended shall be trimmed back neatly to the directed cut-off elevation by means of pneumatic tools, sawing or any other method approved by the Engineer, except that the use of explosives will not be permitted. Where the splice is to be exposed, the pile shall be sawed to a minimum depth of 1/2 inch (12 millimeters) around its perimeter. Holes for the mild steel dowels shall be drilled or preformed as directed, and the top of the pile bush-hammered and cleansed by compressed air. A substantial yoke must be used to align and hold the pile section collinearly until the splicing cement has attained a strength to permit driving. Metal spacers to separate the piles shall be used as required. The splicing cement shall be prepared and injected into the dowel holes and joint in strict conformance with the manufacturer's printed instructions. In no case shall the splicing cement be used when the time lapse between date of manufacture and usage exceeds the manufacturer's recommendations. Nor shall the temperature limits for the material, air or piles be exceeded at time of application. All work shall be done in a workmanlike manner. Exposed splices shall have a degree of finish comparable to the adjacent surfaces. Cracks, separation of material or other signs of distress in the splice shall be cause for rejection. If a splice becomes defective upon resumption of driving, the splice shall be removed and replaced following the same preparatory procedures as before. The upper pile section shall normally be fabricated especially for this purpose in accordance with these specifications. However, sound sections of pile cut-offs or of rejected piles may be used, subject to the approval of the Engineer. Short pile extensions may, with the permission of the Engineer, be cast in place monolithically with the footing or cap.

10. Determination of Bearing Values of Piles: The safe bearing capacity of piles will normally be determined by loading tests. Each test shall consist of loading, unloading, reloading and unloading a pile designated by the Engineer. Where excavation is to be made or embankment placed at the location of such test pile, the excavation or embankment shall be completed to the plan elevation of proposed bottom of footing before any test piles are driven. Except where otherwise required, such excavation shall be completed to at least 5 feet (1.5 meters) horizontally, and embankment completed to at least 30 feet (10 meters) horizontally in all directions from such piles. The load shall be applied not more than 3 feet (1.0 meter) above the plan cutoff.

Unless otherwise specified or ordered, piles shall be loaded to 100% of design load, unloaded, then loaded to 200% of design load and unloaded. Loading increments, unloading decrements and the time interval between increments and decrements shall be as directed by the Engineer. The total test period shall not exceed 7 calendar days. After completion of driving of the pile to be tested, the load test shall not commence until expiration of the minimum waiting period specified, or as directed by the Engineer.

The load may be applied by the "Boot Strap" method or by jacking against a dead load. Non-jacking methods will not be permitted. The "Boot Strap" method of load testing shall not be used on precast concrete or prestressed concrete piles if the anchor piles are to be either type of concrete pile.

Choice of the method to be used shall be made by the Contractor. He shall submit to the Engineer a drawing giving dimensions, sizes and other details of the test apparatus and must receive approval of the Engineer before commencing work on the test. The jack shall be equipped with a calibrated pressure gage for measuring the test load. The pressure gage shall be calibrated immediately prior to use and shall be re-calibrated if at any time the Engineer shall so direct. Certified results of such calibration by an approved commercial laboratory shall be furnished to the Engineer for his review and approval.

For settlement measurement, the Contractor shall furnish and install two dial indicators having a range of 1 inch (25 millimeters) and graduated to 0.001 inch (0.02 millimeter) divisions, or such other means of measurement as are acceptable to the Engineer. Method of installation of dial indicators or other measurement devices shall be as directed by the Engineer. The safe allowable load will be determined by the Engineer from analysis of the loading test data.

The Contractor shall exercise care to prevent eccentric loading of the pile. If the test fails because of eccentric loading, no payment will be made for the test, and no future test shall be performed on the eccentrically loaded pile.

The "Boot Strap" method shall be performed by jacking down on the test pile or piles with a calibrated hydraulic jack placed beneath a horizontal girder. The girder shall be fastened to anchor piles, which shall be located so they can remain in place as part of the completed foundation. In no case shall piles nearer than 6 feet (2 meters) from the test pile or piles be used to assist in anchoring down the girder, unless otherwise permitted by the Engineer. The connections of the girders to the anchors and to the hydraulic jack shall be tight when the test is commenced, and the jack shall then be capable of moving the test pile or piles a distance of at least 5 inches (125 millimeters) during the period of the test.

If temperature variations are found to affect the dial indicators during the test, such equipment shall be suitably protected and maintained at uniform temperature conditions by the Contractor.

If the load is applied to the pile or piles by jacking against a dead load, such dead load shall not have supports closer than 6 feet (2 meters) from the test pile or piles. The jack shall be capable of moving the test pile or piles a minimum of 5 inches (125 millimeters) during the period of the test.

The Contractor shall have a qualified employee present at all times during the performance of the test to maintain the required load exerted by the hydraulic jack. If the test is stopped before completion and the load wholly or partially removed from the pile or piles because of defects in the jack, yield of connections, insufficient load or travel capacity in the jack, or for other mechanical reasons, the Engineer shall order the test abandoned and replaced by a new test on another pile or piles at an adjacent location. Where a loading test is abandoned because of reasons for which the Contractor is responsible, there shall be no payment for such an abandoned test.

In cases where pile loading tests are not performed, the safe bearing value of piles will be determined by the Engineer.

While a pile-loading test is being performed and during a period 48 hours prior thereto, no blasting, driving of piles or piling will be permitted within 300 feet (100 meters) of the location where a pile-loading test is being conducted or is to be conducted.

The Engineer reserves the right to require the Contractor to perform such loading tests on one or more piles prior to construction of the footing or bent.

11. Treatment of Pile Heads: The tops of all timber piles shall be sawed to a true plane as shown on the plans and at the elevation fixed by the Engineer. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the superimposed structure. Broken, split or misplaced piles shall be withdrawn and properly replaced. Piles driven below the cut-off grade fixed by the Engineer shall be withdrawn and replaced by new, and if necessary, longer piles at the expense of the Contractor. All piles pushed up during the process of driving adjacent piles shall be driven down again.

Steel piles and concrete piles shall be cut off to the correct elevation as shown on the plans. Piles damaged in driving or not driven in correct position shall be withdrawn and replaced when so ordered.

Structural steel caps of an approved type shall be provided for steel piles where called for on the plans or required by the Engineer; and in such cases, the ends of the piles shall be smoothed as may be necessary to permit proper attachment.

The portion of the pile heads of concrete piles which is to be embedded in concrete shall be thoroughly roughened and cleaned of all dirt and loose material. Just prior to placing concrete, this portion of the pile shall be thoroughly wetted.

After reaching the required penetration, prestressed concrete piles shall be cut neatly to the proper elevation by means of pneumatic tools, sawing or any other method approved by the Engineer, except that the use of explosives will not be permitted. The projecting tendons shall be cut to the length shown on the plans, or as directed. Where shown on the plans, deformed steel bars shall be placed in drilled holes and grouted in accordance with Subarticle 7.02.03-10.

12. Painting Steel Piles and Steel Pile Shells: When steel piles or steel pile shells extend above the ground surface or water surface, they shall be painted as specified elsewhere in the contract documents or as ordered by the Engineer. This protection shall extend from an elevation 2 feet (600 millimeters) below the ground or water surface to the top of the exposed steel.

13. Welding on Piles: When required or permitted, all welding on piles shall be done in accordance with the requirements of the current AWS Structural Welding Code.

14. Disposition of Pile Cutoffs: All pile cutoffs not incorporated in work shall be the property of the Contractor.

The Contractor shall remove the cutoff material from within the limits of the highway.

7.02.04--Method of Measurement:

1. Steel Piles-Timber Piles-Precast Concrete Piles: The length of (type) piles, which will be the basis for the pay computation to be included under the item of furnishing (type) piles, shall be the number of linear feet (meters) of (type) piles authorized by the Engineer or actually furnished by the Contractor, whichever is the lesser amount.

Length of pile cutoffs previously paid for under authorized lengths of piles and subsequently incorporated into the work will not be measured for payment.

The work, materials, tools, equipment and labor incidental to the disposal of pile cutoffs will not be measured for payment.

The amounts to be included under the item for driving (type) piles will be the number of linear feet (meters) of piles actually driven and accepted in the completed structure.

2. Cast-in-Place Concrete Piles: The amount to be included under the item of cast-in-place concrete piles shall be the number of linear feet (meters) of piles actually driven and accepted in place in the completed structure.

Cut-off materials from shells shall remain the property of the Contractor. They will be paid for in accordance with the unit cost applying in the Contractor's bill or bills for such shells, except that no payment will be made of material cut off from shells furnished by the Contractor in excess of the ordered length. The unit of measurement will be the unit applying in the Contractor's bill or bills for such shells. Material cut off from shells furnished by the Contractor in lengths in excess of those ordered by the Engineer will not be measured for payment hereunder. The work, materials, tools, equipment and labor incidental to the disposal of cut-offs will not be measured for payment.

Reinforcement, if required in cast-in-place concrete piles, will not be measured for payment.

3. Prestressed Concrete Piles (Pretensioned): The length of the prestressed concrete piles, which will be the basis for the pay computation, shall be the number of linear feet (meters) of piles authorized by the Engineer or actually furnished by the Contractor, whichever is the lesser amount. The length of any specified pile tip protruding from the concrete will be included in the length measured for payment.

Also included in the length measured for payment will be the length of precast pile extensions ordered by the Engineer. Not to be included, however, is the length of pile extension furnished in excess of the ordered length. The length of projection dowels shall not be included in the length measured for payment.

Extensions to prestressed concrete piles which are poured monolithically with the footing or pier cap will be paid for at the Contract unit prices for the several items involved, which prices shall be full compensation for all materials, tools, equipment and labor necessary to the completion of the work.

Cut-offs shall not be used for pile extension. The work, material, tools equipment and labor incidental to the disposal of cutoffs will not be measured for payment.

The amounts to be included under the item for driving prestressed concrete piles shall be the number of linear feet (meters) of piles actually driven and accepted in the completed structure.

4. Test Piles: The amounts to be included under the respective items for test piles, of the type and length specified, shall be the number of test piles actually driven and accepted. Lengths of test piles ordered by the Engineer in excess of the length or lengths specified in the contract will be measured for payment by the actual number of linear feet (meters) ordered, furnished and accepted by the Engineer. Driving of such pile extensions will be measured for payment by the actual length driven and left in place.

Authorized splices performed on test piles will be measured for payment by the number of authorized splices actually completed and accepted. Splicing of test piles shall not be considered as authorized splices when such splicing is done to complete piles to the test pile length specified in the contract.

5. Loading Tests: The amount to be included under the item of loading tests shall be the actual number of loading tests completed and accepted.

6. Splices: The amount to be included under the items for splicing timber, steel, cast-in-place concrete, precast concrete and prestressed concrete piles (pretensioned) shall be the number of authorized pile splices actually completed and accepted.

The splicing of timber and steel piles, steel shells for cast-in-place concrete piles, precast concrete piles and prestressed concrete piles (pretensioned) shall not be considered as authorized splices when such splicing is done to complete piles to the order lengths, as defined in Subarticle 7.02.03-7, or when the furnished lengths of such piles are less than the order lengths approved by the Engineer.

7. Point Reinforcement for Piles: The amount to be included under the item of "Point Reinforcement for Piles" for the type of piles specified shall be the number of authorized reinforced points actually completed and accepted.

7.02.05--Basis of Payment: This work will be paid for as follows:

1. Steel Piles: Payment for furnishing steel piles of the lengths authorized will be at the Contract unit price per pound (kilogram) for "Furnishing Steel Piles," which price shall include furnishing, delivery, storage and handling, and all materials, equipment, tools and labor incidental thereto. The mass of steel pile caps will be included with and paid for under this item.

Payment for driving steel piles will be at the contract unit price per linear foot (meter) for "Driving Steel Piles," complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

2. Timber Piles: Payment for furnishing timber piles or treated timber piles, up to a length 10 feet (3 meters) greater than that specified on the plans or in the proposal form, will be at the Contract unit price per linear foot (meter) for "Furnishing Timber Piles Foot (Meter Length)" and "Furnishing Treated Timber Piles Foot (Meter Length)," respectively, which price shall include furnishing, delivery, peeling, storage and handling, and all materials, equipment, tools and labor incidental thereto.

In case the length of any piles finally ordered is more than 10 feet (3 meters), but less than 20 feet (6 meters), greater than the length specified on the plans or proposal form, payment for furnishing such piles shall be at a price per linear foot (meter) equal to the original contract price, plus 20% thereof.

In case the length of any piles finally ordered is 20 feet (6 meters) or more greater than the length specified on the plans or proposal form, payment for furnishing such piles shall be at a price per linear foot (meter) equal to the original contract price plus 40% thereof.

Payment for driving timber piles or treated timber piles will be at the contract unit price per linear foot (meter) for "Driving Timber Piles" and "Driving Treated Timber Piles," respectively, complete in place and regardless of length, which price shall include all materials, equipment, tools and labor incidental thereto.

3. Cast-in-Place Concrete Piles: Payment for cast-in-place concrete piles will be at the contract unit price per linear foot (meter) for "Cast-in-Place Concrete Piles," complete in place, including all materials, equipment, tools and labor incidental thereto.

Cut-off materials from shells shall remain the property of the Contractor. They will be paid for in accordance with the unit cost applying in the Contractor's bill or bills for such shells, except that no payment will be made for material cut off from shells furnished by the Contractor in excess of the ordered length.

4. Prestressed Concrete Piles: Payment for furnishing prestressed concrete piles, of the lengths required, will be at the contract unit price per linear foot (meter) for "Furnishing Prestressed Concrete Piles" of the type and size as shown on the plans, which price shall include furnishing, delivery, storage and handling, and all materials, equipment, tools and labor incidental thereto.

Payment for driving prestressed concrete piles will be at the contract unit price per linear foot (meter) for "Driving Prestressed Concrete Piles," complete in place, which price shall include all material, equipment, tools and labor incidental thereto. Also included shall be all work involved in cutting piles to the direct cut-off elevation.

5. Test Piles: Test piles will be paid for at the contract unit price each for "Test Pile," of the type and length specified, which price shall constitute the complete compensation for furnishing and driving test piles and shall include all materials, equipment, tools and labor incidental thereto. Authorized splices to test piles will be paid for at 200% of the contract unit price bid for Splicing Timber Piles, Splicing Steel Piles, Splicing Cast-in-Place Piles or Splicing Prestressed Concrete Piles, whichever type of test pile the splice has been performed on; and such payment shall be for all costs including materials, equipment, tools and labor incidental thereto.

Extension to test piles in excess of the specified length will be paid for on the following basis, which shall include all equipment, tools, splices, labor and work incidental thereto.

(a) Timber Test Piles: Extensions will be paid for at 125% of the contract unit price per linear foot (meter) for "Furnishing Timber Piles," of the shortest length specified in the proposal, and at 125% of the contract unit price per linear foot (meter) for "Driving Timber Piles."

(b) Steel Test Piles: Extensions will be paid for at 125% of the contract unit price per pound (kilogram) for "Furnishing Steel Piles" and at 125% of the contract unit price per linear foot (meter) for "Driving Steel Piles."

(c) Cast-in-Place Concrete Test Piles: Extensions will be paid for at 125% of the Contract unit price per linear foot (meter) for "Cast-in-Place Concrete Piles." Cut-off materials from shells will be paid for as provided in Subarticle 7.02.05-3.

(d) Prestressed Concrete Test Piles: Extensions will be paid for at 125% of the contract unit price per linear foot (meter) for "Furnishing Prestressed Concrete Piles," and at 125% of the contract unit price per linear foot (meter) for "Driving Prestressed Concrete Piles."

6. Loading Tests: Loading tests will be paid for at the contract unit price each for "Pile Loading Test," which price shall include all expenses incidental to loading the pile or group of piles and removing the load, platform, etc., upon completion of the test.

7. Splices: Authorized splices in timber, steel, cast-in-place piles, precast concrete and prestressed concrete piles will be paid for at the contract unit price each for "Splicing Timber Piles," "Splicing Steel Piles," "Splicing Cast-in-Place Concrete Piles," "Splicing Precast Concrete Piles," "Splicing Prestressed Concrete Piles," respectively, which price shall include all materials, except as otherwise noted, and all equipment, tools and labor incidental thereto. In the absence of such prices, authorized splices will be paid for as extra work.

8. Trimming and Cutting: There shall be no direct compensation for cutting off timber, steel, precast concrete or prestressed concrete piles and shells for cast-in-place concrete piles as ordered; but the cost thereof shall be considered as included in the cost of the pile items.

9. Point Reinforcement for Piles: Authorized points for pointing and reinforcing piles will be paid for at the contract unit price each for "Point Reinforcement for Timber Piles," or "Point Reinforcement for Steel Piles," respectively, whichever applies, which price shall include all materials, equipment, tools and labor incidental thereto. In the absence of such prices, authorized points will be paid for as extra work.

10. Underground Obstructions: If the required pile penetration is not reached due to the presence of underground obstructions which are not the result of the Contractor's operations but are due to the presence of earlier construction at the site, then the cost of removing these obstructions and back-filling the area will be paid for as extra work unless otherwise specified in the contract documents.

11. Painting: There will be no additional payment for painting steel piles and steel pile shells as specified hereinbefore, but the cost thereof shall be considered as included in the cost of furnishing and driving the piles.

12. Disposal of Pile Cutoffs: All costs incidental to the disposal of cutoff material will be included in the price of furnishing of the type of pile specified.

Pay Item	Pay Unit
Furnishing (Type) Piles (Lengths)	lb. (kg)
Driving (Type) Piles	l.f. (m)
Test Pile (Type-Length)	ea. (ea.)
Splicing (Type) Piles	ea. (ea.)
Point Reinforcement for (Type) Piles	ea. (ea.)
Pile Loading Test	ea. (ea.)

**SECTION 7.03
RIPRAP**

7.03.01—Description: Riprap shall consist of angular shaped stones used to protect foundations of piers, abutments, walls, slopes of embankments and waterways from water damage.

7.03.02—Materials:

1. **Stone:** The stone for this work shall be the type called for on the plans and shall conform to the requirements of Article M.12.02.

2. **Bedding:** The bedding material for riprap shall conform to the specifications of the material indicated on the plans.

7.03.03—Construction Methods: The area to be protected by riprap shall be accurately shaped prior to placing of any bedding material or riprap. Where bedding material is called for, it shall be placed on the prepared area and compacted to the depth, lines and grades indicated on the plans.

The riprap shall be placed to its full course thickness in one operation in such a manner as to produce a reasonably well-graded mass of rock without causing displacement of the underlying material. The finished surface shall be free from pockets of small stones and clusters of larger stones. Placing this material by methods likely to cause segregation of the various sizes of stone will not be permitted. Rearranging of individual stones by mechanical or hand methods will be required to the extent necessary to obtain a reasonably well-graded distribution of the specified stone sizes. The completed course shall be of the specified thickness and to the lines and grades as shown on the plans or as ordered by the Engineer.

7.03.04—Method of Measurement: The quantity of riprap measured for payment shall be the number of cubic yards (cubic meters) whose length and width is measured in place as accepted and the thickness as shown on the plans.

7.03.05—Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for the type of riprap indicated, complete in place, including all materials, equipment, tools and labor incidental thereto.

Excavation and bedding material will be measured and each paid for under its particular pay item.

Payment will be made under:

Pay Item	Pay Unit
(Type) Riprap	c.y. (cu. m)

SECTION 7.04

GABIONS

7.04.01—Description: This work shall consist of furnishing, assembling, and tying open wire mesh baskets, and filling them with aggregate, in conformity with the line, grade and dimensions shown on the plans.

7.04.02—Materials: The materials for this work shall conform to the following requirements:

1. Wire Mesh:

All wire shall be coated in accordance with ASTM A 641, Finish 5, Class 3. The tensile strength of lacing wire and wire used for manufacturing the baskets shall be at least 60,000 psi (420 megapascals), and have a minimum elongation of 12%, when tested in accordance with ASTM A 641.

(a) Galvanized gabions: The wire mesh used for galvanized gabions shall be made of galvanized steel wire with a minimum diameter of 0.118 inches (3.0 millimeters). The maximum dimension of the mesh opening shall be 4.5 inches (115 millimeters) and the area of the mesh opening shall not exceed 8 square inches (5160 square millimeters). A selvedge wire running through the edges of the basket shall be made of galvanized steel wire with a minimum diameter of 0.148 inches (3.76 millimeters). The lacing wire necessary for assembling and lacing the basket units and the connecting wires shall be made of galvanized steel wire with a minimum diameter of 0.087 inches (2.20 millimeters).

(b) Polyvinyl-chloride-coated gabions: The wire mesh used for polyvinyl-chloride - coated gabions shall have a galvanized steel wire core with a minimum diameter of 0.104 inches (2.64 millimeters). The maximum dimension of the mesh opening shall be 4.5 inches (115 millimeters) and the area of the mesh opening shall not exceed 8 square inches (5160 square millimeters). The selvedge wire running through the edges of the basket shall be made of galvanized steel wire with a minimum diameter of 0.131 inches (3.32 millimeters). The lacing wire shall have a galvanized wire core with a minimum diameter of 0.085 inches (2.16 millimeters). The minimum PVC coating thickness shall be 0.015 inches (0.38 millimeters). The color of the polyvinyl-chloride shall be black, unless otherwise noted on the plans.

2. Aggregate:

The aggregate used shall conform to the requirements of Article M.12.02 except that each side of the aggregate shall be at least 4 inches (100 millimeters) and not more than 13 inches (330 millimeters) or 7/10 of the basket's smallest dimension, whichever is less. It shall be reasonably well graded between the limiting sizes.

7.04.03—Construction Methods:

(a) Dimensions: The baskets shall be constructed to conform to the details shown on the plans, or as directed by the Engineer. All baskets shall be of uniform width. All basket units shall be subdivided into equal compartments and separated by diaphragms of the same mesh and wire diameter as the basket body. Each compartment's length shall not exceed its width. The overall height of the gabion shall not exceed its overall width.

(b) Fabrication: The baskets shall be fabricated so that the sides, ends, lids and diaphragms can be assembled at the construction site into rectangular baskets of the specified sizes. The wire mesh shall be cut so as to be non-raveling. The front, base, back and lid shall be woven into a single unit. The ends shall be factory-connected to the base section of the basket so that strength and flexibility at the point of connection are at least equal to that of the mesh. All perimeter edges of the mesh shall be securely fastened with selvedge wire so that the joints have at least the same strength as the wire mesh. Lacing wire shall be supplied in a quantity sufficient for securely fastening all edges of the baskets and diaphragms and to provide for the necessary internal connecting wires in each compartment.

There shall be 4 cross connecting wires in each compartment whose height is either 1/3 or 1/2 the width of the gabion and 8 cross connecting wires in each compartment whose height equals the width of the gabion.

Each basket unit shall be assembled by binding together all vertical edges with lacing wire at intervals of no more than 5 inch (125 millimeters) spacing or by a continuous piece of lacing wire looped around the vertical edges with at least one tie every 5 inches (125 millimeters). Empty baskets shall be set to line and grade as shown on the plans. All adjoining empty basket units must be laced along the perimeter of their contact surfaces in the manner described previously for assembling. The empty upper baskets that form the upper tier shall also be laced to the top of the lower ones. A standard fence-stretcher or other approved device shall be used to remove any kinks from the mesh and hold alignment of the units. The aggregate shall be carefully placed to ensure alignment, avoid bulges and create a minimum of voids. After the aggregate is placed to the level at which the connecting wires are to be installed, two connecting wires are to be placed perpendicular to each other, then looped and tied around 2 meshes of each gabion wall. Filling

is then resumed until the level of the next connecting wires or the top of the gabion is reached. After a gabion has been filled, the lid shall be stretched tightly over the filling until the lid meets the perimeter edges of the front and end panels. The lid shall then be tightly laced along all edges, ends and diaphragms in the manner described for assembling. The Contractor shall furnish the Engineer working drawings detailing the layout of the gabions to the Department at least two weeks prior to their installation.

7.04.04—Method of Measurement: This work will be measured for payment by the number of cubic yards (cubic meters) of "Gabions" or "Polyvinyl-Chloride-Coated Gabions", measured in place within neat lines as shown on the plans or as directed by the Engineer. Excavation will be measured for payment under Section 2.02.

7.04.05—Basis of Payment: This work will be paid for at the contract unit price per cubic yard (cubic meter) for "Gabions" or "Polyvinyl-Chloride-Coated Gabions," complete in place, including all materials, equipment, tools and labor incidental thereto.

Excavation will be paid for at the contract unit price for the appropriate excavation item.

Pay Item	Pay Unit
Gabions	c.y. (cu. m)
Polyvinyl-Chloride-Coated Gabions	c.y. (cu. m)

SECTION 7.05

SLOPE PAVING

7.05.01—Description: Slope paving shall be composed of approved stone, cast-in-place or precast concrete slabs. The stones or slabs shall be individually laid or cast in place on slopes where indicated on the plans or directed, and in accordance with these specifications. Unless otherwise specified, the choice of material shall be optional with the Contractor; provided, however, only one type of material shall be used in any one location.

7.05.02—Materials: The stone for this item shall conform to the requirements of Article M.12.03. Concrete shall conform to the requirements of Article M.03.01.

7.05.03—Construction Methods: Slopes where paving is to be used shall be no steeper than the angle of repose of the material unless otherwise indicated or directed. At the bottom of the embankment 2 rows of stone or slabs shall be laid one above the other and securely embedded at least 2 feet (600 millimeters) into the slope. Above these, the paving stone or slabs shall be embedded, one against the other, with the sides in contact. The spaces between the larger stone shall be filled with spalls of suitable size, and all spalls shall be rammed thoroughly into place. The finish of the surface of the slope paving shall present an even, tight surface true to the lines, grades and sections given.

Cast-in-place slabs shall be constructed to the lines, grades, and dimensions shown or as ordered by the Engineer; the vertical joints in each course shall break joints with those in adjoining courses at least 6 inches (150 millimeters). Placing and mixing shall conform to the requirements of Article 6.01.03 insofar as it may apply. The concrete shall contain not less than 4%, nor more than 6%, entrained air at the time the concrete is deposited in the forms.

7.05.04—Method of Measurement: This work will be measured for payment by the number of square yards (square meters) in the face area of accepted slope paving completed within the neat lines as shown on the plans or as ordered by the Engineer.

7.05.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Slope Paving" complete in place, which price shall include all materials, equipment, tools, and labor incidental thereto; also all necessary excavations below the surface of the final slope and the disposal of surplus material.

Pay Item	Pay Unit
Slope Paving	s.y. (s.m)

SECTION 7.07
MEMBRANE WATERPROOFING
(WOVEN GLASS FABRIC)

7.07.01—Description: This item shall consist of furnishing and applying a membrane system of waterproofing to the surface of concrete structures where a bituminous concrete wearing surface is to be constructed, at construction joints and at other locations shown on the plans or ordered.

7.07.02—Materials: The materials for this work shall conform to the requirements of Article M.12.04 for primer, woven glass fabric saturated with asphalt, seal coat, and for asphalt flashing cement.

7.07.03—Construction Methods: Concrete surfaces which are to be waterproofed shall be smooth, free from projections or holes, which might cause puncturing of the membrane fabric. The surface shall be thoroughly cleaned of loose or foreign substances.

No priming or waterproofing shall be done in wet weather nor when the temperature of the air or concrete surface is below 35°F (2°C), without special authorization from the Engineer.

Unless otherwise directed, construction joints above those at the footings of abutments, wing walls and retaining walls shall be made impervious to water by the application of membrane waterproofing on the unexposed surface for a distance of 18 inches (450 millimeters) on each side of the joint.

1. Primer: Beginning at the low point of the surface to be waterproofed, the primer shall be applied in 1 coat at a rate of 0.1 gallon per square yard (0.45 liter per square meter). The cure time of the primer shall be as recommended by the manufacturer.

2. Membrane Fabric: The waterproofing fabric and the seal coat shall be applied as follows:

The asphalt shall be heated to a temperature of about 300°F (150°C) (not over 350°F (175°C)) with frequent stirring to avoid local overheating. The heating kettles shall be equipped with approved thermometers.

Waterproofing shall begin at the low point of the surface so that water will run over and not against or along the laps. A section about 20 inches (500 millimeters) wide and the full length of the surface shall be mopped with hot asphalt, and a strip of fabric of half width shall be rolled into it, pressed into place to eliminate all air bubbles and to obtain close conformity with the surface. This strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used, shall then be mopped with hot asphalt, and a full width of fabric rolled into it, completely covering the first strip, and pressed into place as before. This second strip and adjacent section of the concrete surface shall then be mopped with hot asphalt and the next succeeding strips of fabric "shingled" on so that there will be 2 layers of fabric at all points with laps not less than 2 inches (50 millimeters) wide. All end laps shall be at least 12 inches (300 millimeters).

This process shall be continued until the entire surface to be waterproofed has been covered. The fabric shall then be given a final mopping of hot asphalt. The mopping on concrete shall cover the surface so that no gray spots appear, and on fabric it shall be sufficiently heavy to completely conceal the weave. Special care shall be taken that all laps are thoroughly sealed down.

To insure a watertight joint between the bridge deck and the curb, asphalt flashing cement shall be applied to the joint for a distance of approximately 2 inches (50 millimeters) up on the curb and 2 inches (50 millimeters) out on the deck after the primer has set up and before the membrane is started. After the final mopping of the membrane, an additional coat of asphalt flashing cement shall be applied to the top edge of the membrane waterproofing to completely cover the fabric and to seal the joint made with the curb.

Care shall be taken to prevent injury to the finished membrane by the passage over it of men and equipment. Any damage which may occur shall be repaired by patching. Patches shall extend at least 12 inches (300 millimeters) beyond the outermost damaged portion, and the second ply shall extend at least 3 inches (75 millimeters) beyond the first.

Vehicular traffic shall not be allowed to pass over the finished membrane waterproofing. Upon completion of the membrane waterproofing, at least 1 course of the bituminous concrete wearing surface shall be placed as soon as practicable in order to prevent damage to the membrane waterproofing.

7.07.04—Method of Measurement: The quantity to be paid for under this item will be the number of square yards (square meters) of waterproofed surface in the completed and accepted work.

7.07.05—Basis of Payment: This item will be paid for at the contract unit price per square yard (square meter) for "Membrane Waterproofing (Woven Glass Fabric)" which price shall be full compensation for furnishing all material, equipment, labor and incidentals necessary to complete the item.

Pay Item	Pay Unit
Membrane Waterproofing (Woven Glass Fabric)	s.y. (s.m)

**SECTION 7.08
DAMP-PROOFING**

7.08.01—Description: Damp-proofing of concrete or masonry work shall consist of a coating of asphalt as indicated on the plans and in accordance with these specifications.

7.08.02—Materials: The materials for this work shall conform to the requirements of Article M.12.05.

7.08.03—Construction Methods: The surface to which the damp-proofing coating is to be applied shall be cleaned of all loose and foreign material and dirt and shall be dry. Where necessary, the Engineer may require the surface to be scrubbed with water and a stiff brush, after which the surface shall be allowed to dry before the application of the primer.

Concrete, brick or other surfaces which are to be protected by damp-proofing shall be thoroughly clean and dry before the primer is applied. One (1) coat of primer and one (1) coat of sealer shall be applied using methods, application rates and temperature constraints as recommended by the manufacturer of each product.

Care shall be taken to confine all applied material to the areas to be damp-proofed and to prevent disfigurement of any other parts of the structure by dipping or spreading.

7.08.04—Method of Measurement: This work will be measured for payment by the number of square yards (square meters) of damp-proofing, consisting of primer and seal coat, completed and accepted within the neat lines shown on the plans or as ordered by the Engineer.

7.08.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Damp-proofing," complete in place, including all material, equipment, tools, labor and incidental expense.

Pay Item	Pay Unit
Damp-proofing	s.y. (s.m)

SECTION 7.13

PERMANENT STEEL SHEET PILING

7.13.01—Description: This specification covers only steel sheet piling shown on the plans to be left in place so that it becomes a part of the finished structure. This steel sheet piling shall conform to the sheeting design indicated on the plans with respect to type, size, and waler spacing, or it shall consist of any type of adequately braced steel sheet pile wall meeting these specifications, which the Contractor elects to build to satisfy, and which does satisfy, the condition that existing facilities be properly retained during excavation for and placement of substructures.

7.13.02—Materials: Materials for steel sheet piling shall conform to the requirements of ASTM A 328.

7.13.03—Construction Methods: The sheet piling shall be safely designed and braced as necessary for proper performance of the work. Construction shall be such as to permit excavation as required. Interior dimensions shall be such as to give sufficient clearance for construction of forms and their inspection and for batter pile clearance when necessary. Movements of steel sheet piling or bracing which prevent the proper completion of the substructure shall be corrected at the sole expense of the Contractor. No part of the steel sheet piling or bracing shall be allowed to extend into the substructure without written permission of the Engineer.

The Contractor shall submit to the Engineer for approval plans showing the proposed method of construction prior to the start of such construction. The furnishing of such plans shall not serve to relieve the Contractor of any part of his responsibility for the safety of the work or for the successful completion of the project.

The steel sheet piling shall be cut off at the elevation shown on the plans or as ordered by the Engineer. All material cut off shall remain the property of the Contractor and shall be disposed of by him.

7.13.04—Method of Measurement: Permanent steel sheet piling will be measured for payment by the square foot (square meter). This area will be measured or computed from the horizontal and vertical payment limits shown on the plans or as ordered.

7.13.05—Basis of Payment: This work will be paid for at the contract unit price per square foot (square meter) for "Permanent Steel Sheet Piling," which price shall include the cost of designing, furnishing, driving, cutting off, and all incidental expenses including all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Permanent Steel Sheet Piling	s.f. (s.m)

SECTION 7.14
TEMPORARY SHEET PILING

7.14.01—Description: Temporary sheet piling shall be constructed where shown on the plans. This sheet piling shall be removed upon completion of the permanent work, except that some sections may be left in place when so ordered by the Engineer. For purposes of this specification, temporary sheet piling shall be any type of adequately braced sheet pile wall which the Contractor elects to build to satisfy, and which does satisfy, the condition that existing facilities be properly retained during excavation for the placement of substructure or other facilities.

7.14.02—Materials: Materials of steel sheet piling shall conform to the requirement of ASTM A 328. Timber sheet piling shall conform to the requirements of Subarticle M.09.01-1. Materials other than steel or timber, or a combination of these may be used provided they are properly designed for the purpose intended.

7.14.03—Construction Methods: Temporary sheet piling shall be safely designed and shall be carried to adequate depths and braced as necessary for proper performance of the work. Construction shall be such as to permit excavation as required. Interior dimensions shall be such as to give sufficient clearance for construction of forms and their inspection and for batter pile clearance when necessary. Movements of sheet piling or bracing which prevent the proper completion of the substructure shall be corrected at the sole expense of the Contractor. No part of the temporary sheet piling or bracing shall be allowed to extend into the substructure without written permission of the Engineer.

Working drawings and design calculations for temporary sheeting shall be submitted in accordance with the requirements of Article 1.05.02(2). The working drawings and design calculations shall be prepared, sealed, and signed by a Professional Engineer, licensed in the state of Connecticut. The furnishing of such plans shall not serve to relieve the Contractor of any part of his responsibility for the safety of the work or for the successful completion of the project.

Unless otherwise ordered by the Engineer, all parts of the temporary sheet piling shall be removed upon completion of the work for which it was provided. The excavation shall be backfilled and properly compacted, prior to removal of piling unless otherwise permitted by the Engineer. Sheet piling may be left in place at the option of the Contractor if so permitted by the Engineer, provided that it is cut off at an elevation as directed by the Engineer and the cutoffs removed from the site.

7.14.04—Method of Measurement: Temporary sheet piling will be measured for payment by the number of square feet (square meters) of temporary sheet piling completed and accepted, as computed from the horizontal and vertical payment lines shown on the plans or as ordered. If no payment limits are shown on the plans, the limits used for payment will be the actual horizontal limit of temporary sheet piling installed and accepted, and the vertical limit as measured from the bottom of the exposed face of the sheeting to the top of the retained earth behind the sheeting. The measurement for temporary sheet piling which is used as a common wall for staged construction will be the horizontal payment limit shown on the plans and the greater vertical dimension of the common wall face.

No measurement will be made of end extensions or returns necessary for the safety of the retained facility. Sheeting ordered left in place by the Engineer shall be measured in accordance with Article 7.15.04.

Sheet piling left in place solely at the Contractor's option, with the Engineer's permission, will not have an additional payment at the contract unit price per square foot (square meter) for "Sheet Piling Material Left in Place."

7.14.05—Basis of Payment: Payment for this work will be made at the contract unit price per square foot (square meter) for "Temporary Sheet Piling," measured as described above, which price shall include all design, materials, equipment and labor incidental to the construction and removal of the temporary sheet piling required at the locations specified on the plans; including removal of obstructions, repair and correction, adjustments or reconstruction required by the plans. Any common sheet piling wall required for staged construction will be measured for payment only once. For sheet piling ordered left in place, the Department will, however, make an additional payment at the contract unit price per square foot (square meter) for "Sheet Piling Material Left in Place."

Pay Item	Pay Unit
Temporary Sheet Piling	s.f. (s.m)

SECTION 7.15

SHEET PILING MATERIAL LEFT IN PLACE

7.15.01 and 7.15.02—Description and Materials: This specification covers only that portion of the temporary sheet piling that may be ordered left in place by the Engineer.

7.15.03—Construction Methods: The Contractor shall submit to the Engineer for approval, plans showing the proposed method of construction prior to the start of such construction. If no limits are shown on the plans for the sheet piling that may be ordered left in place, then the plans for the entire temporary installation shall be submitted for approval.

7.15.04—Method of Measurement: Sheet piling material left in place will be measured for payment by the square foot (square meter). This area will be measured or computed from the horizontal and vertical payment limits shown on the plans or as ordered.

7.15.05—Basis of Payment: Payment for this work will be made as follows:

That portion of the temporary sheet piling ordered left in place will be paid for at the contract unit price per square foot (square meter) for "Sheet Piling Material Left in Place," applying to one or more structures or portions of structures, which price shall include only the cost of material left in place. All other expenses shall be paid for under the item for "Temporary Sheet Piling."

Pay Item	Pay Unit
Sheet Piling Material Left in Place	s.f. (s.m)

**SECTION 7.25
BAGGED STONE**

7.25.01—Description: This item shall consist of furnishing and placing crushed stone or gravel in burlap bags at the inlet ends of weep holes in structures to the dimensions indicated on the plans or as ordered by the Engineer.

7.25.02—Materials: The materials for this work shall conform to the following requirements:

- (a) The crushed stone or gravel shall conform to the grading requirements of Article M.01.01 for 2-inch (No. 3) or 1 1/4-inch (No. 4) coarse aggregate or a mixture of both.
- (b) The bag shall be of burlap and shall be large enough to contain loosely 1 cubic foot (0.03 cubic meter) of the granular material.

7.25.03—Construction Methods: Approximately 1 cubic foot (0.03 cubic meter) of the crushed stone or gravel shall be enclosed in the burlap bag which shall then be securely tied at the neck with cord or wire so that the enclosed material is contained loosely. The filled bags shall be stacked at the weepholes to the dimensions shown on the plans or as directed by the Engineer. The bags shall be unbroken at the time pervious material is placed around them, and bags which are broken or burst prior to or during the placing of the pervious material shall be replaced at the expense of the Contractor.

7.25.04—Method of Measurement: The quantity of bagged crushed stone or gravel shall be the actual cubic feet (based on the actual number of bags, of 0.03 cubic meters each), completed and accepted, within the neat lines shown on the plans or as ordered by the Engineer.

7.25.05—Basis of Payment: This work will be paid for at the contract unit price per cubic foot (per bag) for "Bagged Stone," complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Bagged Stone	c.f. (bag)

SECTION 7.28

CRUSHED STONE FOR SLOPE PROTECTION

7.28.01—Description: This item shall consist of crushed stone or gravel placed to a uniform depth on that portion of the embankment at the abutments of designated structures, to the limits and for the depth shown on the plans, or as directed by the Engineer.

7.28.02—Materials: The material for this work shall conform to the requirements of Article M.01.01 for 2 inch (No. 3) coarse aggregate.

7.28.03—Construction Methods: The area on which the crushed stone is to be placed shall be shaped to a reasonably true surface prior to placing the crushed stone. The stone shall be spread by any suitable means which will not crush the stone and shall be shaped to a smooth uniform finished grade.

7.28.04—Method of Measurement: Crushed stone or gravel, except when shipped by rail, shall be weighed (measured for mass) on scales furnished by the Contractor. The scales shall be of a type satisfactory to the Engineer and shall be sealed, at the expense of the Contractor, as often as the Engineer may require. All weighing (mass measuring) shall be done in the presence of a Department representative. If broken stone is shipped by rail, the car weights (masses) may be accepted, but scales shall be used as provided above if the Engineer so directs.

7.28.05—Basis of Payment: This work will be paid for at the contract unit price per ton (metric ton) for "Crushed Stone for Slope Protection," complete in place, which price shall include all materials, tools, equipment and labor incidental thereto.

Pay Item	Pay Unit
Crushed Stone for Slope Protection	ton (t)

SECTION 7.32

CONCRETE BLOCK SLOPE PROTECTION

7.32.01—Description: Work under this item shall consist of furnishing and placing concrete block slope protection on an approved base to the limits and dimensions as shown on the plans or as directed by the Engineer.

7.32.02—Materials: Concrete blocks for this work shall conform to the requirements of Article M.12.12.

Granular Base: This material shall conform to the requirements of M.02.03 and Grading "C" of M.02.06.

Grout: Grout for this item shall conform to the requirements of Article M.11.04.

7.32.03—Construction Methods: The surface on which the granular base is to be placed shall be shaped to an even surface and to the desired grade. The granular base shall be placed to the thickness shown on the plans and after thorough compaction shall be dressed smooth and to the required grade. The blocks shall be set in straight rows as shown on the plans with staggered joints normal to the rows. Joints between concrete blocks shall be not greater than 1/2 inch (12 millimeters) in width. The blocks shall be carefully laid and solidly rammed into position and shall be clean when placed. Cutting of blocks to meet pattern requirements will be permitted, subject to approval of the Engineer. The paved surface shall be tested with a straight edge not less than 10 feet (3 meters) long and the blocks found to be above or below the grade by more than 1/4 inch (6 millimeters) shall be taken up and reset. Each section of paving must be acceptable to the Engineer before the joints in that section are filled.

The blocks shall be thoroughly wetted with water immediately prior to the placing of the grout. Grout shall be spread over the blocks and worked into the joints beginning at the lowest elevation and progressing upward, so as to maintain the upper surface of the grout at approximately even rows, until all joints are completely filled. The surface shall then be swept and all excess grout removed from the surface of the blocks before initial set has developed. At such time after initial set has occurred, as will be determined by the Engineer, the surface of the blocks shall be cleaned by brushing, while simultaneously flushing with water, in such a manner as to completely remove the remaining grout from the surface of the blocks without dislodging any of the grout in the joints.

7.32.04—Method of Measurement: This work will be measured for payment by the number of square yards (square meters) in the face area of accepted "Concrete Block Slope Protection" completed within the neat lines as shown on the plans or as ordered by the Engineer.

7.32.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Concrete Block Slope Protection," complete in place, which price shall include all materials, equipment, tools, and labor incidental thereto, also necessary excavation and grading below the surface of the roadway excavation and outside the limits of structure excavation and placing the granular base.

Pay Item	Pay Unit
Concrete Block Slope Protection	s.y. (s.m)

SECTION 7.51
UNDERDRAIN AND OUTLETS

7.51.01—Description: Underdrains shall consist of pipe pervious to water, laid in a trench refilled with pervious material. They shall be of the dimensions and details as indicated on the plans. They shall be classed as "Underdrains," "Foundation Underdrains," "Slope Underdrains" or "Structure Underdrains."

Outlets for underdrains shall consist of pipe laid in a trench and refilled with earth. The size and type of outlet pipe shall be the same as that of the underdrain to which it is connected, except that it shall not be pervious to water.

7.51.02—Materials:

(1) **Pipe:** The pipe of underdrains and outlets shall conform to the requirements of Article M.08.01. The kind of pipe to be installed shall be at the option of the Contractor unless a specific type of pipe is indicated on the plans or in the special provisions.

(2) **Aggregates:** The aggregates specified for filling the trench shall meet the requirements of Article M.08.03.

(3) **Joint Sealants:** The materials for sealing and coupling of joints shall conform to the requirements of Article M.08.01.

(4) **Geotextile:** Geotextile shall conform to Subarticle M.08.01-26.

7.51.03—Construction Methods: The trench for the underdrain shall be excavated in conformity with the requirements of Article 6.51.03 for pipe culverts. The dimensions of the trench shall be as indicated on the plans or as ordered. Where the bottom of the trench is unstable or in rock, the trench shall be excavated 6 inches (150 millimeters) deeper and an additional 6 inches (150 millimeters) layer of granular fill or aggregate similar to that used to fill the trench shall be placed and compacted in the trench.

Where the perforations are to be at the bottom of the pipe, the aggregate for filling the trench shall then be placed to a depth of 3 inches (75 millimeters) and tamped true to grade. The pipe shall be placed and firmly bedded on the aggregate. This aggregate shall be placed whether the pipe is encased with geotextile or not.

When the pipe used has a bell, the pipe shall be installed with the bell end upgrade with the spigot end entered fully into the adjacent bell.

When clay or concrete pipe is used, the joints will not have to be filled with a joint sealant or fitted with a gasket.

When metal, bituminized fiber, plastic, polyethylene or asbestos cement pipe is used, the pipe shall be carefully butted together and held by bands or other approved means so as to prevent any displacement of the joint.

After the pipe has been installed as described above, the aggregate shall be placed carefully around and over the pipe to a height of 12 inches (300 millimeters) above the top of the pipe. The remainder of the trench shall be filled with aggregate and tamped in layers as shown on the plans. When the underdrain pipe is used with the holes in an upward position, and in all cases where sand is used instead of the aggregate described hereinbefore, a protective 3-inch (75-millimeter) minimum layer of 3/8-inch (Size No. 8) aggregate shall be placed over the pipe and around all of the holes. Geotextile may be substituted for the 3-inch (75-millimeter) layer of aggregate. When geotextile is used, the entire length of each drain pipe shall be wrapped with the fabric and the seams lapped and welded or bonded. Where the seams of the geotextile are not welded or bonded, they shall be lapped to a minimum width equal to the diameter of the pipe for 6-inch (150-millimeter) pipe and larger and a minimum of 6 inches (150 millimeters) for smaller pipe.

In all cases where subbase material or gravel is to be placed over the underdrains, a layer of at least 6 inches (150 millimeters) of subbase material or gravel shall be placed over the underdrain immediately after its completion.

For outlets, the trench shall be excavated and the pipe installed in conformity with the requirements of Article 6.51.03.

Where shown on the plans or directed by the Engineer, the Contractor shall connect underdrains or outlets to existing or proposed drainage systems or structures.

This work shall be performed in a workmanlike manner satisfactory to the Engineer by installation of tees or wyes branches or by providing a hole in the main line underdrain.

Where the upgrade end of the underdrain does not enter a structure, it shall be capped or plugged as directed.

7.51.04—Method of Measurement: This work will be measured for payment by the actual number of linear feet (linear meters) of underdrains, foundation underdrains, slope underdrains, structure underdrains and outlets for underdrains, completed, accepted and measured in place. Trench excavation will not be

measured for payment. Rock in trench will be measured for payment in accordance with Article 2.05.04.

7.51.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Underdrain," "Foundation Underdrain," "Slope Underdrain," "Structure Underdrain" and "Outlets for Underdrain" complete in place, which price shall include pipe of the size specified, elbows, tees, wyes, couplings, fitting, trench excavation, geotextile, aggregate, sand, tools, material and labor incidental thereto.

There will be no direct payment made for capping, plugging or connecting underdrains or outlets to existing or proposed drainage systems or structures, but the cost thereof shall be included in the cost of the underdrain items involved.

Rock in trench will be paid for in accordance with Article 2.05.05 at the contract unit price per cubic yard (cubic meter) for "Rock in Trench Excavation" of the applying depth.

Pay Item	Pay Unit
(Size) Underdrain	l.f. (m)
(Size) Foundation Underdrain	l.f. (m)
(Size) Slope Underdrain	l.f. (m)
(Size) Structure Underdrain	l.f. (m)
(Size) Outlets for Underdrain	l.f. (m)
(Size-Type) Underdrain	l.f. (m)
(Size-Type) Foundation Underdrain	l.f. (m)
(Size-Type) Slope Underdrain	l.f. (m)
(Size-Type) Structure Underdrain	l.f. (m)
(Size-Type) Outlets for Underdrain	l.f. (m)

**SECTION 7.55
GEOTEXTILE**

7.55.01—Description: This item shall consist of furnishing and installing geotextile in the locations and to the dimensions shown on the plans as directed or as approved by the Engineer.

7.55.02—Materials: Geotextile shall conform to the requirements of M.08.01-26. Materials incidental to and necessary for the installation of the geotextile, such as, but not limited to sewing thread, staples, pins, etc., shall conform to the requirements of the manufacturer of the geotextile.

7.55.03—Construction Method: The geotextile shall be installed at the locations and to the dimensions shown on the plans or as directed by the Engineer. Geotextile shall be installed as recommended by the manufacturer for the specific use or purpose intended, or as otherwise approved by the Engineer.

7.55.04—Method of Measurement: This work will be measured for payment by the actual number of square yards (square meters) of the type indicated on the plans or authorized by the Engineer. Geotextile specifically included in the payment of another item will not be measured for payment under this item. No additional measurement will be made for necessary lap material.

7.55.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) of "Geotextile" or "Geotextile (Type)," complete in place, which price shall include all materials, labor, tools, and equipment incidental and necessary for each type of installation and removal where necessary.

Pay Item	Pay Unit
Geotextile	s.y. (s.m)
Geotextile (Type)	s.y. (s.m)

**SECTION 8.03
PAVED DITCHES AND CHANNELS**

8.03.01—Description: Where called for on the plans or directed by the Engineer, the Contractor shall construct paved ditches, leak-off ditches or channels in conformity with the line, grade, compacted thickness and typical cross-section shown on the plans. The surface course shall be bituminous concrete, and the base course may be either rolled granular or processed aggregate base as specified on the plans, or if not specified on the plans, as directed.

The Contractor may construct either the Paved Ditch or Alternate Paved Ditch as shown on the plans, provided that the single runs of the paved ditch shall conform to same typical cross-section throughout.

8.03.02—Materials: The materials for this work shall conform to the following requirements:

1. Rolled Granular Base shall conform to Article M.02.03.
2. Bituminous Concrete shall conform to Sections 4.06 and M.04, Class 3.
3. Processed Aggregate Base shall conform to Article M.05.01.

8.03.03—Construction Methods: The surface course and base course shall be constructed in conformity with Articles 3.02.03, 3.04.03 and Section 4.06, whichever apply. The requirements pertaining to density will not apply.

Sections inaccessible to the roller or distributor shall be hand-tamped until thoroughly compacted.

8.03.04—Method of Measurement: The quantity to be included for payment under this item shall be the number of square yards (square meters) of paved ditch or paved channel actually constructed and accepted.

The area shall be determined by using as a width the designed horizontal distance from outside-to-outside of the paved portion of the leak-off ditch, paved channel, or width designated by the Engineer— and as a length the actual measured length along its surface.

The area of the alternate paved ditch shall be determined by using as a width the horizontal distance from outside-to-outside of the surface course of the alternate paved ditch and as a length the actual measured length along its surface.

8.03.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Paved Ditch" or "Paved Channel," complete in place, which price shall include all materials, tools, equipment and work incidental thereto except for excavation. Excavation shall be paid for in accordance with Section 2.02 or Section 2.06, whichever applies.

No payment for "Formation of Subgrade" will be made for the areas occupied by these paved ditches, paved leak-off ditches, or paved channels.

Pay Item	Pay Unit
Paved Ditch	s.y. (s.m)
Paved Channel	s.y. (s.m)

**SECTION 8.11
CONCRETE CURBING**

8.11.01—Description: This item shall consist of concrete curbing constructed on the prepared subbase in accordance with the dimensions and details shown on the plans or as ordered and in conformity with these specifications.

8.11.02—Materials: The concrete for cast-in-place or slip formed curbing shall be Class "C" concrete conforming to the requirements of Article M.03.01. Joint filler shall conform to the requirements of Article M.03.01. The concrete for precast concrete curbing shall have a minimum 28-day compressive strength of 4,000 psi (28 megapascals) and shall contain 5 to 7% entrained air unless otherwise approved by the Engineer. The material for the precast concrete shall conform to Article M.03.01, except the coarse aggregate gradation may be varied with the approval of the Engineer.

8.11.03—Construction Methods: Construction methods for concrete curbing shall conform to the requirements of Article 6.01.03 for concrete for structures, as supplemented by the following requirements:

- 1. Excavation:** Excavation shall be made to the required depth, and the base upon which the curbing is to be set shall be compacted to a firm, even surface.
- 2. Placing of Concrete:** The concrete shall contain not less than 5% nor more than 7% entrained air at the time the concrete is deposited within the forms. Concrete shall be placed only on a moist base. Concrete shall not be placed on a soft, muddy or frozen base.

Slip form equipment may be used if the resulting product conforms with the plans. Precast concrete curbing may be used if the resulting product conforms with the plans except for the length of each curb unit. Precast concrete curbing units shall be constructed in 6-foot (2-meter) or longer lengths for straight sections.

Where slip form equipment or precast concrete curbing is not used, the concrete shall be placed in forms, struck off with a template, compacted by approved means, and finished to a smooth, even surface. Vibration will not be required.

The concrete curbing shall be constructed in sections having a uniform length of approximately 10 feet (3 meters), unless otherwise directed, so arranged that a joint in the curbing shall come opposite a joint in the adjoining concrete pavement slab and be similar to it. The length of these sections may be varied slightly where necessary for closures, but no section less than 6 feet (2 meters) in length will be permitted. These sections shall be separated by an approved method at the time of placing of the concrete.

3. Forms: Where forms are used, they shall be so constructed that the form for exposed faces may be removed before the concrete has taken final set in order to permit correction of surface irregularities.

4. Curing and Protection: Concrete curbing, except precast curbing, shall be cured and protected in conformity with the requirements of Article 4.01.03 for concrete pavement. Precast curbing shall not be shipped to the project until the 28-day compressive strength is acquired. Precast curbing that has been damaged shall be removed from the project at the Contractor's expense.

5. Backfilling: After the concrete has set sufficiently, the grading shall be completed to the lines shown on the plans, or as ordered, by refilling to the required elevation with approved material which shall be placed in layers of not over 6 inches (150 millimeters) in depth and compacted until firm and solid.

8.11.04—Method of Measurement: This work will be measured for payment along the top of the curb and will be the actual number of meters of concrete curbing completed and accepted.

8.11.05—Basis of Payment: Payment for this work will be made at the contract unit price per linear foot (meter) for "Concrete Curbing" of the type specified, complete in place, which price shall include all materials, equipment, tools and labor incidental thereto; also all excavation, backfilling, disposal of surplus material and drainage openings.

Pay Item	Pay Unit
Concrete Curbing (Type)	1.f. (m)

**SECTION 8.13
STONE CURBING**

8.13.01—Description: This curbing shall consist of approved stone, furnished in accordance with the dimensions and details of the plans, or as ordered, and installed on the prepared base to the lines and grades given and in conformity with these specifications.

8.13.02—Materials: The materials for this work shall conform to the requirements of Article M.12.06 for granite and bluestone curbing, of Article M.11.04 for mortar and of Article M.02.03 for granular base.

Dowels shall conform to the requirements of Article M.06.01.

8.13.03—Construction Methods: Construction methods for stone curbing shall conform to the following requirements:

1. Excavation: Excavation shall be made to the bottom of the 6-inch (150-millimeter) granular base below the curbing, the trench being sufficiently wide to permit thorough tamping. The base shall be compacted to a firm, even surface and shall be approved by the Engineer.

2. Installing Stone Curbing: The curbing shall be set on edge and settled into place with a heavy wooden hand-rammer, to the line and grade required, straight and true for the full depth. The joints of the stone curbing shall be pointed with mortar for the full depth of the curbing. At approximately 50-foot (15-meter) intervals, a 1/2-inch (12-millimeter) joint shall not be filled with mortar but left free for expansion. The ends of the stone curbing at driveways and intersections shall be cut at a bevel or rounded, as directed by the Engineer.

3. Backfilling: The trench for the stone curbing shall be backfilled with approved material; the first layer to be 4 inches (100 millimeters) in depth, thoroughly rammed; the other layers to be not more than 6 inches (150 millimeters) in depth and thoroughly rammed until the trench is filled.

4. Openings: Where indicated on the plans, or directed, drainage openings shall be made through the curbing at the elevations and of the size required.

8.13.04—Method of Measurement: This work will be measured for payment by the actual number of linear feet (meters) of stone curbing or curved stone curbing installed and accepted.

Measurement shall be made along the top arris line of face of curb. Curbing to be set on a radius of 100 feet (30 meters) or less will be measured for payment as curved stone curbing.

8.13.05—Basis of Payment: Payment for this work will be made at the contract unit price per linear foot (meter) for "Stone Curbing" or "Curved Stone Curbing," as the case may be, of the type, size and kind specified, complete in place, which price shall include all materials, equipment, tools and labor incidental thereto, and all excavation, backfilling, disposal of surplus material and all drainage openings.

There will be no direct payment for furnishing, placing and compacting granular base, beveling or rounding the ends of the curbing and pointing the joints with mortar; but the cost of this work shall be considered as included in the general cost of the work.

Pay Item	Pay Unit
Stone Curbing (Type-Size)	l.f. (m)
Curved Stone Curbing	l.f. (m)

SECTION 8.14
RESET STONE CURBING

8.14.01—Description: This work shall consist of the removing and resetting or adjusting of existing stone curbing to the lines and grades given, in accordance with the dimensions and details of the plans or as ordered and in conformity with these specifications.

8.14.02—Materials: All existing curbing which is acceptable shall be used. The reset stone curbing shall be in lengths of not less than 4 feet (1.2 meters), except where necessary for closures, where no piece shall be less than 3 feet (1 meter) in length. Mortar for this work shall conform to Article M.11.04.

8.14.03—Construction Methods: The construction methods for this work shall conform to the requirements of Article 8.13.03 for stone curbing, as supplemented by the following requirements:

The curbing to be reset shall be removed with care to avoid damage and, if ordered, shall be transported to a point or points on the project which will allow all the reset curbing to be installed in continuous lines. Curbing removed and not reset shall remain the property of the State unless otherwise ordered by the Engineer and shall be transported to such points, adjacent to the work, as the Engineer may designate. Where adjustments only have to be made to curbing, such adjustments shall be carried out as specified by the Engineer.

8.14.04—Method of Measurement: This work will be measured for payment by the actual number of linear feet (meters) of the class of curbing, reset and accepted. Measurement shall be made along the top arris line of face of curb.

8.14.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Reset Curbing," complete in place, which price shall include all materials, equipment, tools and labor incidental thereto and all excavation, backfilling, disposal of surplus material and all drainage openings.

There will be no direct payment for furnishing, placing and compacting granular base, beveling or rounding the ends of the curbing, sealing the joints with mortar, removing the curbing and hauling it to any location on or adjacent to the project as directed by the Engineer; but the cost of this work shall be considered as included in the general cost of the work.

Pay Item	Pay Unit
Reset Curbing (Type-Size)	l.f. (m)

SECTION 8.15

BITUMINOUS CONCRETE CURBING

8.15.01—Description: Bituminous concrete curbing shall consist of machine laid bituminous concrete, constructed on the pavement to the dimensions and details shown on the plans, or as ordered, and in conformity with the specifications.

8.15.02—Materials: Materials, including tack coat, for this work shall conform to the requirements of Section M.04, Bituminous Class 3.

8.15.03—Construction Methods: The provisions of Section 4.06 shall govern except that the requirements pertaining to density will not apply. In addition, the curbing shall be constructed in accordance with the following requirements: Prior to the arrival of the mixture on the Project site, the surface of the pavement where the curbing is to be constructed shall be cleaned of all loose and foreign material. The surface, which shall be perfectly dry and clean at the time the mix is placed, shall be coated with an approved tack coat just prior to placing the mixture.

On arrival at the site, the mixture shall be transferred from the truck to the hopper of the curbing machine; and the mixture shall be kept clean and free from dirt and foreign materials at all times.

The surface of the curbing shall be tested with a 10-foot (3-meter) straightedge, and any variation from a true line exceeding 1/4 inch (6 millimeters) shall be satisfactorily corrected. The only compaction required shall be that obtained by the approved mechanical curbing machine.

Where machine work is impractical, the Engineer may permit hand-laid curbing to be constructed.

If the design of the curbing machine is such that the outside wheels operate outside of the curb, the Contractor will be required to obtain a smooth surface by grading and consolidating the area on which the outside wheel of the machine rides, and this work shall be done at the Contractor's expense.

After the completion of curbing, traffic shall be kept at a safe distance for a period of not less than 24 hours and until the curbing has set sufficiently to prevent injury or damage to the work.

8.15.04—Method of Measurement: This work will be measured for payment along the top of the curb and will be the actual number of linear feet (meters) of bituminous concrete curbing completed and accepted.

8.15.05—Basis for Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Bituminous Concrete Curbing" of the type specified, complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Bituminous Concrete (Type) Curbing	l.f. (m)

SECTION 8.16

GRANITE SLOPE CURBING

8.16.01—Description: Granite slope curbing shall consist of approved granite furnished in accordance with the dimensions and details of the plans, or as ordered, and installed on the prepared base to the lines and grades given and in conformity with these specifications.

8.16.02—Materials: The materials for this work shall conform to the requirements of Article M.12.07 and Subarticle M.03.01-8 for joint seal.

8.16.03—Construction Methods: Construction methods for granite slope curbing shall conform to the following requirements:

1. Excavation: Excavation shall be made of sufficient depth and width to accommodate the granular base as shown on the plans. The granular base shall be compacted to a firm, even surface and shall be approved by the Engineer.

2. Granular Base: The granular base for the granite slope curbing shall be placed in layers not to exceed 6 inches (150 mm) in depth, loose measurement, and thoroughly rammed.

3. Installing Granite Slope Curbing: The curbing shall be set as shown on the typical section and settled into place with a heavy wooden hand rammer to the line and grade required, straight and true for the full depth. The top line of the curbing shall be set straight and true, allowing natural variations in depth of curbing to occur at the bottom of the face. The joints of the stone curbing shall be pointed with mortar for the full depth of the curbing. At approximately 50-linear-foot (15-meter) intervals, a 1/2-inch (12-millimeter) joint shall not be filled with mortar but left free for expansion.

When the slope curbing is set adjacent to concrete surfaces, it shall be set as shown on the plans. The joint between the concrete surface and the slope curbing shall then be sealed flush with the surface of the concrete. At the time of sealing the joint, the concrete, the stone curbing and the joint area shall be clean and dry to the depth specified for placement of the seal material.

When the slope curbing is to be placed adjacent to surfaces other than concrete, the curbing shall be set before the final surfacing is placed.

4. Openings: Where indicated on the plans, or directed by the Engineer, details of curbing shall be adjusted as ordered to provide for drainage openings.

8.16.04—Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of granite slope curbing or curved granite slope curbing actually installed and accepted, measured along the top arris line of face of curb. Only curbing placed on a radius of less than 100 feet (30 meters) will be measured for payment as curved granite slope curbing.

8.16.05—Basis of Payment: Payment for this work will be made at the contract unit price per linear foot (meter) for "Granite Slope Curbing" or "Curved Granite Slope Curbing," as the case may be, complete in place, which price shall include all materials, equipment, tools and labor incidental thereto, and all excavation, backfilling and disposal of surplus material.

There will be no direct payment for furnishing, placing and compacting granular base, pointing the joints with mortar and sealing the longitudinal joint, but the cost of this work shall be considered as included in the general cost of the work.

Pay Item	Pay Unit
Granite Slope Curbing (Size)	l.f. (m)
Curved Granite Slope Curbing (Size)	l.f. (m)

SECTION 8.18

PROTECTIVE COMPOUND FOR BRIDGES

8.18.01—Description: Under this item, the Contractor shall furnish and apply uniformly a protective compound to the exposed concrete surfaces as indicated on the plans or as ordered by the Engineer.

8.18.02—Materials: The material for this work shall conform to the requirements of Subarticle M.03.01-11.

8.18.03—Construction Methods: Surface preparation, minimum number of days between casting of concrete and application of protective compound, number of coats, rate of coverage, method of application, and other pertinent criteria shall be in strict accordance with the instructions supplied by the manufacturer and as directed by the Engineer.

All surfaces to be coated shall be thoroughly cleaned of any dust, dirt, oil, or other objectionable materials prior to application of the protective compound.

8.18.04—Method of Measurement: This work will be measured for payment by the actual number of square yards (square meters) of concrete coated and accepted within the designated limits.

8.18.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (meter) for "Protective Compound for Bridges," complete, which price shall include all equipment, tools, labor and materials, incidental thereto, including the preparation of the concrete surfaces.

Pay Item	Pay Unit
Protective Compound for Bridges	s.y. (s.m)

SECTION 8.21
PRECAST CONCRETE BARRIER CURB

8.21.01—Description: Under this item, the Contractor shall furnish and install precast concrete barrier curb in the locations shown on the plans, or as directed by the Engineer.

8.21.02—Materials:

1. Concrete shall conform to the requirements of Article M.14.01 amended as follows:
 - (a) Concrete shall have a minimum 28 days strength (f'c) of 4,000 psi (28 megapascals).
 - (b) Coarse Aggregate shall meet the requirements of M.03.01-1, and the grading requirements for "Class 'F' Concrete".
 - (c) Fine Aggregate shall be light in color and shall conform in color and type to the samples on file at the Laboratory of the Department of Transportation located in Rocky Hill, Connecticut.
 - (d) Cement for light concrete shall be Type III or Type IIIA Portland Cement or light colored cement approved by the Engineer.
 - (e) The entrained air content shall be not less than 5%, or more than 7%.
 - (f) The manufacturer identification and casting date shall be permanently marked on the barrier curb by means of a non-corrosive metal or plastic tag as approved by the Engineer and in the location as shown on the plan.
2. Reinforcing steel shall conform to the requirements of Article M.06.01.
3. Lifting hooks, keys, threaded inserts, bolts, devices and attachments shall be of the size indicated on the plans or of a design satisfactory for the purpose intended as approved by the Engineer.
4. Dowels shall conform to the requirements of ASTM A36.
5. Galvanizing shall conform to the requirements of ASTM A123.
6. Penetrating Sealer Protective Compound shall conform to the requirements of M.03.01-11.
7. Precast concrete barrier curb shall be accepted on the basis of manufacturer's certification, as defined in Article M.08.02.

8.21.03—Construction Methods:

1. Precast Units: Concrete barrier units shall be precast in an approved plant in conformance with the applicable requirements of Subarticles 5.14.03-4, 6, 7, 8 and 15 supplemented as follows:

Forms for precast concrete barrier units shall be of substantial construction, lined so as to produce a smooth dense surface with a uniform appearance. Form oil shall be a non-staining type. Air holes on exposed surfaces shall be filled immediately after removal of the forms to the satisfaction of the Engineer.
2. The precast units shall be placed on a prepared subbase and shall be installed to the lines and grades given and in accordance with the dimensions and details shown on the plans so as to produce a smooth continuous barrier curb.

Special transition units, as required, may be cast in place in accordance with Article 6.01.03.
3. Backfilling: The backfilling shall be completed to the lines shown on the plans, or as ordered, by filling to the required elevation with approved material which shall be placed in layers of not over 6 inches (150 millimeters) in depth with each layer compacted until firm and solid.
4. Whenever concrete barrier is being constructed adjacent to areas open to traffic, the Contractor shall complete the installation to and including the designed terminal treatment at the close of each day's work so as to prevent any hazard that would be caused by leaving an exposed end.

On long runs or other locations where it is not practical to complete the installation to and including the designed terminal treatment, the Contractor shall install and maintain temporary protection by methods such as impact attenuating devices for terminating the barrier so as to minimize any hazard.

The Contractor shall submit to the Engineer for approval details of his proposed methods for the temporary terminal treatment of the end section.
5. Precast units shall meet the 28-day strength requirements before shipping. Precast units that have been damaged shall be removed from the project at the Contractor's expense. Each line of barrier shall be uniform in color.
6. Precast units shall be coated with a penetrating sealer protective compound that meets the requirements of M.03.01-11.

8.21.04—Method of Measurement: This work will be measured for payment along the centerline of the top of the concrete barrier and will be the actual number of linear feet (meters) of the size of concrete barrier installed and accepted.

8.21.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Precast Concrete Barrier Curb," of the size specified, complete in place, which price shall include all

backfill, sand backfill, joint seal, materials, reinforcing steel, dowels, penetrating sealer protective compound, transportation, equipment, tools and labor incidental thereto. Backfill placed between a double row of concrete barrier curb shall be paid for under the item "Granular Fill." The concrete cap shall be paid for under the item "Class 'A' Concrete."

Pay Item	Pay Unit
Precast Concrete Barrier Curb (Size)	l.f. (m)

SECTION 8.22

TEMPORARY PRECAST CONCRETE BARRIER CURB

8.22.01--Description: Work under this item shall consist of furnishing, installing, relocating and removing temporary precast concrete barrier curb used to separate traffic from opposing traffic or the work area.

8.22.02--Materials: The materials for this work shall conform to the requirements of Article 8.21.02.

When used barrier curb is furnished, the contractor shall provide documentation stating from where the material came, what project it will be used on, the casting dates, and certification that the barrier conforms to all State requirements.

The delineator shall be fabricated of aluminum, steel, and plastic or of a material approved by the Engineer. The reflective sheeting shall be encapsulated lens sheeting conforming to Article M.18.09. Delineator fastening hardware or adhesive shall be suitable for the purpose intended.

The threaded steel connection rod shall be manufactured in conformance with AASHTO M314, Grade 55. Threads shall be Unified National Coarse Series as specified in ANSI B1.1 and shall have Class 2A threaded tolerances before galvanizing.

Plain steel washers shall be manufactured in accordance with ANSI B18.22.

Heavy hex nuts shall be Grade A, manufactured in conformance with AASHTO M291 and tapped oversize for galvanizing.

The threaded rod, washers and nuts shall be hot-dip galvanized in conformance with AASHTO M232, Class C.

Connection loop bars shall be bent from smooth bars that conform to ASTM A36.

8.22.03--Construction Methods:

1. Precast Unit: Temporary concrete barrier units shall be precast in conformance with the pertinent requirements of Article 8.21.03, except the penetrating sealer protective compound need not be applied to the precast unit.

2. Installation: Temporary precast concrete barrier units shall be placed as shown on the plans or as directed by the Engineer, on a firm even surface so as to produce a smooth continuous barrier curb.

The Contractor shall maintain the temporary concrete barrier during all stages of construction. Any damaged material shall be removed and replaced by the Contractor at his expense.

The Contractor shall relocate the concrete barrier and its appurtenances to locations within the project limits as shown on the plans or as ordered by the Engineer. When the temporary barrier is no longer required, it shall be removed completely from the project and shall remain the property of the Contractor.

3. Delineator: The delineator shall be installed in the center on top of the barrier at the locations designated on the plans. They may be fastened by adhesive or hardware and must be maintained in good condition at all times.

DE-7 delineators shall be used when the barriers are on the right side of traffic or dividing traffic in the same direction. DE-7 A delineators shall be used when the barriers are on the left side of traffic. DE-7B delineators shall be used when the barriers divide opposing traffic lanes. DE-7C delineators shall be used with the yellow side on the left side of traffic when traffic is alternated.

4. Connection Rod: Nuts at the connection rod shall be turned until the washer is drawn up against the connection loop. The connection loops must not be bent in the tightening process. For ease in removing the nuts, the threads may be waxed.

8.22.04--Method of Measurement: This work will be measured for payment along the centerline of the top of the concrete barrier and will be the actual number of linear feet (meter) of temporary concrete barrier furnished, installed and accepted.

Relocated temporary concrete barrier will be measured along the centerline of the top of the concrete barrier each time the barrier has been satisfactorily relocated as directed by the Engineer, including to and from the storage area. Storage of concrete barrier curb will not be measured for payment.

Delineators will be measured in accordance with Article 12.05.04.

8.22.05--Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Temporary Precast Concrete Barrier Curb" complete in place, which price shall include all furnishing, transportation, initial installation, final removal, storage, materials, reinforcing steel, connecting rods, equipment, tools and labor incidental thereto. Each temporary precast concrete barrier curb will be paid for once regardless of the number of times it is used on the project. Any temporary precast concrete barrier curbs that become lost, damaged or defaced shall be replaced by the contractor at no cost to the State.

The relocation of the temporary precast concrete barrier curb will be paid for at the contract unit price per linear foot (meter) for "Relocated Temporary Precast Concrete Barrier Curb," which price shall include all transportation, materials, equipment, tools and labor incidental thereto.

Delineators will be paid for in accordance with Article 12.05.05.

Pay Item	Pay Unit
Temporary Precast Concrete Barrier Curb	l.f. (m)
Relocated Temporary Precast Concrete Barrier Curb	l.f. (m)

**SECTION 9.04
METAL BRIDGE RAIL**

9.04.01—Description: This railing shall be selected from the different types of railing shown on the bridge plans and shall consist of metal pipe and fittings, structural steel shapes, castings or other material, anchor bolts, hardware fasteners, anchorages and terminal elements for connection to bridge parapets and fabricated in accordance with the dimensions and details given, and erected where shown on the plans or as ordered, in accordance with these specifications.

9.04.02—Materials: The material for the type of metal bridge rail selected for this work shall conform to the requirements of Subarticles M.06.02-1 for metal bridge rail (structural steel), M.06.02-9(d) for metal bridge rail (cast post—aluminum).

9.04.03—Construction Methods: The railing shall be accurately fabricated in accordance with the plans or as ordered.

Fabrication and erection shall be done in accordance with the requirements for steel bridges and structural steel as given hereinbefore. In the case of welded railing, after welding, all exposed joints shall be finished by grinding or filing to give a neat appearing job.

Metal railings shall be carefully adjusted prior to fixing in place to insure proper matching at abutting joints and correct alignment and cambers throughout their length. Holes for field connections to be drilled in the field shall be drilled with the railing in place in the structure and at proper grade and alignment. Welding may be substituted for rivets or bolts in field connections, with the approval of the Engineer.

Aluminum welding shall be in accordance with the AWS "Structural Welding Code, Aluminum," AWS D1.2, latest issue.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be thoroughly coated with an aluminum impregnated caulking compound conforming to FSS TT-C598 plaster type caulking compound, aluminum pigmented.

Aluminum Alloys shall not be placed in contact with copper, copper base alloys, lead or nickel.

Metal railing shall be painted in accordance with the painting requirements for structural steel, except that aluminum railing and aluminum posts shall not be painted.

9.04.04—Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of metal bridge rail, of the type selected, completed and accepted.

9.04.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Metal Bridge Rail" complete in place, which price shall include all material, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Metal Bridge Rail (Type)	l.f. (m)

**SECTION 9.05
STONE WALL FENCE**

9.05.01—Description: This item shall consist of approved rubble stones laid without the use of mortar to form a standard stone wall fence of the dimensions and details shown on the plans, constructed where indicated on the plans or as ordered and in accordance with these specifications. The foundation courses shall be of large stones, and the thinnest courses shall be placed toward the top of the wall. Vertical joints shall be broken and the wall bound together with each fourth to sixth stone a header. Headers shall be evenly distributed throughout the wall. The exposed sides and top of the wall shall be roughly faced within the minimum and maximum dimensions called for, and all exposed stones shall fit neatly.

9.05.02—Materials: Stones for this work shall be rubble stones of suitable size and of a quality satisfactory to the Engineer. The stones shall be roughly rectangular in shape with at least one fairly even face.

9.05.03—Construction Methods: The earth along the lines of the proposed wall shall be excavated to a depth of not less than 6 inches (150 millimeters) and leveled off and stepped as necessary in a satisfactory manner so that the first or base course of stones may be stably bedded. All stones shall be laid on their natural beds. Sufficient chip stones or spalls shall be used so that each stone is bedded securely and all interstices shall be firmly-chinked. Spalls will not be allowed in the heart of the wall. The top of the wall shall be capped with suitable stones, conforming to the minimum and maximum dimensions called for on the detailed plans.

9.05.04—Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of completed and accepted stone wall fence.

9.05.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Stone Wall Fence," complete in place, which price shall include materials, equipment, tools, labor and work incidental thereto; also all necessary excavation, refilling and disposal of surplus material.

Removal of material in stone walls that are to be removed and not used in new stone wall fences, will be paid for according to the provision of Section 2.02.

Pay Item
Stone Wall Fence

Pay Unit
l.f. (m)

SECTION 9.06 WIRE FENCE

9.06.01—Description: This item shall consist of wire fencing supported by wood or metal posts erected as shown on the plans or as ordered and in accordance with these specifications.

9.06.02—Materials: Materials for this work shall conform to the requirements of Article M.10.04 for wire fencing, wood post and metal post.

Where chain link fabric is used for wire fence, it shall conform to the requirements of Article M.10.05 except the Chain Link Fabric may be 11 gauge. Aluminized fabric shall be coated with aluminum alloy applied at the rate of 0.35 ounces per square foot (0.1 kilograms/square meter) of uncoated wire surface. Tension wire and wire ties shall conform to the requirements of Article M.10.05. Posts shall conform to the requirements of Article M.10.04 or M.10.05 and the plans.

9.06.03—Construction Methods: For wire fence with wood posts, the posts shall be set plumb, butt end down, spaced 10 feet (3 meters) apart on centers, set 3 feet (1 meter) in the ground and a minimum of 4 feet 6 inches (1375 millimeters) above the ground and to lines and grades given. The wire fencing shall normally be placed on the side of the posts facing the roadway. It shall be attached to the wood posts by means of No. 9 galvanized wire staples 1 1/2 inches (38 millimeters) long. The bottom wire shall be 6 inches (150 millimeters) above the ground level unless otherwise ordered. The fencing shall be stretched taut and fastened to the posts at each horizontal wire. A sufficient number of braces shall be added to the posts to hold them firmly when the wire fencing is pulled tight. Untreated posts shall be cut off at the top a uniform distance of 3 inches (75 millimeters) above the top wire of the fence on a bevel as directed by the Engineer.

When exposed ledge rock is encountered, the fence shall be attached to metal posts which shall be set in holes drilled into the rock at least 12 inches (300 millimeters) in depth and grouted or otherwise firmly held in correct position.

For wire fence with metal posts, all line posts set in earth shall be set plumb with anchor plate down, spaced 10 feet (3 meters) apart on centers, set 3 feet (1 meter) in the ground and 4 feet 6 inches (1375 millimeters) above the ground and to lines and grades given. On metal line posts set in rock, the anchor plate shall be omitted; and the posts set in holes drilled into the rock at least 12 inches (300 millimeters) in depth and grouted in correct position. In driving steel line posts into place, the top of the post shall be protected by a driving cap, or a suitable maul shall be used.

All end, corner and pull posts shall be set in concrete footings. The footings shall be constructed of Class A Concrete, which may be hand-mixed, and shall have a depth of not less than 3 feet (1 meter) and a horizontal area of not less than 8 inches x 8 inches (200 millimeters x 200 millimeters) at the top and 10 inches x 10 inches (250 millimeters x 250 millimeters) at the bottom.

Braces shall be fastened to the post approximately 18 inches (450 millimeters) from the top of the post and shall be of sufficient length and so set in the ground that they form an angle in the vertical plane of not less than 45 degrees with the post. The lower end of braces shall be set in a concrete base having a volume of not less than 1 cubic foot (0.03 cubic meter). Metal brace plates having a face area of not less than one square foot (0.1 square meter) and a thickness of not less than 3/16 inch (5.0 millimeters) may be substituted for the concrete base on braces, provided performance equal to that of the concrete base can be demonstrated by the Contractor in tests conducted at the Contractor's expense.

The Engineer will direct on which side of the post the wire fencing is to be placed. It shall be stretched taut and securely fastened to the posts by standard approved means such as aluminum bands, zinc-coated steel bands or clips made of No. 11 gage rust-resisting spring wire at each horizontal wire. Braced pull posts shall be installed as needed. Unless otherwise ordered, the bottom wire shall be 6 inches (150 millimeters) above the ground.

At his option the Contractor may substitute chain link fabric with tension wire in conformance with these specifications or Section 9.13. When wire fencing conforming to M.10.04 is not available or "Alternate Wire Fence" is indicated on the plans, the Contractor shall install the fence with chain link fabric.

9.06.04—Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of completed and accepted wire fence measured from outside to outside of end posts.

9.06.05—Basis of Payment: This work will be paid for as follows:

1. Wire Fence with Wood Posts: This work will be paid for at the contract unit price per linear foot (meter) for "Wire Fence with Wood Posts," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto, also all excavation, refilling and disposal of surplus material.

No additional compensation will be made for furnishing metal fence posts where required or for the drilling and grouting necessary to place them.

2. Wire Fence with Metal Posts: This work will be paid for at the contract unit price per linear foot (meter) for "Wire Fence with Metal Posts," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto, also all excavation, refilling and disposal of surplus material.

No additional payment will be made for wire fence installed with chain link fabric.

Pay Item	Pay Unit
Wire Fence with Wood Posts	l.f. (m)
Wire Fence with Metal Posts	l.f. (m)

SECTION 9.07

BARWAYS

9.07.01—Description: These barways shall consist of wood posts and rails with the necessary fittings, erected in the locations and to the dimensions and details shown on the plans or as ordered and in accordance with these specifications.

9.07.02—Materials: The materials for this work shall conform to the requirements of Article M.10.03.

9.07.03—Construction Methods: The barways shall be built in the locations and in accordance with the dimensions and details shown on the plans or as ordered. The posts shall be set plumb and firm in the ground, braced, and the fittings shall be neatly and firmly attached. The whole shall be completed in a neat and workmanlike manner to the satisfaction of the Engineer.

9.07.04—Method of Measurement: The quantity to be paid for under this item will be the number of completed and accepted barways.

9.07.05—Basis of Payment: This work will be paid for at the contract unit price each for "Barway," complete in place, which price shall include all materials, tools, equipment, and labor incidental thereto, also all excavation, refilling and disposal of surplus material.

Pay Item	Pay Unit
Barway	ea. (ea.)

**SECTION 9.08
FARM WALL FENCE**

9.08.01—Description: This item shall consist of approved rubble stones laid without the use of mortar to form a farm wall fence of the dimensions and details shown on the plans, constructed where indicated on the plans or as ordered, and in accordance with these specifications. The foundation courses shall be of large stones, and the thinnest courses shall be placed toward the top of the wall. Vertical joints shall be broken as much as possible, and the wall bound together with occasional headers to form a structurally stable wall. Uniformity of either face or top within the minimum and maximum dimensions called for will not be required.

9.08.02—Materials: Stones for this work shall be rubble stones of suitable size and of a quality satisfactory to the Engineer. Only a minimum amount of cut or split stones will be required.

9.08.03—Construction Methods: The ground shall be cleared of heavy sod, moss, bogs, brush and deep leaves; and sufficient shaping of the ground shall be done so that the first or base course of stones is stably bedded. All stones shall be laid on their natural beds. Sufficient chip stones or spalls shall be used so that each stone is bedded securely, but chinking of interstices will not be required. Spalls and chips will not be allowed in the heart of the wall.

9.08.04—Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of completed and accepted farm wall fence.

9.08.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Farm Wall Fence," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto, also all necessary excavation, refilling and disposal of surplus material.

Removal of material in stone walls that are to be removed and not used in new walls will be paid for according to the provisions of Section 2.02.

Pay Item	Pay Unit
Farm Wall Fence	l.f. (m)

SECTION 9.10 METAL BEAM RAIL

9.10.01—Description

9.10.02—Materials

9.10.03—Construction Methods

9.10.04—Method of Measurement

9.10.05—Basis of Payment

9.10.01—Description: Work under this item shall consist of the installation of or conversion to a single or double line of steel rail elements fastened to wood or steel posts with or without rubrail, and the appropriate treatment at bridge parapets, barriers, or other fixed objects as shown on the plans. This item shall include metal beam rail types: w-beam, thrie-beam and box-beam. It shall be installed or converted in the locations indicated and fabricated in conformity with the lines, designations, dimensions, and details on the plans or as ordered by the Engineer.

9.10.02—Materials: The material for metal beam rail shall meet the requirements of Article M.10.02 and the following:

1. Chemical anchoring material shall meet the requirements of Subarticle M.03.01-15.
2. Metal beam rail delineators shall meet the requirements of Subarticle M.18.09-02 and Article M.18.13.
3. When converting rail, the Contractor shall reuse any undamaged existing rail elements, appropriate posts, delineators, and lap bolts within the project limits as approved by the Engineer to construct the converted rail. The Contractor shall use new materials when any components of the existing railing are damaged or missing and cannot be obtained from other rail systems being removed or converted within the Project limits.

9.10.03—Construction Methods: Steel posts shall be driven. The Contractor shall use suitable driving caps and equipment to prevent damage to the posts during driving. Where rock, boulders or debris are encountered while driving the posts, the obstruction shall be removed to make each hole large enough to permit driving of the posts. Each hole shall then be backfilled with suitable material and thoroughly compacted before driving the posts. Any surplus or unsuitable material remaining after the completed installation shall be removed and disposed of by the Contractor.

Wood posts shall be set in holes, and the area adjacent to the posts shall be backfilled with suitable material and thoroughly compacted. Any surplus or unsuitable material remaining after the completed installation shall be removed and disposed of by the Contractor.

The Contractor is cautioned that underground utilities, which may be energized, may be present within the Project limits.

The posts shall be located as shown on the plans, set plumb and in alignment with the rail or rail treatments. Where required, the blockouts, brackets, rubrails, back-up rails and rail elements shall then be erected to produce a smooth continuous rail as shown on the plans. The terminal connectors, rubrails, and rail elements shall be lapped in the direction of traffic.

Whenever metal beam rail or rail treatments are being constructed adjacent to areas open to traffic, the Contractor shall complete the installation up to and including the designated terminal treatment at the close of each day's work.

On long runs or other locations when it is not practical to complete the installation up to and including the designated terminal treatment by the end of the workday, the Contractor shall use temporary methods to terminate the metal beam rail.

Prior to any rail installations, the Contractor shall submit to the Engineer for review its proposed methods for temporarily terminating the end section.

The Contractor shall furnish posts of sufficient length where field conditions warrant to obtain the depth in the ground shown on the plans.

When existing metal beam rail is being converted, the Contractor may punch or drill a hole in the flange of the existing post to facilitate attachment of the blockout and rail element to the post. No other methods shall be used to create this hole.

End anchorages not needed for the converted rail shall be removed in their entirety.

In the welding of steel plates to the steel posts, the welds shall be of the size and type shown on the plans and shall conform to the applicable requirements of the AWS and supplemented by the following:

- 1) The Engineer will make a visual inspection of welds. All welds found unacceptable by the Engineer

shall be corrected by the Contractor at no additional cost.

Before final erection, all galvanized elements which have been cut or worked so as to damage the zinc coating and cause the base metal to be exposed shall have the exposed base metal thoroughly cleaned and brush coated with two coats of zinc-rich touch-up material in conformance with Subarticle M.10.02-8.

9.10.04—Method of Measurement:

1. **Metal Beam Rail (Type):** The length of metal beam rail measured for payment will be the number of linear feet (meters) of accepted rail of the type or designation installed, including radius rail other than Curved Guide Rail Treatment, measured along the top of rail between centers of end posts in each continuous section.
2. **Metal Beam Rail R-B 350 (Type I, II, or III) Section:** Metal Beam Rail R-B 350 (Type I, II, or III) Section measured for payment will be the actual number of each type accepted and installed in accordance with the "Pay Limit" shown on the plans.
3. **(Type) Attachment:** The number of rail attachments to bridge parapets, barriers or other fixed objects measured for payment will be the actual number of accepted attachments of each type or designation installed in accordance with the "Pay Limit for Attachment" shown on the plans.
4. **Convert Metal Beam Rail (Type) to Metal Beam Rail (Type):** The conversion of existing metal beam rail (Type) to the (Type) specified will be measured for payment by the number of linear feet (meters) of rail installed measured along the top of rail between centers of end posts in each continuous section. If a new end anchorage for the converted rail is needed, it shall be measured for payment in accordance with Section 9.11.
5. **(Type) Curved Guide Rail Treatment:** The (Type) Curved Guide Rail treatment measured for payment will be the actual number of each type installed and accepted in accordance with the "Pay Limit Curved Guide Rail Treatment" shown on the plans.

9.10.05—Basis of Payment:

1. **Metal Beam Rail (Type):** This will be paid for at the contract unit price per linear feet (meters) for the type or designation indicated on the plans or ordered by the Engineer, complete in place. Prices shall include all materials, posts of all lengths, equipment, tools, removal and disposal of surplus material, and labor incidental to the installation of the rail.
2. **Metal Beam Rail R-B 350 (Type I, II or III) Section:** This will be paid for at the contract unit price each for the types specified on the plans complete in place. Prices shall include all materials, CRT wood posts, equipment, tools, removal and disposal of surplus material, backfilling, and labor incidental to the installation of the rail.
3. **(Type) Attachment:** This will be paid for at the contract unit price each for the type of attachment complete in place. The price shall include all materials, drilling & grouting including anchor bolts, removal of existing rail system, removal and disposal of surplus material, equipment, tools, and labor incidental to the installation of the attachment.
4. **Convert Metal Beam Rail (Type) to Metal Beam Rail (Type):** The conversion of existing metal beam rail will be paid for at the contract unit price per linear feet (meters) for the type shown on the plans complete in place. The price shall include all materials (excluding new parts for damaged or missing parts), backfilling, punching or drilling of holes in existing posts, removal and resetting of existing railing, removal of the end anchorages where indicated on the plans, removal and disposal of surplus material, equipment, tools and labor incidental to the conversion of the existing rail. Surplus material not needed for the conversion, unless specified otherwise in the Contract, shall become the property of the Contractor.

Payment for new parts approved by the Engineer, which replace damaged or missing parts will be paid for at the applicable contract unit prices, or in their absence, in accordance with Article 1.04.05.

5. **(Type) Curved Guide Rail Treatment:** This will be paid for at the contract unit price for each type indicated or as ordered by the Engineer, complete in place. The price shall include all materials, excavation, backfilling, removal and disposal of surplus material, equipment, tools and labor incidental to the installation of the rail treatment.

Drilling in or removal of rock or boulders and backfilling with suitable material when required for the installation of posts will be paid for in accordance with Article 1.04.05, unless an item for the removal of rock appears in the Contract.

Payment for temporary terminations for metal beam rail and galvanized coating touch-up will be included in the general cost of the work.

Pay Item	Pay Unit
Metal Beam Rail (Type)	l.f. (m)
Metal Beam Rail R-B 350 (Type I, II or III) Section (Type) Attachment	ea. (ea.) ea. (ea.)
Convert Metal Beam Rail (Type) to Metal Beam Rail (Type)	l.f. (m)
(Type) Curved Guide Rail Treatment	ea. (ea.)

SECTION 9.11

METAL BEAM RAIL ANCHORAGES

9.11.01—Description: This work shall consist of installing metal beam rail end anchorages of the type shown on the plans or as ordered by the Engineer.

9.11.02—Materials: The materials for this work shall conform to the requirements of Subarticle M.10.02-7.

Non-shrink grout shall conform to the requirements of Subarticle M.03.01-12.

9.11.03—Construction Methods: Anchorages, channels, rails, w-beam terminal elements, and fittings shall be installed as indicated on the plans. The excavated area for the anchorages shall be backfilled with suitable material and compacted in 6-inch (150 millimeters) layers. Any surplus material remaining after the completed installation shall be removed by the Contractor.

When the rail is anchored to rock, preparation of the rock including rock removal and the drilling of holes shall be as shown on the plans. The diameter of the holes shall be sufficient to permit the placement of the bolts and the non-shrink grout, but shall not exceed twice the diameter of the bolts. The bolt holes shall be blown clean with an air jet prior to installing the bolts and non-shrink grout. Spalled areas behind the steel plate shall be filled with non-shrink grout.

The rail elements shall be lapped in the direction of traffic.

Before final erection, all galvanized elements which have been cut or worked so as to damage the zinc coating and cause the base metal to be exposed shall have the exposed base metal thoroughly cleaned and brush coated with zinc-rich touch-up material in conformance with Subarticle M.10.02-8.

9.11.04—Method of Measurement: The number of end anchorages measured for payment shall be the actual number of end anchorages of each type installed and accepted in accordance with the "Pay Limit Anchorage" shown on the plans.

9.11.05—Basis of Payment: End anchorages will be paid for at the Contract unit price each for the type of end anchorage, complete in place, which price shall include materials, excavation, backfilling, drilling and grouting, removal and disposal of surplus material, equipment, tools, and labor incidental to complete the installation.

Payment for rock removal required for "Anchor in a Rock Cut Slope", shall be included in the cost of the item. Removal of rock or boulders encountered during excavation for other end anchorages and backfilling with suitable material will be paid for in accordance with Article 1.04.05, unless an item for the removal of rock appears in the Contract.

Pay Item	Pay Unit
(Type) End Anchorage Type I	ea. (ea.)
(Type) End Anchorage Type II	ea. (ea.)
Anchor in (Type) Slope	ea. (ea.)

SECTION 9.12
REMOVE AND RESET POSTS,
RAIL AND RAIL ANCHORAGES

9.12.01—Description: This work shall consist of removing or resetting existing single posts, anchorages, cable guide rail and a single or double line of metal beam rail in the locations indicated on the plans or as ordered by the Engineer.

9.12.02—Materials: When resetting rail, the Contractor shall reuse any undamaged existing rail elements, appropriate posts, delineators, and lap bolts within the Project limits, as approved by the Engineer to construct the reset rail. The Contractor shall use new materials conforming to the requirements of M.10 to replace any parts of the existing rail system that are damaged or missing and cannot be obtained from other rail systems being removed or reset within the Project limits.

9.12.03—Construction Methods: The Construction Methods for Section 9.10, 9.11, and 9.18 when applicable, shall apply to the resetting of existing rail systems.

Prior to commencement of work, the Contractor and Engineer shall inventory the existing rail systems within the Project limits to determine which materials are suitable for reuse.

If resetting or removing railing, the Contractor must complete that work, including any required grading and any replacement of materials, by the end of each day's work. When it is not practical to complete such rail work by the end of the day's work, the Engineer may allow the Contractor to temporarily attach the existing rail to the new rail, concrete barrier curb or temporary terminal treatment.

9.12.04—Method of Measurement:

1. Reset Cable Guide Rail and Reset Metal Beam Rail: The length of reset rail measured for payment shall be the number of linear feet (meters) of completed rail of each type specified on the plans, measured along the top of rail between centers of posts in each continuous section of reset rail.

2. Reset Single Posts and Reset Rail Anchorages: The number of reset single posts or rail anchorages measured for payment shall be the actual number of each single post or rail anchorage reset as shown on the plans.

3. New Materials: The amounts of new material measured for payment will be the numbers of new rail components authorized by the Engineer.

4. Removal: Removal of cable guide rail or metal beam rail shall be measured for payment by the number of linear feet (meters) of such rail including posts removed between the centers of anchors, including the anchors, and any rail system attachments.

5. Remove Single Post: Removal of single posts not attached to any rail system will be measured for payment by counting each such post.

9.12.05—Basis of Payment:

1. Reset Cable Guide Rail and Reset Metal Beam Rail: This will be paid for at the contract unit price per linear foot (meter) for "Reset (Type) Cable Guide Rail (Type-Post)" and "Reset Metal Beam Rail (Type) (System)," complete in place. This price shall include the complete removal, storage and resetting of existing rail, including excavation, backfilling and disposal of surplus or unsuitable material, and all equipment, tools and labor incidental thereto.

2. Reset Single Posts and Reset Rail Anchorages: This will be paid for at the contract unit price each for "Reset Single Post," and "Reset Rail Anchorage" complete in place. This price shall include the complete removal, storage and resetting of existing posts and anchorages, including excavation, backfilling and disposal of surplus or unsuitable material, and all equipment, tools, and labor incidental thereto.

3. New Materials: Authorized new materials will be paid for at the applicable contract unit prices, or in their absence, in accordance with Article 1.04.05.

4. Remove Cable Guiderail and Remove Metal Beam Rail: This will be paid for at the contract unit price per linear foot (meter) for "Remove Cable Guide Rail" and "Remove Metal Beam Rail (Type)". This price shall include removal of each post, rail and end anchorages, backfilling, equipment, tools and labor incidental thereto. Surplus rail, cable, posts and hardware not needed for the resetting of railing, unless specified otherwise in the Contract, shall become the property of the Contractor.

5. Remove Single Post: This will be paid for at the Contract unit price each for "Remove Single Post". This price shall include removal and disposal of each post, backfilling, equipment, tools and labor incidental thereto.

6. Temporary Treatment: There will be no payment for any temporary treatments or attachments.

Pay Item	Pay Unit
Reset (Type) Cable Guide Rail (Type Post)	l.f. (meter)
Reset Metal Beam Rail (Type) (System)	l.f. (meter)
Reset Single Post	ea. (ea.)
Reset Rail Anchorage	ea. (ea.)
Remove Single Post	ea. (ea.)
Remove Cable Guide Rail (Type)	l.f. (meter)
Remove Metal Beam Rail (Type)	l.f. (meter)

SECTION 9.13
CHAIN LINK FENCE

9.13.01—Description: Work under this item shall consist of furnishing and installing woven wire fencing and gates of the type and height specified and supported by metal posts erected where indicated on the plans or as ordered and in conformity with these specifications.

9.13.02—Materials: The materials for this work shall conform to the requirements of Article M.10.05.

When aluminum-coated steel fabric is used, the posts and hardware will be galvanized.

When aluminum fabric is used, the posts and hardware will be aluminum.

When polyvinyl chloride-coated steel fabric is used, the posts and hardware will be polyvinyl chloride coated.

Where the item "Chain Link Fence" is called for, the Contractor shall have the option of using either aluminum chain link fence or aluminum-coated chain link fence. However, only one type of chain link fence shall be used on the project under the "Chain Link Fence" item.

9.13.03—Construction Methods: The posts shall be spaced in line of fence not further than 10 feet (3 meters) on centers. Intermediate or line posts, except where indicated on the plans, may be driven by mechanical means. A suitable driving cap shall be used to insure that no damage is caused to the post, galvanization or polyvinyl chloride coating. Posts not driven, and all other type posts shall be set in portland cement concrete acceptable to the Engineer.

In earth, the hole for the concrete footing shall extend at least 4 inches (100 millimeters) below the bottom of the post but not less than 9 inches (225 millimeters) in diameter for all line posts and 12 inches (300 millimeters) in diameter for terminal, pull or corner posts. The tops of the concrete footings shall be crowned to shed water.

When ledge rock is encountered, the posts shall be set in holes drilled into rock at least 12 inches (300 millimeters) in depth and grouted or otherwise firmly held in correct position.

For fence 5 feet (1.5 meters) in height or less where runs of fence are 100 feet (30 meters) or over, end posts shall be braced. All corner posts where runs are over 100 feet (30 meters) in either direction shall have two braces. For fence more than 5 feet (1.5 meters) in height, end posts shall be braced; and corner posts shall have two braces.

Pull posts with two braces shall be provided for all heights where changes in horizontal or vertical alignment of ten (10) degrees or more occur.

Where braces are required, they shall be spaced as indicated on the plans.

Braces shall be securely fastened to posts by suitable connections and trussed from line post back to post requiring bracing with 3/8-inch (9.5-millimeter) round rod, having a turnbuckle adjustment.

Where a top rail is used, it shall pass through the base of the line post cap and form a continuous brace from end to end of fence. The rail shall be provided with couplings approximately every 20 feet (6 meters). The couplings shall be of the outside-sleeve type and at least 7 inches (175 millimeters) long, one coupling in every five to have a heavy spring to take up expansion and contraction in the top rail.

Fabric shall be fastened to line posts with bands or wire clamps of No. 6-gage aluminized or PVC coated steel wire 4 3/4 inches (120 millimeters) long. These bands shall be spaced approximately 14 inches (350 millimeters) apart. The fabric shall be fastened to the top rail with tie wires. These tie wires shall be 6 1/4 inches (160 millimeters) long, spaced approximately 24 inches (600 millimeters) apart.

If a top rail is not specified, a top tension wire shall be provided. The tension wire shall be one continuous length between pull posts. Sufficient tension shall be applied to provide a wire without a visible sag between posts. Tension wires shall be tied or otherwise fastened to end, gate, corner or pull posts by a method acceptable to the Engineer. Ties or clips shall be provided for attaching the tension wire to the fabric at intervals not exceeding 2 feet (600 millimeters).

Where it is not practicable to conform the fence to the general contour of the ground, as at ditches, channels, etc., the opening beneath the fence shall be enclosed with chain link fabric and sufficiently braced to preclude access, but not to restrict the flow of water.

Fabric shall be fastened to the end of the gate frames by stretcher bars and fabric bands, and to the top and bottom of the gate frames by tie wires in the same manner as specified for the chain link fence fabric.

The drop bar locking device for the gate shall be provided with a footing of portland cement concrete crowned at the top to shed water and provided with a hole to receive the locking bar. A heavy-duty padlock with 2 keys shall be furnished by the Contractor for each gate or set of double gates. The size of the footing and depth of penetration of the locking bar into the footing shall be as specified by the manufacturer of the locking device.

9.13.04—Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of completed and accepted chain link fence or polyvinyl chloride chain link fence of the height specified, measured from outside to outside of terminal posts.

Gates will be measured for payment by the number of gates installed, of the type and size specified, completed and accepted.

9.13.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Chain Link Fence" or "Polyvinyl Chloride Chain Link Fence" of the height specified, complete in place, which price shall include all materials, equipment, tools, excavation, backfill, disposal of surplus material and labor incidental thereto. Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
(Height) Chain Link Fence	l.f. (m)
(Height) Polyvinyl Chloride Chain Link Fence	l.f. (m)

Gate work will be paid for at the contract unit price each for "Chain Link Gate" or "Polyvinyl Chloride Chain Link Gate" of the type and size specified; complete in place, which price shall include gate frame, gate posts, chain link fabric, lock, concrete, excavation, backfill, fabrication, installation, disposal of surplus material, and all materials, equipment, tools, labor and any work incidental thereto. Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
(Type) (Size) Chain Link Gate	ea. (ea.)
(Type) (Size) Polyvinyl Chloride Chain Link Gate	ea. (ea.)

**SECTION 9.14
METAL HANDRAIL**

9.14.01--Description: This item shall consist of furnishing and installing a 1 1/2-inch (38-millimeter) Welded and Seamless Steel pipe hand-railing on the proposed concrete steps, as shown on the plans, or as directed by the Engineer.

9.14.02--Materials: All pipe for railing and posts shall be standard weight (mass) 1 1/2-inch (38-millimeter) Welded and Seamless Steel pipe conforming to the requirements of Subarticle M.06.02-8.

Caps shall be malleable iron conforming to the requirements of Subarticle M.06.02-9(d) except that the grade shall be 32510.

Paint shall conform to the requirements of Section M.07.

9.14.03--Construction Methods: The rail elements shall be erected to produce a smooth, continuous rail as shown on the plans.

Pipe posts shall be set in sleeves and fastened by means of setscrews. The sleeves for the post shall be firmly embedded in concrete to the depth shown on the plans. The Contractor shall seal annular space between the pipe and the sleeve with a bituminous compound satisfactory to the Engineer to prevent water from entering.

The top rail shall consist of a single, continuous pipe and shall be welded to posts.

The lower rail shall be welded to the posts.

All joints shall be finished smooth. No rough or sharp projections will be permitted.

The entire railing and exposed portion of the sleeve into which the railing is set shall be thoroughly cleaned before painting and shall be painted with a field coat of zinc rich primer, ready-mixed paint and two field coats of paint to be selected by the Engineer and meeting the pertinent requirements of Section 6.03.

9.14.04--Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of railing measured along the top of the rail from end to end of the rail.

9.14.05--Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Metal Handrail," complete in place, which price shall include all materials, including sleeves and fastening devices in which the posts are set, and all equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Metal Handrail	l.f. (m)

SECTION 9.15

TREE ROOT PROTECTION

9.15.01—Description: This item shall consist of the protection of selected trees, shrubs, or other woody plants by placing pervious material to protect the root system, as shown on the plans, and in accordance with these specifications.

9.15.02—Materials: The materials for root protection shall consist of approved materials ranging from 1 to 6 inches (25 to 150 millimeters) in size such as stone or screened gravel.

9.15.03—Construction Methods: Where tree root protection is required, the area to be protected shall be thoroughly cleared of all vegetation. The pervious material shall then be uniformly spread to the line and grade specified.

Care shall be taken to assure that the trees, shrubs, or other woody plants which are to be preserved in place are not scarred or damaged by the operations under this item. The root area to be protected shall be the area of ground surface lying within the drip line of the outermost branches of the tree concerned.

9.15.04—Method of Measurement: This work will be measured for payment by the number of cubic yards (cubic meters) of tree root protection complete in place.

9.15.05—Basis of Payment: This work shall be paid for at the Contract unit price per cubic yard (cubic meter) for "Tree Root Protection," which price shall be full compensation for clearing the ground surface, for placing the pervious material and all materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Tree Root Protection	c.y. (cu. m)

SECTION 9.16 NOISE BARRIER WALL

9.16.01—Description: This work shall consist of furnishing and constructing noise barriers in the locations and to the dimensions and details shown on the plans or as ordered by the Engineer.

Unless a specific type of wall is required by the plans, the Contractor may select any one of the types whose details are shown on the plans.

The Contractor shall identify by type and name, in his proposal, the specific type of wall for each location upon which his bid is based.

If the contractor proposes to use different types of wall, he shall design the transition or connection of the two types and submit the design and details to the Engineer for overall consideration, review and approval prior to furnishing material.

Rock in so far as it applies to "Rock in Pole Excavation" shall be defined as rock in definite ledge formation, boulders or portions of boulders, cement masonry structures, concrete structures or Portland cement concrete pavement which has a cross-sectional area that exceeds 50% of the cross-sectional area of the designed pier hole.

9.16.02—Material: Materials for Portland cement concrete shall conform to the requirements of Article M.03.01. The size of aggregate and the mix formulation shall be submitted to the Engineer for approval.

All other materials shall conform to the requirements as indicated on the individual noise barrier wall plans.

9.16.03—Construction Methods: All walls shall be constructed as shown on the plans and as recommended by the manufacturer or fabricator.

Shop Drawings: The Contractor shall submit shop drawings to the Engineer for approval in accordance with Article 1.05.02(b). These drawings shall include, but not be limited to, the following information: The layout plans, details of stepped installation on grades, transition and connection of wall on a structure to the adjacent wall, material lists and material designations.

All vertical joints shall be plumb.

Where poles are used, they shall be set in concrete in predrilled holes. The concrete shall fill the bore to the full depth of hole and shall be crowned at the top for drainage. The drilled hole shall be reasonably true and plumb to the stated diameter and depth. Precautions shall be taken in the operational procedures to protect the hole from collapse. Should rock or other obstructions be encountered in making the hole, this material shall be removed and any space outside the designed pier diameter shall be replaced with concrete.

The concrete shall be placed in the dry, against the existing soil or rock. All disturbed material around the concrete shall be compacted.

Compacted granular fill shall be constructed in accordance with Section 2.14.

All ground beyond the gravel or stone limits disturbed by the installation of the wall shall be restored to its original condition and all excess material removed from the site.

9.16.04—Method of Measurement: This item shall be measured for payment by the number of square feet (square meters) of noise barrier wall completed and accepted within the limits indicated on the plans or as ordered by the Engineer. The horizontal pay limit shall be from center to center of each pier, pole or post. The vertical pay limit shall be from the finished ground elevation, prior to placement of crushed stone, measured at the center of the panel, to the top of the wall. Areas above the design height and the overhang area beyond the centerline of pier, pole or post will not be measured for payment.

The horizontal pay limit for structure mounted noise barrier wall shall be as described above, whereas the vertical pay limit shall be measured from the top to the bottom of sheathing.

Where rock is encountered, it will be measured for payment from the top of the rock to the bottom of the necessary rock excavation.

9.16.05—Basis of Payment: Payment for this work will be made at the contract unit price per square foot (square meter) for "Noise Barrier Wall" or "Noise Barrier Wall (Type)" complete in place, which price shall include all materials, including stone, foundation, and materials for the fabrication and installation of the wall itself, grading, disposal of surplus material, equipment, tools, labor and work incidental to the installation of the wall.

When rock is encountered within the limits of excavation, its removal will be paid for at the contract unit price per vertical foot (vertical meter) for "Rock in Pole Excavation," which price shall include any additional excavation to remove the rock and any additional concrete required to fill the excavation beyond the designed pier hole diameter or depth.

Pay Item
Noise Barrier Wall (Type and Designation)
Rock in Pole Excavation

Pay Unit
s.f. (s.m)
v.f. (v.m.)

SECTION 9.18
THREE-CABLE GUIDE RAILING
(I-BEAM POSTS) AND ANCHORAGES

9.18.01--Description: This railing shall consist of three wire cables attached to American Standard Beam Posts, as indicated on the plan, installed in the locations indicated and in accordance with the dimensions and details shown on the plans or as ordered and in conformity with these specifications.

Anchorage shall consist of the necessary concrete anchors or "deadmen," end posts with base plates, anchor assemblies, turnbuckle cable-end assemblies and spring cable-end assemblies (compensating device), singly or in combination, appurtenance hardware and the necessary excavation and backfill, all installed in the locations indicated or ordered in accordance with the dimensions and details shown on the plans or as ordered and in conformity with these specifications.

9.18.02--Materials: The materials for this work shall conform to the requirements of Article M.10.08 for wire rope, steel posts and plate anchors, fittings, and anchorages. The materials for reflective delineators shall conform to Article M.18.09.

9.18.03--Construction Methods: The Contractor is cautioned that within the limits of any project, buried cable for illumination or utilities, which may be energized, may be present.

In the welding of steel plates to the steel posts, the welds shall be of the size and shape as shown on the plans and shall conform to the applicable requirements of the current AWS Structural Welding Code as supplemented and revised by the following:

Only a visual inspection of welds will be required.

The Engineer will make a visual inspection of welds. All welds shall have no visual cracks nor be defective in any way and shall be formed in a neat and workmanlike manner. Any weld found unacceptable by the Engineer shall be corrected by the Contractor at no additional cost.

Line posts are to be driven into the ground as shown on the plans, unless otherwise ordered by the Engineer. Posts shall be driven by approved methods and equipment that will provide the posts in their final position free of any distortion and burring or any other damage.

The Contractor shall be required to furnish extra length posts at transition areas, and these posts shall be driven so as to provide the 2-inch (50-millimeter) nominal cover over the plate as required by the plans.

End posts are to be set in holes dug in thoroughly compact soil. The bottoms of dug holes shall be thoroughly rammed so that the posts have a stable foundation. Backfill for all dug holes shall be approved material and is to be machine-tamped in 4-inch (100-millimeter) layers in such a way as not to shift the posts from the correct alignment.

Should rock or boulders be encountered, a hole of sufficient size to set the post to the normal depth called for on the plans shall be drilled and back-filled with tamped sand.

Anchorage, plate anchors, cables, turnbuckle cable-end assemblies and spring cable-end assemblies (compensating device), singly or in combination, and all fittings shall be placed as indicated on the plans and in a workmanlike manner. The cable shall be drawn taut and fastened securely at both ends as shown on the plans. No punching, drilling, cutting or welding of posts, post plates or any hardware will be permitted after galvanizing.

After erection, galvanized cable, fittings, steel posts and plate anchors that have been abraded so that the base metal is exposed, threaded portions of all fittings and fasteners and the cut ends of all bolts shall be painted with two coats of zinc dust primer conforming to FS TTP-641B, Type II, or MIL P 21035.

After the rail has been erected, the Contractor shall install a reflectorized delineator on every other line post as shown on the plans and wherever the railing is parallel to, but not greater than 12 feet (4 meters) from, the edge of the shoulder. Reflectorized delineators shall not be installed on railing installations or single posts where such installations are greater than 12 feet (4 meters) from the shoulder. An object marker shall be installed at the end of the anchorage, Type II.

9.18.04--Method of Measurement: This work will be measured for payment as follows:

1. Three-Cable Guide Railing (I-Beam Posts): The length of cable railing to be included for payment shall be the number of linear feet (meters) from centerline to centerline of the most remote end post from the concrete anchor in End Anchorage, Type I, and from centerline to centerline of the end post to which the anchor rod is attached in End Anchorage, Type II. No deduction will be made for the overlap at intermediate anchorages.

2. Anchorages: The number of anchorages to be included for payment shall be the actual number of anchorages installed and accepted.

9.18.05--Basis of Payment: Payment for this work will be made as follows:

1. Three-Cable Guide Railing: This railing will be paid for at the contract price per linear foot (meter) for "Three-Cable Guide Railing (I-Beam Posts)," complete in place, which price shall include all materials, including reflectorized delineators and fittings, equipment, tools and labor necessary for complete installation, also all excavation, refilling and disposal of surplus material.

2. Anchorages: These will be paid for at the contract unit price each for "End Anchorage" of the type specified, complete in place, which price shall include concrete anchors, end posts with base plates, all cable and fastenings from end post to concrete anchor, anchor assemblies (compensating device), singly or in combination, all materials, fittings, equipment, tools and labor necessary for complete installation, also all excavation, refilling and disposal of surplus materials.

There will be no separate payment for the object marker at the end of the End Anchorage, Type II, but the cost shall be included in the contract bid price for "End Anchorage-Type II."

Drilling in rock or boulders and backfilling with tamped sand, where required for the installation of posts, will be paid for as "Extra Work" according to the provisions of Articles 1.04.05 and 1.09.04, as amended elsewhere herein.

Pay Item	Pay Unit
Three-Cable Guide Railing (I-Beam Posts)	l.f. (m)
End Anchorage (Type)	ea. (ea.)

SECTION 9.21

CONCRETE SIDEWALKS

9.21.01—Description: This item shall consist of concrete sidewalks constructed on a gravel or reclaimed miscellaneous aggregate base course in the locations and to the dimensions and details shown on the plans or as ordered and in accordance with these specifications.

9.21.02—Materials: Materials for this work shall conform to the requirements of Article M.03.01 for Class "C" Concrete.

Air-entraining Portland cement and air-entraining admixtures shall conform to Article M.03.01

Gravel or reclaimed miscellaneous aggregate for base shall conform to Article M.02.01 for granular fill.

The concrete sidewalk constructed as a pad adjacent to a traffic control foundation, shall conform to the requirements of Article M.03.01 for Class "A" Concrete.

9.21.03—Construction Methods:

1. Excavation: Excavation, including removal of any existing sidewalk, shall be made to the required depths below the finished grade, as shown on the plans or as directed. All soft and yielding material shall be removed and replaced with suitable material.

When connecting new concrete sidewalk to a section of existing concrete sidewalk, the connection point shall be at the nearest joint in the existing sidewalk.

2. Gravel or Reclaimed Miscellaneous Aggregate Base: The gravel or reclaimed miscellaneous aggregate base shall be placed in layers not over 6 inches (150 millimeters) in depth and to such a depth that after compaction it shall be at the specified depth below the finished grade of the walk. The base shall be wetted and rolled or tamped after the spreading of each layer.

3. Forms: Forms shall be of metal or wood, straight, free from warp and of sufficient strength to resist springing from the pressure of the concrete. If made of wood, they shall be of 2-inch (38-millimeter) surfaced plank except that at sharp curves thinner material may be used. If made of metal, they shall be of approved section and shall have a flat surface on the top. Forms shall be of a depth equal to the depth of the sidewalk. Forms shall be securely staked, braced and held firmly to the required line and grade and shall be sufficiently tight to prevent leakage of mortar. All forms shall be cleaned and oiled or wetted before concrete is placed against them. Sheet metal templates 1/8 inch (3 millimeters) in thickness, of the full depth and width of the walk, shall be spaced at intervals of 12 feet (4 meters) or as directed. If the concrete is placed in alternate sections, these templates shall remain in place until concrete has been placed on both sides of the template. As soon as the concrete has obtained its initial set, the templates shall be removed.

4. Concrete: The concrete shall be proportioned, mixed, placed, etc., in accordance with the provisions of Section 6.01 for Class "C" Concrete, except as modified herein.

The concrete shall contain not less than 5% or more than 7% entrained air at the time the concrete is deposited in the forms.

Air-entrainment shall be obtained and the concrete cured in accordance with the provisions of Article 4.01.03 for Concrete Pavement.

5. Finishing: The surface of the concrete shall be finished with a wood float or by other approved means. The outside edges of the slab and all joints shall be edged with a 1/4-inch (6-millimeter) radius edging tool. Each slab shall be divided into two or more sections by forming dummy joints with a jointing tool as directed.

6. Backfilling and Removal of Surplus Material: The sides of the sidewalk shall be backfilled with suitable material thoroughly compacted and finished flush with the top of the sidewalk. All surplus material shall be removed and the site left in a neat and presentable condition to the satisfaction of the Engineer.

9.21.04—Method of Measurement: This work will be measured for payment as follows:

1. Concrete Sidewalk: This work will be measured by the actual number of square feet (square meters) of completed and accepted concrete sidewalk.

2. Excavation: Excavation below the finished grade of the sidewalk, backfilling, and disposal of surplus material will not be measured for payment, but the cost shall be included in the price bid for the sidewalk. Excavation above the finished grade of the sidewalk will be measured and paid for in accordance with Section 2.02

3. Gravel or Reclaimed Miscellaneous Aggregate Base: This work will not be measured for payment, but the cost shall be considered as included in the price bid for the sidewalk.

9.21.05—Basis of Payment: This work will be paid for at the contract unit price per square foot (square meter) for "Concrete Sidewalk," complete in place, which price shall include all excavation as specified above, backfill, disposal of surplus material, gravel or reclaimed miscellaneous aggregate base, equipment,

tools, materials and labor incidental thereto.

Pay Item
Concrete Sidewalk

Pay Unit
s.f. (s.m)

SECTION 9.22
BITUMINOUS CONCRETE SIDEWALK
BITUMINOUS CONCRETE DRIVEWAY

9.22.01--Description: This item shall consist of bituminous concrete surfaced sidewalk or driveway constructed on either gravel or reclaimed miscellaneous aggregate base course in the locations and to the dimensions and details shown on the plans or as directed by the Engineer and in accordance with these specifications.

9.22.02--Materials: Materials for this work shall conform to the following requirements:

1. Gravel or Reclaimed Miscellaneous Aggregate: Gravel or reclaimed miscellaneous aggregate for the base course shall conform to the requirements of Article M.02.01 for granular fill.

2. Bituminous Concrete Surface: Materials for this surface shall conform to the requirements of Section M.04, Class 2.

9.22.03--Construction Methods:

1. Excavation: Excavation, including removal of any existing sidewalk, or driveway, shall be made to the required depth below the finished grade, as shown on the plans or as directed by the Engineer. All soft and yielding material shall be removed and replaced with suitable material.

2. Forms: When the bituminous concrete is spread by hand, forms shall be used. Forms shall be of metal or wood, straight, free from warp and of sufficient strength to resist springing from the impact of the roller. If made of wood, they shall be of 2-inch (38-millimeter) surfaced plank except that at sharp curves thinner material may be used; if made of metal, they shall be of an approved section. All forms shall be of a depth equal to the depth of the sidewalks or driveways and shall be securely staked, braced, and held firmly to the required line and grade. All forms shall be cleaned and oiled each time they are used.

3. Base Course: Gravel or reclaimed miscellaneous aggregate for the base course shall be uniformly spread upon to the required depth and thoroughly compacted with a roller with a mass of not less than 500 pounds (226 kilograms).

4. Bituminous Concrete Surface: This surface shall be constructed in accordance with the requirements of Section 4.06, except that the material may be spread by hand and thoroughly compacted by multiple passes of a roller weighing (with a mass) of not less than 500 pounds (226 kilograms).

5. Backfilling and Removal of Surplus Material: The sides of the sidewalk or driveway shall be backfilled with suitable material thoroughly compacted and finished flush with the top of the sidewalk or driveway. All surplus material shall be removed and the site left in a neat and presentable condition to the satisfaction of the Engineer. In sections inaccessible to the roller, the base course, surface course and backfill shall be hand-tamped with tampers weighing not less than 12 pounds (with a mass of not less than 5.5 kilograms), the face of which shall not exceed 50 square inches (32,000 square millimeters) in area.

9.22.04 Method of Measurement: This work will be measured for payment as follows:

1. Bituminous Concrete Driveway--Bituminous Concrete Sidewalk: This work will be measured by the actual number of square yards (square meters) of completed and accepted sidewalk or driveway.

2. Excavation: Excavation below the finished grade of the sidewalk or driveway, backfilling, and disposal of surplus material will not be measured for payment; but the cost shall be included in the price bid for the sidewalk or driveway. Excavation above the finished grade of the sidewalk or driveway will be classified and paid for in accordance with Section 2.02

3. Gravel or Reclaimed Miscellaneous Aggregate Base: This work will not be measured for payment but the cost thereof shall be included in the price bid for the sidewalk or driveway.

9.22.05--Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Bituminous Concrete Sidewalk" or "Bituminous Concrete Driveway," as the case may be, complete in place, which price shall include all excavation as specified above, backfill, disposal of surplus material, gravel or reclaimed miscellaneous aggregate base, and all equipment, tools, labor and materials incidental thereto.

Pay Item	Pay Unit
Bituminous Concrete Sidewalk	s.y. (s.m)
Bituminous Concrete Driveway	s.y. (s.m)

SECTION 9.23

BITUMINOUS CONCRETE FOR PATCHING

9.23.01—Description: The work under this item shall consist of the temporary patching of any pavement surfaces or pedestrian passways which have become rutted, broken, damaged or otherwise unserviceable, and at such other locations as the Engineer may designate.

9.23.02—Materials: The materials furnished and used in this work shall conform to the requirements of Section 4.06 and M.04. The specific material to be used for patching shall be as directed by the Engineer and shall be one of the following Class 2, 3, 5, 5A, 5B or 12.

9.23.03—Construction Methods: Patching shall be done only at the locations and at such time as is deemed necessary by the Engineer. Prior to placing the patching material, the areas to be patched shall be cleaned of dirt and other debris and shall be reasonably dry. Compaction of the patching material shall be attained by methods approved by the Engineer.

9.23.04—Method of Measurement: The quantity of material to be included for payment will be determined by the net weight (mass), in tons (metric tons), measured in the hauling vehicles furnished by and at the expense of the Contractor. The scales shall be a type satisfactory to the Engineer and shall be sealed. An inspector, to be appointed and compensated by the Department, shall check the weight (mass measurements) of all material entering into construction. The total weight (mass) will be the summation of the weigh slips of bituminous concrete actually incorporated in the work included under this item.

9.23.05—Basis of Payment: This work will be paid for at the contract unit price per ton (metric ton) for "Bituminous Concrete for Patching," complete in place, which price shall include furnishing all materials, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Bituminous Concrete for Patching	ton (t)

**SECTION 9.24
CONCRETE DRIVEWAY RAMPS**

9.24.01—Description: This item shall consist of concrete driveway ramps constructed on a granular fill base in accordance with the Contract.

9.24.02—Materials: Materials for this work shall conform to the following requirements:

1. **Portland Cement:** Concrete shall conform to the requirements of Article M.03.01 for Class "C" Concrete.

2. **Granular Fill Base:** Granular fill shall conform to the requirements of Article M.02.01.

3. **Reinforcement:** Shall conform to the requirements of Article M.06.01.

9.24.03—Construction Methods: Construction methods shall conform to the requirements of Article 9.21.03. The surface shall be finished and marked off as directed by the Engineer.

9.24.04—Method of Measurement: This work will be measured for payment as follows:

1. **Concrete Driveway Ramps:** This work will be measured for payment by the actual number of cubic yards (cubic meters) of completed and accepted concrete driveway ramp.

2. **Excavation:** Excavation below the finished grade of each ramp, backfilling and disposal of surplus material will not be measured for payment; but the cost shall be included in the Contract price for Concrete Driveway Ramps.

Excavation above the finished grade of each ramp will be classified and paid for in accordance with Section 2.02.

3. **Granular Fill Base:** This work will not be measured for payment, but the cost shall be included in the Contract price for Concrete Driveway Ramps.

4. **Reinforcement:** This material will not be measured for payment, but the cost shall be included in the Contract price for Concrete Driveway Ramps.

9.24.05—Basis of Payment: This work will be paid for at the Contract unit price per cubic yard (cubic meter) for "Concrete Driveway Ramps," complete in place, which price shall include all excavation as specified above, backfill, disposal of surplus materials, and all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Concrete Driveway Ramps	c.y. (cu. m)

**SECTION 9.25
PAVEMENT FOR RAILING**

9.25.01—Description: The work under this item shall consist of any excavation found necessary for the placing of a course of bituminous concrete, shaping and compacting of the foundation material for the bituminous concrete, and the furnishing and placing of a single course of bituminous concrete at locations where rail or railing is to be constructed in accordance with the limits and details shown in the plans or as directed by the Engineer.

9.25.02—Materials: The bituminous concrete mix, materials for the bituminous concrete mixture, source of supply, formula for mix, mix tolerances, approval of mix formula and the control of the mixture shall conform to the requirements of Section M.04, Class 3.

9.25.03—Construction Methods: The work required under this item shall be completed before the posts for the rail or railing are erected. Where an underground anchorage or terminal treatment is to be constructed, the bituminous concrete shall be placed after the underground portion of the anchorage or terminal treatment is installed.

The bituminous concrete shall be constructed in accordance with the requirements of Article 4.06.03 except that the following subarticles shall not apply: 1—Samples, 7—Paving Equipment, 8—Placing of Mixture, 9—Compaction, 10—Surface Test of Pavement and 11—Joints. The asphalt percentage shall be increased up to an additional 1% of the total weight (mass) of the mixture at no additional cost to the State when compaction method cannot obtain 95% density.

Where possible, appropriate paving equipment shall be used to spread the bituminous concrete. Upon arrival, the mixture shall be dumped into the spreader and immediately spread and stuck off to the full width required and to a uniform layer of such depth as will result in a completed, compacted course having the designed depth.

Where it is impossible to place the bituminous concrete by the use of paving equipment, the material shall be spread by hand. The mixture, upon arrival, shall be dumped on approved steel dump sheets outside of the area on which it is to be spread and shall then be immediately distributed into place by use of hand shovels and spread with metal lutes in a uniform layer of such depth as will result in a completed, compacted course having the designed depths.

The Engineer may direct that other means of placing the material be used to insure better control of the depth of material and surface finish.

After spreading, and when sufficient set has developed to permit proper compaction, the course of bituminous concrete shall be compacted by rolling with a suitable roller. The roller shall be a self-propelled, steel wheel roller of a weight (mass) necessary to accomplish an acceptable compaction without displacing the material horizontally to a greater degree than the material is compacted vertically. The rolling shall be continued until the material is compacted to the satisfaction of the Engineer. Rolling shall be discontinued if the surface shows signs of excessive cracking or displacement and shall be continued later as directed by the Engineer.

In all places inaccessible to a roller, such as adjacent to anchorage or terminal treatment, etc., the required compaction shall be secured with tamps.

If the bituminous concrete course is depressed or damaged due to the installation of the rail or railing post, it shall be replaced or repaired to the satisfaction of the Engineer.

Unless specifically authorized by the Engineer, the mixture shall be laid only when the atmospheric temperature in the shade is not less than 40°F (4°C), the weather is not foggy or rainy and the surface is free of frost and dried to the satisfaction of the Engineer.

The Engineer may, however, permit work of this character to continue when overtaken by sudden storms up to the amount which may be in transit from the plant at the time, provided the mixture is within temperature limits specified. The mixture, at the time of placement, shall be within 25°F (±) (14°C (±)) of the temperature specified in the approved mix formula, unless, in the opinion of the Engineer, job conditions warrant varying these limits.

9.25.04—Method of Measurement: This work will be measured for payment by the actual number of square yards (square meters) of pavement for railing completed and accepted within the lines, to the grade and of the thickness shown on the plans or as ordered by the Engineer. Excavation, disposal of excavated material, and the repairing or replacing of any damaged bituminous concrete will not be measured for payment.

9.25.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Pavement for Railing" which price shall include all excavation, disposal of excavated material,

repairing or replacing of the bituminous concrete, materials, tools, labor and equipment incidental thereto.
No direct payment will be made for excavation or any other item connected with this work.

Pay Item	Pay Unit
Pavement for Railing	s.y. (s.m)

SECTION 9.30
OBJECT MARKER

9.30.01—Description: This item shall consist of furnishing and installing an object marker at locations shown on the plans or as ordered and in accordance with these specifications.

9.30.02—Materials: Aluminum sign blanks shall conform to the requirements of Article M.18.13.

Reflective sheeting shall conform to the requirements of Article M.18.09.

Silk screening shall conform to the requirements specified by the reflective sheeting manufacturer.

Steel posts shall conform to the requirements of Article M.18.14.

Sign mounting bolts and nuts shall conform to the requirements of Article M.18.15.

9.30.03—Construction Methods: Object marker posts shall be erected to the elevation and at locations shown on the plans. They shall be set vertically, facing the direction noted on the plans or as directed by the Engineer.

Posts shall be driven by approved methods and equipment that will provide the posts in their final position, free from any distortion and burring or any other damage. The panel shall be attached after the posts are driven.

The black legend shall be applied by either the silk screen process or by the application of pressure sensitive opaque film.

9.30.04—Method of Measurement: The number of object markers to be included for payment shall be the number of each type of object markers installed and accepted.

9.30.05—Basis of Payment: This work will be paid for at the contract unit price for each type of "Object Marker," complete in place, which price shall include all panels, posts, hardware, materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Object Marker (Type)	ea. (ea.)

SECTION 9.39
SWEEPING FOR DUST CONTROL

9.39.01—Description: This item shall consist of furnishing a pickup sweeper and accessory equipment and utilizing it for the removal of earth and/or other dust producing materials from paved surfaces for the purpose of allaying dust conditions.

9.39.03—Construction Methods: The Contractor shall have available and maintain in an operable condition equipment capable of efficiently sweeping up earth and/or other materials from paved surfaces. This equipment shall include suitable provisions for the application of water ahead of the sweeping brooms to prevent dusting, for the pickup, internal storage and removal of sweepings, and for the cleaning of areas of heavy accumulation beyond the capacity of the sweeper.

The sweeping operations shall be under the control of the Engineer at all times. Sweeping shall take place at locations and times directed by the Engineer. The disposal of all sweepings shall meet with the approval of the Engineer.

9.39.04—Method of Measurement: Sweeping will be measured for payment by the number of hours of actual sweeping activity by the pickup sweeper or other mechanized equipment necessary for the removal of earth or dust producing materials from paved surfaces as directed by the Engineer and/or in the Contract.

9.39.05—Basis of Payment: Sweeping will be paid for at the Contract unit price per hour for "Sweeping For Dust Control," which price shall include the furnishing of all equipment, water, tools, labor and work incidental thereto. This price shall also include the maintenance of the pickup sweeper for the life of the Contract.

Pay Item	Pay Unit
Sweeping for Dust Control	hr. (hr.)

SECTION 9.41
SERVICE BRIDGES

9.41.01—Description: This item shall consist of the construction, placing and removal of service bridges constructed in accordance with these specifications and erected where indicated or directed. The purpose of these bridges is to permit traffic to cross over open trenches or newly constructed sections of concrete pavement or concrete base course without injury to the concrete.

9.41.02—Materials: The timber for these bridges shall be sound, durable material, capable of carrying safely the required loads and shall be of the dimensions shown on the plans. All fittings, nails, etc., shall be in accordance with standard commercial specifications and shall be approved by the Engineer.

9.41.03—Construction Methods: These service bridges shall be built in accordance with the requirements of the plan. They shall be connected by suitable approaches, built of material that can be maintained in a reasonably smooth and useable condition at all times. The Contractor shall maintain the service bridges and approaches by renewing and repairing any places which may have become worn or damaged, and he shall keep the whole at all times in a suitable condition for the use of traffic until no longer required. Upon orders from the Engineer, the Contractor shall remove the service bridges and approaches and leave the site in a neat and presentable condition to the satisfaction of the Engineer.

9.41.04—Method of Measurement: This work will be measured for payment as units. Every location at which a service bridge is constructed will be considered a unit. Should the Engineer order more than one service bridge constructed at one location in order to provide for a wider crossing, each bridge shall be considered as one separate unit.

9.41.05—Basis of Payment: This work will be paid for at the contract unit price each for "Service Bridge," complete in place, which price shall include all material, tools, equipment and labor incidental thereto; also all necessary approach work, maintenance of structure and approaches while in use, and the final removal of the structure and approaches, and cleaning up the site when no longer required.

Pay Item
Service Bridge

Pay Unit
ea. (ea.)

SECTION 9.42

CALCIUM CHLORIDE FOR DUST CONTROL

9.42.01—Description: This item shall consist of furnishing calcium chloride and spreading it on the subgrade or in other areas of a project under construction, for the purpose of allaying dust conditions.

9.42.02—Materials: Calcium chloride shall conform to the requirements of AASHTO M 144, except that the pellet form and the flake form shall be equally acceptable.

9.42.03—Construction Methods: Calcium chloride shall be applied only at the locations, at such times and in the amount as may be directed by the Engineer. It shall be spread in such a manner and by such devices that uniform distribution is attained over the entire area on which it is ordered placed.

9.42.04—Method of Measurement: Weights (Masses) as marked on the shipping containers shall be used; or if directed by the Engineer, scales shall be furnished by and at the expense of the Contractor, and the calcium chloride weighed (measured) in a manner satisfactory to the Engineer.

9.42.05—Basis of Payment: Payment for this work will be made at the contract unit price per ton (metric ton) for "Calcium Chloride for Dust Control," which price shall include all material, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Calcium Chloride for Dust Control	ton (t)

**SECTION 9.43
WATER FOR DUST CONTROL**

9.43.01—Description: This item shall consist of furnishing water equipment, water, and applying it for the purpose of allaying dust conditions.

9.43.03—Construction Methods: The application of water shall be under the control of the Engineer at all times. It shall be applied only at locations at such times, and in the amount as may be directed by the Engineer. Quantities of water wasted or applied without authorization will not be paid for.

The Contractor shall have available and maintain in an operable condition at all times, sufficient equipment for the purpose of applying water for dust control. This equipment shall consist of pipelines, tanks, tank-trucks, pumps, meters, hose, distributors or other devices approved by the Engineer. A suitable device for a positive shutoff and for regulating the flow of water shall be located so as to permit positive operator control.

9.43.04—Method of Measurement: This work will be measured for payment by the number of m. gallons (kiloliters). The water will be measured in tanks or tank-trucks of predetermined capacity, or by means of satisfactorily installed meters. Any and all measuring devices shall be furnished by the Contractor.

9.43.05—Basis of Payment: This work will be paid for at the contract unit price per m. gallon (kiloliter) for "Water for Dust Control," which price shall include all water, labor, and equipment including devices to measure and apply to surfaces designated by the Engineer and at the times specified.

This price shall also include all work necessary to erect, relocate, re-erect, and dismantle the entire water equipment system.

Pay Item	Pay Unit
Water for Dust Control	m. gal. (kL)

**SECTION 9.44
TOPSOIL**

9.44.01--Description: This work shall consist of furnishing, placing and shaping topsoil in areas shown on the plans or where directed by the Engineer. The topsoil shall be placed to a depth of 4 inches (100 mm) unless stated otherwise in the contract.

9.44.02--Material: The material shall conform to the requirements of Subarticle M.13.01-1.

9.44.03--Construction Methods: The areas on which topsoil is to be placed shall be graded to a reasonably true surface. Topsoil shall then be spread and shaped to the lines and grades shown on the plans, or as directed by the Engineer. The required depth to which the topsoil is to be placed is to be the depth after settlement of the material has taken place. All stones, roots, debris, sod, weeds and other undesirable material shall be removed. After shaping and grading, all trucks and other equipment shall be excluded from the topsoiled area to prevent excessive compaction. The Contractor shall perform such work as required to provide a friable surface for seed germination and plant growth prior to seeding.

During hauling and spreading operations, the Contractor shall immediately remove any material dumped or spilled on the shoulders or pavement.

It shall be the Contractor's responsibility to restore to the line, grade and surface all eroded areas with approved material and to keep topsoiled areas in acceptable condition until the completion of the construction work.

9.44.04--Method of Measurement: This work will be measured for payment by the number of square yards (square meters) of area on which the placing of topsoil has been completed and the work accepted.

9.44.05--Basis of Payment: Payment for this work will be made as follows:

1. Furnishing and Placing Topsoil: This work will be paid for at the contract unit price per square yard (square meter) for "Furnishing and Placing Topsoil" which price shall include all materials, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Furnishing and Placing Topsoil	s.y. (s.m)

**SECTION 9.45
WILDFLOWER ESTABLISHMENT**

9.45.01—Description: The work included in this item shall consist of providing an accepted stand of established wildflowers by furnishing and placing seed, and mulch on all areas to be treated as shown on the plans or where designated by the Engineer.

9.45.02—Materials: The materials (mulch) for this work shall conform to the requirements of Article M.13.05.

Wildflowers shall be from commercial seed suppliers.

9.45.03—Construction Methods: Construction methods shall be those established as agronomically acceptable and feasible and which are approved by the Engineer.

1. Preparation of the Seedbed:

(a) Level areas, medians, interchanges and lawns: These areas shall be made friable and receptive for seeding by discing or by other approved methods to the satisfaction of the Engineer. In all cases the final prepared and seeded soil surface shall meet the lines and grades for such surface as shown in the plans, or as directed by the Engineer.

(b) Slope and Embankment Areas: These areas shall be made friable and receptive to seeding by approved methods which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.

(c) All areas to be seeded shall be reasonably free from weeds taller than 3 inches (75 millimeters). Removal of weed growth from the slope areas shall be by approved methods, including hand mowing, which do not rut or scar the slope surface, or cause excessive disruption of the slope line or grade. Seeding on level areas shall not be permitted until substantially all weed growth is removed.

2. Seeding Season: The calendar dates for seeding shall be:

Spring—March 1 to May 15

Fall—November 15 to December 15

3. Seeding Methods: The wildflower seed mixture shall be applied by an agronomically acceptable procedure. The rate of application shall be shown on the plans or directed by the Engineer.

9.45.04—Method of Measurement: The quantity for which payment will be made will be the number of pounds (kilograms) of each size and kind of wildflower seed counted, planted and accepted.

9.45.05—Basis of Payment: Payment for this work will be made at the contract unit price, per pound (kilogram) for the kind of wildflower seed, completed and accepted in place, which shall include all materials, equipment, tools, labor, transportation, operations, and all work incidental thereto.

Pay Item	Pay Unit
(Wildflower Name)	lb. (kg)

**SECTION 9.46
LIMING**

9.46.01—Description: The work included under this item consists of furnishing and placing agricultural ground dolomitic limestone on those areas designated by the Engineer.

9.46.02—Material: Agricultural ground dolomitic limestone shall conform to the requirements of Article M.13.02.

9.46.03—Construction Methods: On the basis of the subsequent tests, the Contractor shall apply limestone to such areas and in such amounts as the Engineer may direct. The limestone may be applied by any approved method.

9.46.04—Method of Measurement: This work will be measured for payment by the actual number of tons (metric tons) of limestone applied and accepted within the limits designated by the Engineer.

9.46.05—Basis of Payment: This work will be paid for at the contract unit price per ton (metric ton) for "Liming," which price shall include all materials, equipment, tools labor and work incidental thereto.

Pay Item	Pay Unit
Liming	ton (t)

SECTION 9.47
BUS PASSENGER SHELTER

9.47.01—Description: This item shall consist of the furnishing and installation of bus passenger shelters in the locations as shown on the plans or directed by the Engineer.

9.47.02—Materials:

1. The framework material shall conform to ASTM B221, alloy 6061-T6, or alloy 6063-T5 or T6 aluminum, and shall be anodized in accordance with the project plans or specifications.
2. The glazing shall be bronze tinted, coated polycarbonate with an abrasion resistance of 1.2 change in percent haze, or greater when tested in accordance with ASTM D-1044. It shall have a minimum flexural strength of 13,000 psi (90 megapascals) when tested in accordance with ASTM D-790.
3. The roof shall not be transparent. It shall have sufficient strength for the purpose intended, and shall be fully weatherproof. Proper seals and drainage shall be provided to prevent water or ice from entering the shelter. All drains shall be directed away from the shelter and its entranceways.
4. The hardware shall either be aluminum conforming to ASTM B211, alloy 2024-T4, or stainless steel conforming to ASTM A167, alloy 304. Anchor bolts shall be either stainless steel conforming to ASTM A167, alloy 304, or steel conforming to ASTM A36. The A36 steel anchor bolts shall be galvanized in accordance with the requirements of ASTM A153.
5. Concrete shall be Class "C" in accordance with Article M.03.01.
6. There shall be a seat in the shelter with a width of 12 to 15 inches (305 millimeters to 380 millimeters). The seat shall include a backrest with a minimum width of 8 inches (200 millimeters). The seat and backrest shall be constructed of the same material and may be built as an integral unit. The material utilized is optional but shall be limited as follows:

Bare metal shall not be utilized. The rate of thermal conductance of the material shall be comparable to that of wood or molded fiberglass. Examples of acceptable materials are wood, fiberglass, high impact thermoplastic, and plastic coated (bonded) aluminum.

All wood surfaces shall be protected from warping, swelling, checking, and shrinking. The wood shall be finished with three coats of polyurethane finish.

The seat shall be vandal resistant and maintenance free; and it shall have no burrs, splinters, sharp edges or corners, nor any other shortcomings that will pose a hazard to personnel using the seat.

The seat shall afford reasonable comfort to the user and shall be of such design as to allow for drainage of liquids that may be spilled on it. The color and design of the seat shall be consistent with other portions of the shelter.

The seat and its supports shall be designed to accommodate a load of 120 pounds per lineal foot (1750 newtons per meter) without appreciable deflection. Appreciable deflection shall be considered to be any deflection over 1/8 inch in 3 feet (3 millimeters in a meter) in any direction. The supports shall be attached to the shelter frame at every vertical member, both posts and mullions, along the back wall panel. The support-to-frame attachments shall be made in such a manner that the fasteners will be subjected to shearing stress only.

The top of the backrest shall be at least 13 inches (330 millimeters) above the seat surface, and the seating surface shall be 17 inches (432 millimeters) above the floor. Lengths of both backrest and seat shall be such that the ends are 4 inches (100 millimeters) clear of one of the end walls and 36 inches (1 meter) clear of the opposite wall to permit a seating area for wheelchair patrons.
7. Anchor bases shall be provided for all shelter posts. The material shall be the same as the framework, and the hardware shall be of the same material as specified above. Any exposed hardware shall not protrude into the entrance areas, and shall be vandal resistant.
8. A schedule holder shall be provided in the panel closest to the front of the shelter at the end farthest from an approaching bus. Glazing on the inside of the holder shall be clear rather than tinted and conform to the specifications for "glazing" stated herein. The minimum size of the schedule holder shall be 36 inches (1 meter) long and the width of one window panel. It shall be 36 inches (1 meter) above the shelter floor.

The holder shall include a locking or sealing assembly that is tamperproof and will not allow the insertion of foreign materials, but will provide easy access by employees for frequent changes in schedule information. No padlocks or key-type cabinet locks will be used. One edge of the holder shall be hinged. Fasteners used in the locking and sealing assembly shall have a maximum spacing of 12 inches (300 millimeters) on the side opposite the hinge.
9. All components of the shelter are to be designed with attention to a clean appearance and a tamper-

proof assembly. No regular, phillips, hex, or square head screws or bolts will be used except where approved and concealed. The Contractor shall submit, for approval, the type(s) of security fasteners if other than aluminum flush-break rivets. All fasteners shall be of the same material as stated herein, and shall be of the same color as the surrounding material.

10. The shelter shall be designed to support safely a uniform live load of 40 pounds per square foot (mass of 1900 pascals), plus a uniform load of 75 pounds per lineal foot (mass of 1100 newtons per meter) applied along the edge of front fascia, or if there are intermediate supports along the front, point load of 400 pounds (1800 newtons) each applied at the front fascia at midpoints between intermediate supports. The horizontal wind force shall be 15 pounds per square foot (720 pascals), and the uplift wind force shall be 18 pounds per square foot (860 pascals).

All structural components shall be designed so that, upon completion of construction, the shelter shall act as an integral unit and be free of any structurally detrimental movement.

11. The Contractor shall submit structural calculations and plans for approval in accordance with Article 1.05.02 a minimum of four weeks before performing any fabrication or on-site work for the shelter. The working drawings shall show materials, alloys, dimensions, sizes, thicknesses, gauges, tempers, colors, finishes, joining details, attachments, minimum foundation requirements, and relationship of work to any adjoining construction that may be in progress.

The plans and working drawings shall be stamped by a Professional Engineer registered in the State of Connecticut.

Certified Tests Reports and Materials Certificates, showing compliance with the provisions of these specifications shall be submitted in accordance with Article 1.06.07.

9.47.03—Construction Methods:

The bus passenger shelter shall be installed at the location indicated on the plan or as directed by the Engineer. The shelter shall be plumb, level, true, neat, rigid, and in accordance with approved working drawings, pertinent sections of the Connecticut Basic Building Code, and these specifications.

Field welding shall not be allowed without prior approval. Where shop welding is required, the working drawings shall show all pertinent information and locations.

Shelters requiring special foundations because of shelter design, (i.e., those which cannot be attached directly to an existing sidewalk slab) shall have working drawings delineating the necessary foundation work.

The dimensions of the completed bus shelter shall be a minimum of 5 feet wide and 12 feet long (1.5 meters x 3.6 meters), measured from center to center of the walls. The height shall be a minimum of 7 feet 6 inches (2.3 meters) from the floor to the lowest part of the roof or overhang.

The open area between the floor and the bottom of the panels shall not exceed 8 inches (200 millimeters).

All bus shelters constructed under this item shall have a front "wind screen." The wind screen shall be of panel construction, including glazing and anchorages identical to that provided for the back wall. Two entrances shall be provided for each shelter. They each shall be a minimum of 36 inches (915 millimeters) to a maximum of 40 inches (1016 millimeters) wide. In areas where the distance from the sidewalk curb to the front shelter fascia is less than 42 inches (1067 millimeters), the entrances shall be on the side walls. Where the distance from curb to fascia is 42 inches (1067 millimeters) or more, entrances may be placed in either the front wind screen or the side wall. In no case shall the clear opening between vertical supports be less than 3 feet (1 meters) wide. In order to ensure accessibility for the handicapped, the shelter shall be located, unless otherwise directed by the Engineer, in an area where there are no poles, posts, sidewalk furniture, or impediments to the handicapped, within a 4-foot (1.2-meter) radius of the vertical support that is closest to the curb. The wind screen, unless otherwise directed, shall be to the front of the shelter, which is defined as the longitudinal face closest to the designated bus stop.

All exposed surfaces and edges shall be smooth, free from burrs, slivers and other projections and neatly finished. All parts are to be manufactured so as to allow interchangeability of components.

All clamps used to fabricate or install the shelter shall be adequately padded to prevent scarring to the material surfaces. The shelter materials shall be adequately protected to prevent scarring or damaging of the various surfaces during shipment.

Prior to installation of glazing in its panel, the protective material (masking) shall be removed around the perimeter only. The amount of material to be removed shall be the engagement width plus a 1/4 inch (6 millimeters). The protective material shall not be removed by cutting or scarring the glazing in any way. The remainder of the material shall be removed cleanly only after the panel is completely secured in its respective frame.

Plastic glazing shall be regarded as a finishing operation and shall be scheduled as one of the last steps in the completion of the shelter. When material is supplied masked, the masking paper should not be exposed to sunlight for longer than 15 minutes to avoid the deposition of adhesive residues.

Any residue left on the glazing material shall be completely removed, utilizing a process recommended by the glazing manufacturer. Any panels that are, in the opinion of the Engineer, excessively scratched or hazed shall be replaced by the Contractor at his own expense.

The framework shall be designed so that glazing material is securely engaged and able to withstand vandalism without disengaging, secured with tamper-proof fasteners such as aluminum flush-break rivets, and be able to resist the prying out of panels by vandals. The assembly design shall provide for each glazing replacement when the need arises. Each glazing frame shall provide for a minimum engagement width of 1/2 inch (13 millimeters), but in no case shall it be less than the width recommended by the glazing manufacturer.

If the Contractor's work results in any damage, it will be his responsibility to restore or repair the damaged items or properties to the Engineer's satisfaction. Any costs involved will be borne solely by the Contractor.

The Contractor shall remove all excess materials and restore the work area to its original condition.

Immediately prior to acceptance, the Contractor shall clean the entire shelter in strict accordance with the various materials manufacturers' published directions.

9.47.04—Method of Measurement:

This work shall be measured for payment by the number of bus passenger shelters completely installed and accepted in place.

9.47.05—Basis of Payment:

This work will be paid for at the contract unit bid price each for "Bus Passenger Shelter," and this price shall include all materials, equipment, labor, tools, and work incidental thereto. In those locations where the Engineer determines that the existing sidewalk slab will not safely support the shelter, replacement of the sidewalk slab will be paid for under the appropriate items or as extra work in the absence thereof.

Special foundations required because of the design of the shelter will be paid for by the Contractor.

Pay Item	Pay Unit
Bus Passenger Shelter	ea. (ea.)

SECTION 9.49
FURNISHING, PLANTING and MULCHING
TREES, SHRUBS, VINES and GROUND COVER PLANTS

9.49.01--Description

9.49.02--Materials

9.49.03--Construction Methods

9.49.04--Method of Measurement

9.49.05--Basis of Payment

9.49.01--Description: The work under these items shall consist of furnishing, planting and mulching trees, shrubs, vines and ground cover plants of the type and size indicated on the plans or special provisions. It shall also include all incidental operations, such as the care of the living plants and the replacement of dead and unsatisfactory plants or unsatisfactory materials before final acceptance of the contract.

9.49.02--Materials: The material for this work shall conform to the requirements of Section M.13.

9.49.03--Construction Methods: Construction methods shall be performed in accordance with these specifications.

The Contractor is cautioned that within the limits of any project, buried cable for illumination or utilities, which may be energized, may be present.

1. Planting Season: Unless otherwise shown on the plans or directed by the Engineer, the planting seasons shall be those indicated below. No planting shall be done in frozen ground or when snow covers the ground, or the soil is otherwise in an unsatisfactory condition for planting.

Deciduous Material - Spring: March 1st to May 1st (inclusive) except for balled and burlapped material, the planting of which will terminate on May 15th.

- **Fall:** From October 15th until the ground freezes. Such plant items, as may be designated elsewhere in the contract documents, shall be planted in the spring planting season only.

Evergreen Material - Spring: March 1st to June 1st (inclusive).

- **Fall:** August 15th to October 1st (inclusive).

2. Protection: Plants received by the Contractor shall be kept moist, fresh and protected against exposure to sun, wind and freezing temperatures whether in the receiving yard, in transit, while being handled or in temporary storage on the job site awaiting planting. Bare-root plants, which are not planted immediately upon receipt, shall be heeled-in in trenches with the bundles opened, the plants separated and all roots covered so as to leave no air spaces. Balled and burlapped plants shall have their earth balls covered by earth, wood chips, cloth, straw or other suitable material which shall be kept moist.

3. Layout: Plant material locations and bed outlines will be staked on the project site by the Engineer-Designer or his designee in the presence of the Contractor, or his representative, before any plant pits or beds are excavated. Request by the Contractor for the staking of the plant layout shall be at least 48 hours, excluding weekends and holidays, prior to the date he wishes to have the layout staked. Labor, equipment and new, smooth stakes of approved quality are to be furnished by the Contractor for this purpose.

4. Excavation: Excavation for planting beds and pits shall conform to the approved staked locations and outlines. The latter shall be neatly formed by means of spades or other approved tools. All sod, weeds, roots and other objectionable material excavated from the plant beds or pit sites which are unsuitable for backfill shall be removed from the site immediately and disposed of by the Contractor in a manner satisfactory to the Engineer.

The Contractor at his option may apply, prior to excavating plant pits in designated planting bed locations, at no expense to the State, a post-emergent aqueous spray treatment of Glyphosate (isopropylamine salt of glyphosate) 41% acid equivalent (ae) to the existing bed vegetation in accordance with the manufacturer's recommendations for perennial vegetation control, instead of excavating the planting bed.

A minimum of fourteen (14) days post application, or when the perennial species shows the visible effects of the treatment, the Contractor shall mow, at no expense to the State, all treated bed areas to a maximum height of 4 inches (100 millimeters).

Plant pits may then be excavated, and the excavated soil and vegetative debris shall then be immediately removed from the project site.

In planting bed areas following the excavation of the pits, but before the installation of plant material, the remaining turf grasses and unwanted vegetation shall be sprayed, unless otherwise directed by the Engineer, with Glyphosate at the manufacturer's recommended rate.

5. Pits: Size of pits, in earth excavation, shall bear the following relation to the spread of the roots (or the diameter of balls) of the plants to be planted in them:

Pit diameters shall be twice the rootspread up to and including a 2-foot (600-millimeter) rootspread.

Pit diameters shall be 2 feet (600 millimeters) greater than that for rootspreads of 2 to 4 feet (600 millimeters to 1200 millimeters).

Pit diameters shall be one and one-half times the rootspread diameter for rootspreads of over 4 feet (1200 millimeters).

The depth of all pits shall be adequate to permit a minimum of 12 inches (300 millimeters) of soil backfill under all roots or balls. Pits for vines shall be at least 10 inches (250 millimeters) in diameter and 10 inches (250 millimeters) in depth.

Any excavation in excess of that required shall be replaced with planting soil.

6. Obstructions Below Ground: Any rock or underground obstruction shall be removed to the depth necessary for planting as specified, unless other locations for the planting are approved by the Engineer.

7. Preparation of Backfill: The planting soil shall be delivered to the project site and stockpiled. The peat shall be delivered to the project site in containers conforming to Subarticle M.13.07-13. The planting soil and peat shall be thoroughly mixed on the project site, in the presence of the inspector, at the rate of one part of peat to two parts of planting soil.

8. Setting Plants: All plants shall be set plumb and at such a level that after settlement they bear the same relation to the surrounding ground as they bore to the ground from which they were dug. Backfill material for all plants shall be thoroughly and properly settled by firming or tamping. Thorough watering shall accompany backfilling unless otherwise approved. Saucers capable of holding water shall be formed about individual plants (exclusive of plant beds) by placing ridges of planting soil around each, or as directed by the Engineer.

Balled or burlapped plants shall be carefully placed in the prepared pits so that the balls rest on the backfill material. Planting soil and peat backfill shall then be filled in around the plant ball and thoroughly tamped. The remaining burlap around the ball shall then be loosened and spread out away from the plants or cut away and removed. Such roots as may have been wrapped around the ball and contained within the burlap shall be straightened and the remainder of the pit filled with tamped planting soil and peat mixture, making certain that no air pockets remain. The bare roots plants shall be properly spread out in a natural position and planting soil and peat backfill carefully worked in among them. All broken or frayed roots shall be cleanly cut off.

9. Fertilizing: Shrub beds shall be fertilized at the rate of 3 pounds per 100 square feet (1.3 kilograms per 9 square meters) of surface area (broadcast). The fertilizer shall be uniformly applied to the surface of the beds and worked into the upper 2 inches (50 millimeters) of soil. Individual trees shall be fertilized at the rate of 2 pounds per inch (1 kilogram per 25 millimeters) of trunk diameter, and the fertilizer shall be mixed into the upper 2 inches (50 millimeters) of soil.

A second application of fertilizer shall be applied to all plant items at the same specified rates over the wood-chip mulch at the end of the period of establishment.

10. Watering: All plants shall be watered within 48 hours after planting if conditions warrant, and as many times thereafter as ordered by the Engineer. At each watering, the soil around each plant shall be thoroughly saturated. All plants shall be watered at least once a week from April 1st to October 1st, inclusive, or as directed by the Engineer.

11. Guying and Staking: Immediately after planting, trees shall be guyed or staked as shown on the planting detail sheet of the plans, or as directed by the Engineer. Guy wires, hose and tree support stakes shall be removed after the initial establishment period.

12. Wrapping: Wrapping shall be placed around all trunks of deciduous trees 2 inches (50 millimeters) or more in caliper or as directed by the Engineer. The wrapping shall start at the base of trees, shall cover the entire trunk surfaces, and shall terminate at the first branches. The wrapping shall be tied at top, bottom, and at intervals of not more than 2 feet (600 millimeters). Wrapping shall be done at the time of planting but not before inspection of the plant.

13. Pruning: As directed by the Engineer, plants shall be pruned at the project site before or immediately after planting in accordance with the best horticultural practice. No leader shall be cut unless directed by the Engineer. Broken, or badly bruised branches, sucker growth, etc., shall be removed with clean cuts. Cuts over 3/4 inches (20 millimeters) in diameter shall be painted with tree wound paint.

14. Spraying: Spraying with antidesiccant shall be at the Contractor's discretion and as approved by the Engineer at no additional cost to the State.

15. Mulching: Following the plant material installations woodchip mulch (or gravel mulch when specifically called for on the plans or in the special provisions) shall be hand placed and spread to a depth of 4

inches (100 millimeters) and raked to an even surface over all saucer areas for individual trees and shrubs and over the entire area of shrub beds and elsewhere as directed.

16. Repair: Repair of existing grass areas damaged by the Contractor in the progress of his work shall be the responsibility of the Contractor, who shall restore the disturbed areas to their original condition at no additional expense to the State.

17. Establishment Period: The acceptability of the plant material furnished and planted shall be determined at the end of a period of establishment during which period the Contractor shall, as necessary, employ all possible means to preserve the plants in a healthy and vigorously growing condition to insure their successful establishment.

During this period, the Contractor shall water, cultivate, prune the plants, and repair, replace or readjust guy wires, stakes, posts and flagging, as may be required or as ordered by the Engineer. He shall reshape plant saucers, repair washouts and gullies, replace lost wood-chip mulch, keep all planting sites free from weeds, and do other work necessary to maintain the plants in a healthy growing condition. This shall include seasonal spraying with approved insecticides or fungicides as may be required.

All dead or rejected plants shall be promptly removed from the project during the period of establishment, and shall be replaced by the Contractor in kind, quantity and size with live, healthy specimens planted during the stipulated planting season.

The establishment period does not begin until all plant materials stipulated in the contract have been planted. When the plant establishment period begins at the end of the spring planting season, an inspection to determine the acceptability of plant establishment will be held by the Contractor and the Engineer no later than November 1st in the same year. When the plant establishment period begins at the end of the fall planting season an inspection to determine the acceptability of plant establishment will be held by the Contractor and the Engineer by August 1st of the following year. During the plant establishment inspection, an inventory of losses and rejected materials will be made and corrective and necessary clean up measures will be determined.

Replaced plant material shall be subject to all the requirements specified for the original material.

A final inspection will be held in accordance with Article 1.08.12. Any further work to be done will be in accordance with Article 1.08.13 before the project can be accepted.

9.49.04--Method of Measurement:

1. Planting: The quantity for which payment will be made will be the number of each size and kind of plants counted in place, planted and accepted.

2. Mulching: This work will be measured for payment by the number of square yards (square meters) surface measurement of the specified thickness for the area on which woodchip mulch (or gravel mulch) has been completed and accepted.

9.49.05--Basis of Payment:

1. Planting: Payment for this work will be made at the contract unit price each for the kind and size of plant and method of planting, as the case may be, completed and accepted in place, except that when approved, partial payment for work satisfactorily performed in the excavation of plant pits and for furnishing and placing planting soil and peat humus admixture may be made in amounts not to exceed 20% of the unit bid price for the respective plant.

2. Mulching: This work will be paid for at the contract unit price per square yard (square meter) for wood chip mulch (or gravel mulch) complete in place.

3. The unit prices shall include all materials, equipment, tools, labor, transportation, operations and all work incidental thereto, including the removal of guy wires, hose and tree support stakes after the initial establishment period, except that payment for excavation of solid ledge rock, concrete pavement and boulders 1/2 cubic yard (0.5 cubic meter) in volume or greater will be made under item for "Rock Excavation for Planting."

Pay Item	Pay Unit
(Caliper) (Deciduous Tree Name)	ea. (ea.)
(Height) (Evergreen Tree Name)	ea. (ea.)
(Size) (Shrub Name)	ea. (ea.)
(Size) (Broad-leaved Evergreen Name)	ea. (ea.)
Vines (Name)	ea. (ea.)
Groundcover (Name)	ea. (ea.)
Wood Chip Mulch	s.y. (s.m)
Gravel Mulch	s.y. (s.m)
Spraying Glyphosate	s.y. (s.m)

SECTION 9.50
TURF ESTABLISHMENT

9.50.01—Description: The work included in this item shall consist of providing an accepted uniform stand of established perennial turf grasses by furnishing and placing fertilizer, seed, and mulch on all areas to be treated as shown on the plans or where designated by the Engineer.

The work will also include the installation of erosion control matting consisting of mulch and netting woven together as one unit where shown on the plans or as directed by the Engineer.

9.50.02—Materials: The materials for this work shall conform to the requirements of Section M.13.

9.50.03—Construction Methods: Construction Methods shall be those established as agronomically acceptable and feasible and which are approved by the Engineer.

1. Preparation of the Seedbed:

(a) Level areas, medians, interchanges and lawns: These areas shall be made friable and receptive for seeding by disking or by other approved methods to the satisfaction of the Engineer. In all cases the final prepared and seeded soil surface shall meet the lines and grades for such surface as shown in the plans, or as directed by the Engineer.

(b) Slope and Embankment Areas: These areas shall be made friable and receptive to seeding by approved methods which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.

(c) All areas to be seeded shall be reasonably free from weeds taller than 3 inches (75 millimeters). Removal of weed growth from the slope areas shall be by approved methods, including hand-mowing, which do not rut or scar the slope surface, or cause excessive disruption of the slope line or grade. Seeding on level areas shall not be permitted until substantially all weed growth is removed. Seeding on slope areas shall not be permitted without removal or cutting of weed growth except by written permission of the Engineer.

2. Seeding Season: The calendar dates for seeding shall be:

Spring—March 15 to June 15

Fall—August 15 to October 15

All disturbed soil areas shall be treated during the seeding seasons as follows:

(a) Areas at final grade: Seeding will be accomplished.

(b) "Out-of-season" seedings shall be performed in the same manner as "in-season" seedings. Since acceptable turf establishment is less likely, the Contractor shall be responsible for "in-season" reseeding until the turf stand conforms to 9.50.03-5.

(c) During "out-of-season" periods unseeded areas shall be treated in accordance with Section 2.10, Water Pollution Control.

3. Seeding Methods: The grass seed mixture conforming to Article M.13.04 shall be applied by any agronomically acceptable procedure. The rate of application shall be no less than 175 pounds per acre (195 kg/hectare).

Fertilizer conforming to M.13.03 shall be initially applied at a rate of 320 pounds per acre (360 kilograms/hectare) during or preceding seeding. When wood fiber mulch is used, it shall be applied in a water slurry at a rate of 2,000 pounds per acre (2250 kilograms/hectare) with or immediately after the application of seed, fertilizer and limestone. When the grass seeding growth has attained a height of 6 inches (150 millimeters), the specified areas designated herein shall be mowed to a height of 3 inches (75 millimeters). Following mowing, all seeding grass areas (mowed and un-mowed) shall receive a uniform application of fertilizer hydraulically placed at the rate of 320 pounds per acre (360 kilograms/hectare).

4. Compaction: The Contractor shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the Contractor shall rework the soil to make a suitable seedbed; then re-seed and mulch such areas with the full amounts of the specified materials, at no extra expense to the State.

5. Stand of Perennial Turf Grasses: The Contractor shall provide and maintain a uniform stand of established turf grass species having attained a height of 6 inches (150 millimeters) consisting of no less than 100 plants per square foot (1100 plants per square meter) throughout the seeded areas until the entire project has been accepted.

6. Establishment: The Contractor shall keep all seeded areas free from weeds and debris, such as stones, cables, baling wire, and he shall mow at his own expense, on a one-time-only basis, all slopes 4:1 or less (flatter) and level turf established (seeded) areas to a height of 3 inches (75 millimeters) when the grass growth attains a height of 6 inches (150 millimeters).

Clean-up shall include, but not be limited to, the removal of all debris from the turf establishment operations on the shoulders, pavement, and/or elsewhere on adjacent properties publicly and privately owned.

7. Erosion Control Matting: Erosion control matting shall be installed following seeding where called for on the plans or as directed by the Engineer. Staples shall be installed as per Manufacturer's recommendations. Where two lengths of matting are joined, the end of the up-grade strip shall overlap the down-grade strip.

The Contractor shall maintain and protect the areas with erosion control matting until such time as the turf grass is established. The Contractor shall replace or repair at his own expense any and all erosion control matting areas damaged by fire, water or other causes including the operation of construction equipment. No mowing will be required in the locations where erosion control matting is installed.

9.50.04—Method of Measurement: This work will be measured for payment by the number of square yards (square meters) of surface area of accepted established perennial turf grass as specified or by the number of square yards (square meters) surface area of seeding actually covered and as specified.

Erosion control matting will be measured by the number of square yards (square meters) of surface area of erosion control matting installed and accepted.

9.50.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Turf Establishment" which price shall include all materials, mowing, maintenance, equipment, tools, labor, and work incidental thereto. Partial payment of up to 60% may be made for work completed, but not accepted.

Erosion control matting will be paid for at the contract unit price per square yard (square meter) for "Erosion Control Matting" complete in place and accepted, which price shall include the hay mulch, netting, staples, maintenance, equipment, tools, labor, and work incidental thereto.

Pay Item	Pay Unit
Turf Establishment	s.y. (s.m)
Erosion Control Matting	s.y. (s.m)

SECTION 9.51

ROCK EXCAVATION FOR PLANTING

9.51.01—Description: When solid ledge rock, concrete pavement, or boulders 1/2 cubic yard (0.5 cubic meter) in size or greater, are encountered in the planting area, the Contractor shall notify the Engineer who will determine whether the rock or concrete pavement shall be removed or the plant or plants relocated.

Rock or concrete pavement as defined herein shall not be removed without the permission of the Engineer.

9.51.03—Construction Methods: When rock or concrete pavement removal is approved by the Engineer, the plant pit diameter shall be 3 feet (1 meter) greater than the diameter of the ball of earth or root spread of the plant; and the depth of the pit shall be the same as when the excavation is made in earth.

All unsuitable material resulting from rock or concrete pavement excavation, even if beyond the payment lines, and all breakage and slides shall be removed and disposed of as directed.

When blasting is necessary, the work shall conform to the requirements of Article 1.07.08

9.51.04—Method of Measurement: The measurement for payment of the quantity of ledge rock, concrete pavement, or boulders 1/2 cubic yard (0.5 cubic meter) in size or greater, removed upon orders of the Engineer, will be the actual number of cubic yards (cubic meters) of such material ordered removed within the designated limits.

9.51.05—Basis of Payment: Payment for the removal of ledge rock, concrete pavement, or boulders 1/2 cubic yard (0.5 cubic meter) in size or greater, will be made at the contract unit price per cubic yard (cubic meter) for "Rock Excavation for Planting," which price shall include all materials, equipment, tools, labor and work incidental thereto. It shall also include disposal of surplus or unsuitable material.

Pay Item	Pay Unit
Rock Excavation for Planting	c.y. (cu. m)

SECTION 9.52

SELECTIVE CLEARING AND THINNING

9.52.01—Description: This work shall consist of cutting, trimming and removal of trees, stumps, brush, rubbish and objectionable material as shown on the plans.

9.52.03—Construction Methods: All work pertaining to the cutting, trimming and removal of trees, stumps, brush, rubbish and other objectionable material shall be done in a neat and orderly manner so as not to cause damage to adjacent vegetation. Trees, stumps and brush to be removed shall be cut flush with the ground surface. Branches of trees shall be trimmed as directed.

Prior to clearing operations, a meeting must be held. Those attending the meeting should include the Contractor, the Engineer, the designer, local tree warden or equivalent, and the District Environmental Coordinator. All clearing issues shall be resolved to the satisfaction of the Engineer before any trees are cut.

All trees scheduled to be removed shall be visibly marked or flagged by the Contractor at least 7 days prior to the cutting of such trees.

The Engineer will inspect the identified trees and verify the limits of clearing and thinning prior to the Contractor proceeding with its cutting operation.

The Contractor shall dispose of all such trees, branches, stumps, brush, etc., in a satisfactory manner and shall remove all rubbish and refuse from within the highway limits.

9.52.04—Method of Measurement: Selective clearing and thinning, being paid for on a lump sum basis, will not be measured for payment.

9.52.05—Basis of Payment: This work will be paid for at the contract lump sum price for "Selective Clearing and Thinning" which price shall include all material, tools, equipment and labor incidental thereto.

Pay Item	Pay Unit
Selective Clearing and Thinning	l.s. (l.s.)

SECTION 9.53

SODDING

9.53.01—Description: Work under this item shall consist of furnishing and placing of live sod and also the furnishing and preparing a sodbed composed of 4 inches (100 millimeters), after tamping, of approved topsoil in the areas designated on the plans or where directed by the Engineer and in conformance with these specifications.

9.53.02—Materials: The material for this work shall conform to the requirements of Article M.13.01 for Topsoil, Article M.13.02 for Agricultural Ground Dolomitic Limestone, Article M.13.03 for Fertilizer, and Article M.13.08 for Sod. Stakes for pegging sod shall be of wood, approximately 1 inch x 2 inch (25 millimeters x 50 millimeters) and of sufficient length to penetrate the sod, the topsoil and to a minimum depth of 2 inches (50 millimeters) of subsoil.

9.53.03—Construction Methods:

1. Season: The work may be performed at any season of the year unless otherwise specified. The Contractor shall notify the Engineer at least 48 hours in advance of the time he intends to begin sodding and shall not proceed with such work until permission to do so has been granted. No frozen sod shall be placed. No sodding shall be done on frozen earth. When sodding is to be accomplished on the same general area where seeding is to be done under the same contract, the sodding work shall be carried out before the seed is sown.

2. Procuring Sod: Care shall be exercised at all times to retain the native soil on the roots of the sod during the process of transplanting. Dumping from vehicles will not be permitted. The sod shall be planted within twenty-four hours from the time it is harvested unless it is tightly rolled or stored roots-to-roots in a satisfactory manner. All sod in stacks shall be kept moist and shall be protected from exposure to the sun and from freezing. No storage longer than five days will be permitted. Sod which becomes dried out or does not meet the specifications will be rejected.

3. Ground Preparation: There shall be a minimum of 4 inches (100 millimeters), after tamping, of topsoil under all sod unless otherwise specified. Excavations or trenches shall be made to a sufficient depth below the finished grade of the sod to accommodate the depth of topsoil as specified and the thickness of sod as specified. Fertilizer shall be applied at a rate to provide 100 pounds per acre (110 kilograms/hectare) of nitrogen unless fertilizer has been applied under another item in this contract to the topsoil in the sod bed. Lime, although not required in sodbed preparation, will be permitted in the sodbed if applied in a previous operation. Fertilizer applied under this item shall be incorporated with the topsoil to a depth of at least 2 inches (50 millimeters) before the sod is laid, unless otherwise specified or approved. Incorporation shall be accomplished by disking, harrowing, drilling, raking or other approved means.

4. Planting Sod: The soil on which the sod is laid shall be reasonably moist and shall be watered, if so directed. The sod shall be laid smoothly, edge to edge, and all openings shall be plugged with sod. In drainage-ways and where continuous or solid sodding is called for on the plans, the sod shall be laid with their longest dimensions parallel to the contours. Such sodding shall be begun at the base of slopes or grades and the sodding progress in continuous parallel rows working upward. Vertical joints between such sod shall be staggered. All sod shall be laid to the grades specified and the grades formed with special care at the junction of drainage-ways. Immediately after the sod is laid, it shall be pressed firmly into contact with the sodbed by tamping, rolling, or by other approved methods so as to eliminate all air pockets, provide true and even surfaces, insure knitting and protect all exposed sod edges but without displacement of the sod or deformation of the surface of the sodded areas and watered at the rate of 5 gallons per square yard (20 liters/square meter) of sodded area unless otherwise directed.

5. Pegging: Sod shall be held in place by stakes in all drainage-ways, on all slopes steeper than 1:4 and elsewhere where specified or as directed. Pegging shall be done immediately after tamping. At least one stake shall be driven through each sod to be staked, and the stakes shall be not more than 2 feet (600 millimeters) apart. Stakes shall have their flat sides against the slope and be driven flush.

6. Finishing: Excess sod or excess soil resulting from excavations or trenching shall be disposed of as approved. Excess soil shall not be left to form a ridge adjacent to the sodded area or sodded strips. No payment will be made for rejected or excess sod which is not laid.

7. Care During Construction: The Contractor shall care for the sodded areas until all work on the entire contract has been completed and accepted. Such care shall consist of providing protection against traffic by approved warning signs or barricades, and the mowing of grass to the height of 2 inches (50 millimeters) when the growth attains a maximum height of 4 inches (100 millimeters).

Sod shall also be watered if so required by the Engineer. When watered, sufficient water shall be applied

to wet the sod at least 2 inches (50 millimeters) deep in the sodbed. Watering shall be done in a manner which will not cause erosion nor other damage to the finished surfaces. Any surfaces which become gullied or otherwise damaged shall be repaired to re-establish the grade and conditions of the soil prior to sodding and shall then be re-fertilized and re-sodded as specified under this item.

9.53.04—Method of Measurement: This work will be measured for payment by the number of square yards (square meters) of surface area acceptably sodded.

9.53.05—Basis of Payment: This work will be paid for at the contract unit price per square yard (square meter) for "Sodding," which payment shall constitute full compensation for furnishing all labor, materials, including topsoil placed under the sod, equipment and incidentals necessary to complete and care for the work as specified, including water and its application.

Pay Item	Pay Unit
Sodding	s.y. (s.m)

SECTION 9.70
TRAFFICPERSON

9.70.01—Description: Under this item the Contractor shall provide the services of Trafficpersons of the type and number, and for such periods, as the Engineer approves for the control and direction of vehicular traffic and pedestrians.

On a weekly basis, the Contractor shall inform the Engineer of their scheduled operations for the following week and the number of Trafficpersons requested. The Engineer shall review this schedule and approve the type and number of Trafficpersons required.

If the Contractor changes or cancels any scheduled operations without prior notice of same as required by the agency providing the Trafficpersons, and such that Trafficperson services are no longer required, the Contractor will be responsible for payment at no cost to the Department of any show-up cost for any Trafficperson not used because of the change. Exceptions, as approved by the Engineer, may be granted for adverse weather conditions and unforeseeable causes beyond the control and without the fault or negligence of the Contractor.

Trafficpersons assigned to a work site are to only take direction from the Engineer.

Trafficpersons shall consist of the following types:

State Police Officers: State Police Officers shall be uniformed off-duty sworn Connecticut State Police Officers. Their services will also include the use of official State Police vehicles and associated equipment.

State Police Officers will be used on all limited access highways. State Police Officers will not be used on non limited access highways unless specifically authorized in writing by the Engineer. State Police Officers with official State Police vehicles will be used at such locations and for such periods as the Engineer deems necessary to control traffic operations and promote increased safety to motorists through the construction sites. On limited access highways, the Engineer may determine that State Police Trafficpersons will be utilized for regional work zone traffic safety and enforcement operations in addition to project-related work zone assignments.

Uniformed Municipal Police Officers: Uniformed Municipal Police Officers shall be sworn Municipal Police Officers or Uniformed Constables who perform criminal law enforcement duties from the Municipality in which the project is located. Their services will also include an official Municipal Police vehicle when requested by the Engineer. Uniformed Municipal Police Officers will be used on all non limited access highways. If Uniformed Municipal Police Officers are unavailable, other Trafficpersons may be used when authorized in writing by the Engineer.

Uniformed Municipal Police Officers and requested Municipal Police vehicles will be used at such locations and for such periods as the Engineer deems necessary to control traffic operations and promote increased safety to motorists through the construction sites.

Uniformed Flagger: Uniformed Flaggers shall be persons who have successfully completed flagger training by the ATSSA, National Safety Council or other programs approved by the Engineer. A copy of the Flagger's training certificate shall be provided to the Engineer before the Flagger performs any work on the project. Services of Uniformed Flaggers shall include the following equipment: garments (including high visibility headgear) so as to be readily distinguishable as a Flagger in accordance with Standard 6E-2 of the MUTCD, and these specifications, and a STOP/SLOW paddle that is at least 18 inches (450 millimeters) in width with letters at least 6 inches (150 millimeters) high, mounted on a handle of sufficient length so that the bottom of the sign will be 6 feet (1.8 meters) above the ground, and conforms to Standard 6E-3 of the MUTCD and catalog number 387-80-9950 of the Catalog of Signs ConnDOT.

Uniformed Flaggers will only be used on non limited access highways when authorized in writing by the Engineer. Uniformed Flaggers will be used at such locations and for such periods as the Engineer deems necessary to control traffic operations.

General: Uniformed Law Enforcement Personnel being used as Trafficpersons may conduct motor vehicle enforcement operations in and around work areas as directed and approved by the Engineer.

Trafficpersons shall wear a high visibility safety garment that complies with OSHA, MUTCD, ASTM Standards and the following:

Uniformed Law Enforcement Personnel shall wear the high visibility safety garment provided by their law enforcement agency. If no high visibility safety garment is provided, the Contractor shall provide the law enforcement personnel with a garment meeting the requirements stated below for the Uniformed Flaggers' garment.

Uniformed Flagger: The base material for the safety garment shall be a fluorescent color of orange, yellow, or strong yellow-green. The garment shall have vertical and horizontal stripe markings of

contrasting color to the base material to enhance noticeability of the wearer. These markings shall be made of retroreflective or combination of retroreflective and non-retroreflective materials. The retroreflective material shall be orange, yellow, white, silver, strong yellow-green, or a fluorescent version of one of these colors and shall have a minimum width of 5/8 inch (15 millimeters). A minimum area of 40 square inches (25800 square millimeters) of retroreflective material must be visible when the garment is viewed from either the front or back and a minimum area of 12 square inches (7740 square millimeters) of retroreflective material must be visible from any other normal observation angle. The safety garment shall have the words "Traffic Control" clearly visible on the front and rear panels (minimum letter size 2 inches (50 millimeters).

Worn/faded safety garments that are no longer highly visible shall not be used. The Engineer shall direct the replacement of any worn/faded garment at no additional cost to the State.

A Trafficperson shall assist in implementing the traffic control specified in the Maintenance and Protection of Traffic contained elsewhere in these specifications or as directed by the Engineer. Any situation requiring a Trafficperson to operate in a manner contrary to the Maintenance and Protection of Traffic specification shall be authorized in writing by the Engineer.

Prior to the start of operations on the project requiring the use of Trafficpersons, a meeting will be held with the Contractor, Trafficperson agency, and Engineer to review the Trafficperson operations, lines of responsibility, and operating guidelines which will be used on the project.

In the event of an unplanned, emergency, or short term operation, the Engineer may approve the use of properly clothed, non-certified Trafficpersons until such time as a certified Trafficperson may be obtained. In no case shall this temporary use exceed 8 hours for any particular operation.

9.70.04—Method of Measurement: Only Trafficperson services approved by the Engineer will be measured for payment. Services of Trafficpersons will be measured for payment by the actual number of hours for each person rendering services in accordance with these specifications. Services of Trafficpersons utilized by the Contractor for which the Engineer did not approve and deems not necessary for the proper completion of the project or at locations where traffic is unnecessarily restricted by the Contractor's method of operation, will not be measured for payment.

The minimum hours of payment for each Trafficperson supplied by a law enforcement agency or Trafficperson subcontractor in any one day shall be four hours. No Uniformed Trafficperson shall work more than twelve hours in any one day. In case such services are required for more than twelve hours, the Contractor may request additional Trafficpersons. In cases where the Trafficperson is an employee on the Contractor's payroll, payment for the Trafficperson will be made only for those hours when the Contractor's employee is performing Trafficperson duties.

Travel time charged by State Police Officers, up to one hour per day, will be measured for payment. No travel time will be allowed or paid for Uniformed Municipal Police Officers or Uniformed Flaggers.

Safety garments and STOP/SLOW paddles will not be measured for payment.

9.70.05—Basis of Payment: The sum of money shown on the Estimate and in the itemized proposal as "Estimated Cost" for this work will be considered the bid price even though payment will be made as described below. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded and the original price will be used to determine the total amount for the contract.

"Trafficperson" will be paid for at the actual hourly rate charged for Trafficperson services (monthly statement or receipted bills) by the entity which actually provided the service which have been approved by the Engineer plus a 5% markup. In situations where the Uniformed Flagger is an employee on the Contractor's payroll, payment will be made in accordance with Article 1.09.04(a) of the Standard Specifications. Use of a Municipal police vehicle requested by the Engineer will be paid at the actual rate charged by the Municipality plus a 5% markup. The rate charged by the Municipality for use of a Uniformed Municipal Police Officer and/or an official Municipal Police vehicle shall not be greater than the rate it normally charges others for similar services.

There will be no direct payment for safety garments or STOP/SLOW paddles. All costs associated with furnishing safety garments and STOP/SLOW paddles will be considered as being included in the general cost of the Contract.

Pay Item	Pay Unit
Trafficperson	est. (est.)

SECTION 9.71
MAINTENANCE AND PROTECTION OF TRAFFIC

9.71.01—Description: Unless other provisions are made on the plans or in the special provisions of the contract, the Contractor shall keep the roadway under construction open to traffic for the full length of the project and shall provide a sufficient number of travel lanes and pedestrian passways to move that traffic ordinarily using the roadway. The travel lanes and pedestrian passways shall be drained and kept reasonably smooth and in suitable condition at all times in order to provide minimum interference to traffic consistent with the proper prosecution of the work.

Suitable ingress and egress shall be provided at all times where required, for all intersecting roads and for all abutting properties having legal access.

When a scheme for maintenance of traffic, which may include detours, is shown on the plans or described in the special provisions of the contract, this shall govern unless an alternate scheme acceptable to the Engineer is offered by the Contractor at no additional cost. If no scheme is shown on the plans or described in the special provisions of the contract, and the Contractor wishes to deviate from the provisions of maintaining traffic as described in this section, the Contractor may submit and the Engineer may approve a schedule showing a proposed sequence of operations and a compatible method of maintaining traffic.

9.71.03—Construction Method: The Contractor shall furnish and erect signs legally closing the highway to traffic, as shown on the plans or directed by the Engineer, prior to commencing any work on the Project.

The Contractor shall furnish a sufficient number of signs, barricades, drums, traffic cones and delineators to forewarn traffic of the construction as shown on the traffic control plans contained within or as directed by the Engineer.

The Contractor shall also provide such safety measures, pavement markings, warning devices and signs as deemed necessary to safeguard and guide the traveling public through detours ordered by the Engineer, included in the approved scheme for maintenance of traffic, or as shown on the plans. The Contractor shall erect, maintain, move, adjust, clean, relocate and store these signs, barricades, drums, traffic cones and delineators when, where and as directed by the Engineer, and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices."

The use of unauthorized or unapproved signs, barricades, drums, traffic cones or delineators will not be permitted.

All signs in any one signing pattern shall be mounted the same height above the traveled surface. The Contractor shall keep all signs in proper position, clean and legible at all times. Care shall be taken so that weeds, shrubbery, construction materials or equipment, and soil, are not allowed to obscure any sign, light, or barricade. Signs that do not apply to existing conditions shall be removed or adjusted so that the legend is not visible to approaching traffic.

The Contractor, when ordered by the Engineer, shall remove snow and take care of icy conditions on temporary, new and existing sidewalks on any part of the right-of-way within the limits of the project. Payment for the cost thereof, will be made as extra work.

Snow removal and correction of icy conditions, other than those resulting from the Contractor's operations, on uncompleted contracts under traffic, will remain an obligation of the State or others.

Should the Contractor fail to perform any of the work required under this section, the State may perform or arrange for others to perform such work. In such cases, the State will deduct from money due or to become due the Contractor all expenses connected therewith which are found to be greater than the cost to the State had the Contractor performed the specified work.

9.71.05—Basis of Payment: When the item of "Maintenance and Protection of Traffic" appears in the contract, this work will be paid for at the contract lump sum price for "Maintenance and Protection of Traffic." This price shall include all costs for labor, equipment and services involved in the erection, maintenance, moving, adjusting, cleaning, relocating and storing of signs, barricades, drums, traffic cones and delineators furnished by the Contractor as well as all costs of labor and equipment involved in the maintenance of traffic lanes and detours, except for pavement markings, ordered or included in the approved scheme for maintenance of traffic. "Maintenance and Protection of Traffic" does not include the cost of signs, barricades, drums, traffic cones, delineators, or the furnishing and placing of materials such as borrow, gravel, crushed stone, bituminous concrete for patching and pipe. These items will be paid for at contract unit prices, or in the absence of applicable contract unit prices, as extra work. If the Engineer requires the Contractor to provide facilities in excess of the requirements of the adopted scheme for maintenance and protection of traffic, the Contractor shall perform the required work; and payment for the

cost thereof will be made at applicable contract unit prices, or in the absence of applicable contract unit prices, as extra work.

Pay Item	Pay Unit
Maintenance and Protection of Traffic	l.s. (l.s.)

SECTION 9.73
SAFETY PATROL SERVICE

9.73.01—Description: Under this item, the Contractor shall provide safety patrol services within the limits of the construction project open to the traveling public and on project-connected State-established detours open to the traveling public when and for such period as ordered by the Engineer.

9.73.03—Construction Methods: The patrolman shall be so clothed and equipped as to be readily distinguished as a patrolman and to the satisfaction of the Engineer.

The Contractor shall provide the patrolman with an appropriate motor vehicle marked with the words "Safety Patrol" for patrolling the project as well as the detours and will be responsible for all maintenance and operation costs of such vehicle.

The patrolman shall patrol the construction project as well as any and all State-established detours used by the traveling public in connection with this project during those hours ordered by the Engineer and in accordance with the Engineer's directions.

The responsibility of the patrolman shall be to assure that all signs, barricades, delineators, flares, markers and all other traffic protective devices are erect, in good condition, performing their intended function, and that the traveled way is in a safe and reasonably smooth condition, both within the limits of the project and all other outside areas connected with the project.

The patrolman shall also assure that all pollution control devices are functioning properly.

The Contractor shall make previous arrangements for any emergency assistance required by the patrolman in the event the patrolman can not personally remedy a hazardous condition.

It is not the intention of this specification to provide patrolmen for the protection of property or other police duties.

When so ordered by the Engineer, the Contractor shall furnish the patrolman with a recording time clock of a type satisfactory to the Engineer; and the patrolman shall "punch in" at properly equipped, designated stations on the project which have been selected by the Engineer. At the times designated by the Engineer, the clock shall be presented to the Engineer for removal of the time record.

This specification in no way diminishes the responsibility of the Contractor under any other specification of the contract.

9.73.04—Method of Measurement: Safety patrol service will be measured for payment by the number of hours for each person rendering service in accordance with the orders of the Engineer.

The minimum hours of payment for any period of safety patrol service in any one day shall be 4 hours. No patrolman shall work more than 15 continuous hours without an 8-hour off-duty period.

If the Contractor fails to provide safety patrol service as directed by the Engineer under this specification, the State may perform or arrange for others to perform such safety patrol services. In such cases the State will deduct from money due or to become due the Contractor for all expenses connected therewith.

9.73.05—Basis of Payment: Safety patrol service will be paid for at the contract unit price per hour for "Safety Patrol Service," actually provided by the Contractor as ordered by the Engineer, which price shall include the cost of providing and maintaining the motor vehicle, the furnishing of the time clock ordered by the Engineer and all relative services connected therewith, as well as all compensation, insurance, benefits and any other costs or liabilities incidental to the furnishing of safety patrol service in accordance with this specification.

Pay Item	Pay Unit
Safety Patrol Service	hr. (hr.)

**SECTION 9.74
REMOVAL OF EXISTING MASONRY**

9.74.01—Description: This work shall include the removal and satisfactory disposal of all retaining walls constructed of dry masonry, cement rubble masonry or concrete, and bridge substructures, the removal of which is necessary to the final completion of the work.

9.74.03—Construction Methods: Existing masonry shall be removed to the lines shown on the plans or as ordered by the Engineer, due precaution being taken to avoid injury to new construction, public utility installations or abutting property. The material excavated shall be used in the embankment fill, or it shall be disposed of as directed by the Engineer.

9.74.04—Method of Measurement: Masonry removed under this item shall be measured for payment by the volume in cubic yards (cubic meters) in place before removal.

Only individual masonry units of one cubic yard (cubic meter) or more will be measured for payment.

The frequency of intermediate measurements to develop the approximate cross-section of a structure shall be at the discretion of the Engineer.

9.74.05—Basis of Payment: Payment for removing existing masonry will be made at the contract unit price per cubic yard (cubic meter) for "Removal of Existing Masonry," which price shall include all equipment, tools and labor incidental to the removal of the material and the disposal thereof as directed by the Engineer.

Pay Item	Pay Unit
Removal of Existing Masonry	c.y. (cu. m)

**SECTION 9.75
MOBILIZATION**

9.75.01--Description: This item shall consist of all work necessary for the movement of personnel and equipment to the project site, and for the establishment of all Contractor's field offices, buildings and other facilities necessary to the performance of the work.

9.75.04--Method of Measurement: This work will be measured for payment in the manner described hereinafter; however, the determination of the total contract price earned shall not include the amount of mobilization earned during the period covered by the current monthly estimate--but shall include amounts previously earned and certified for payment:

1. When the first payment estimate is paid, 50% of the lump sum bid price for this item or 5% of the total original contract price, whichever is less, will be certified for payment.
2. When ten percent of the original contract price is earned, 75% of the lump sum price of this item or 7.5% of the total original contract price, whichever is less, minus any previous payment, will be certified for payment.
3. When 30% of the total original contract price is earned, 100% of the lump sum price for this item or 10% of the total original contract price, whichever is less, minus any previous payment, will be certified for payment.

Upon completion of all work on the project, payment of any amount bid for mobilization in excess of 10% of the original contract amount will be paid.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided for by the contract.

9.75.05--Basis of Payment: This work will be paid for at the contract lump sum price for "Mobilization" which price shall include materials, equipment, tools, labor, transportation, operations and all work incidental thereto.

When no price for "Mobilization" is asked for on the proposal form, the cost of the work described above shall be included in the general cost of the contract, with no direct payment for the work.

Pay Item	Pay Unit
Mobilization	l.s. (l.s.)

**SECTION 9.76
BARRICADE WARNING LIGHTS**

9.76.01—Description: This item shall include furnishing and maintaining designated type barricade warning lights on signs and barricades and elsewhere as ordered by the Engineer.

9.76.02—Materials: Barricade warning lights are portable, lens-directed, enclosed lights. The color of the light emitted shall be yellow. They may be used in either a steady-burn or flashing mode. Barricade warning lights shall be in accordance with the requirements of the ITE Standard for Flashing and Steady-Burn Barricade Warning Lights and the following table:

	Type A Low Intensity	Type B High Intensity	Type C Steady Burn
Lens Directional Faces	1 or 2	1	1 or 2
Flash Rate per minute	55 to 75	55 to 75	Constant
Flash Duration ¹	10%	8%	Constant
Minimum Effective Intensity ²	4.0 Candelas	35 Candelas	— — —
Minimum Beam Candelas	— — —	— — —	2 Candelas
Hours of Operation	Dusk to dawn	24 hrs. per day	Dusk to dawn

¹Length of time that instantaneous intensity is equal to or greater than effective intensity.

²These values must be maintained within a solid angle 9° on each side of the vertical axis and 5° above and 5° below the horizontal axis.

9.76.03—Construction Methods: Barricade warning lights shall be used as follows:

Type A low-intensity flashing warning lights shall be mounted on separate portable supports, on Class II barricades or on vertical channelizing devices.

Type B high-intensity flashing warning lights shall be mounted on the advance warning signs or on independent supports. Extremely hazardous site conditions within the construction area may require that the lights be mounted on Class II barricades, signs or other supports.

Type C steady-burn lights shall be used to delineate the edge of the traveled way on detour curves, on lane changes, on lane closures and on other similar conditions.

The Engineer shall determine the type of barricade warning lights to be used. Portable supports for barricade warning lights shall provide a minimum mounting height of 36 inches (1 meter) to the bottom of the lens.

The Contractor shall furnish and securely fasten the units to signs, barricades and other objects in such numbers and for such lengths of time as the Engineer may order.

The Contractor shall maintain and relocate the units and, upon final removal, dispose of them.

Any barricade warning lights that are missing, damaged, defaced, or improperly functioning so that they are not effective, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor at no cost to the State.

9.76.04—Method of Measurement: This work will be measured for payment by the number of calendar days that each individual unit is in place and in operation as herein before described, measured to the nearest day.

9.76.05—Basis of Payment: Barricade warning lights will be paid for at the contract unit price per day for the type barricade warning lights used, which price shall include all materials, equipment, tools, labor

and work incidental to furnishing, maintaining, changing location, removing and disposing of the units.

Pay Item	Pay Unit
Barricade Warning Lights (Type)	day (day)

**SECTION 9.77
TRAFFIC CONE**

9.77.01—Description: Under this item the Contractor shall furnish all reflectorized orange traffic cones required on the project to conform to the requirements as stated in the item "Maintenance and Protection of Traffic," as shown on the plans and as directed by the Engineer.

The Contractor shall have, available on the project, a sufficient number of traffic cones to fulfill all the requirements as specified in the contract and to replace those traffic cones which have become damaged.

9.77.02—Materials: Traffic cones shall be constructed of materials to a thickness to withstand impact without damage to cones or to vehicles. The traffic cones shall be of sufficient mass or have bases to which ballast may be added to assure that they will not be blown over or displaced by wind from passing vehicles. Traffic cones used at night shall be reflectorized by utilizing Type VI Retroreflective Sheeting, in accordance with Subarticle M.18.09.01.

9.77.04—Method of Measurement: This item will be measured for payment by the number of traffic cones used on the Project.

9.77.05—Basis of Payment: This item will be paid for at the contract unit price each for "Traffic Cone" used on the Project. Each cone will be paid for once, regardless of the number of times it is used on the Project.

Any traffic cones that are missing, damaged or defaced so that they are not effective, as determined by the Engineer in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor at no cost to the State.

When the traffic cones are no longer required on the Project they shall remain the property of the Contractor.

Pay Item	Pay Unit
Traffic Cone	ea. (ea.)

SECTION 9.78
TRAFFIC DRUM

9.78.01—Description: Under this item the Contractor shall furnish all traffic drums required on the project to conform to the traffic patterns, as indicated in the "Maintenance and Protection of Traffic," as shown on the plans and as directed by the Engineer.

9.78.02—Materials: Traffic Drums shall be manufactured plastic or rubber devices designed in accordance with the latest edition of the MUTCD. The design of the device will allow for the installation of barricade warning lights. The device shall be stabilized with the use of sandbags or other approved means.

The traffic drum shall have, as a minimum, two 4-inch (100-millimeter) wide retroreflective orange stripes and two 6-inch (150-millimeter)-wide retroreflective white stripes. The stripes shall be placed horizontally and alternated with the orange stripe on top. The alternated stripes should not touch. The sections of the traffic drum not covered with retroreflective sheeting shall be orange.

Either Type III or Type VI Retroreflective Sheeting, in accordance with Subarticle M.18.09.01, shall be used on traffic drums. Only one type sheeting shall be used on a drum and all drums furnished on a construction project shall be manufactured with the same type retroreflective sheeting. Retroreflective sheeting shall conform to the requirements of Article M.18.09.01. For this material, a Materials Certificate shall be required.

9.78.03—Construction Methods:

The Contractor shall have, available on the project, a sufficient number of traffic drums to fulfill all the requirements, as specified in the contract, to provide adequate traffic control during periods of unforeseen circumstances or emergencies.

Traffic drums shall be designed and installed in accordance with the plans, the MUTCD latest edition, and as directed by the Engineer.

Any traffic drum that is missing, damaged or defaced so that it is not effective, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor.

When the traffic drums are no longer required on the project, they shall remain the property of the Contractor.

9.78.04—Method of Measurement: This work will be measured for payment by the number of traffic drums used on the project.

9.78.05—Basis of Payment: This item will be paid for at the contract unit price each for "Traffic Drum" used on the project. Each drum will be paid for once, regardless of the number of times it is used on the project.

Pay Item	Pay Unit
Traffic Drum	ea. (ea.)

SECTION 9.79
CONSTRUCTION BARRICADES

9.79.01—Description: Under this item the Contractor shall furnish all construction barricades of the specified type required on the project to conform to the requirements stated in the item "Maintenance and Protection of Traffic," as shown on the plans and as directed by the Engineer.

9.79.02—Materials: Construction barricades shall consist of the following materials:

The frame shall be of polyvinyl chloride pipe conforming to ASTM D 2241 for PVC 1120 or 1220, SDR21 (pressure rating 200 psi (1380 kilopascals)); ASTM D3034, SDR 35 or an approved equal. All straight members shall be of white color.

Wyes, tees and elbows for joint connections shall be polyvinyl chloride of suitable size and strength for the purpose intended.

Joints shall not be glued and a 3/16-inch (5.0-millimeter) nylon rope (or equivalent) shall be threaded loosely through the pipe to keep sections from flying if hit by a vehicle.

Face panels used as horizontal members shall be constructed of a suitable plastic material, .060-inch (1.5-millimeter) high impact styrene, anodized aluminum of no less than .025-inch (0.64-millimeter) thickness or a comparable substitute approved by the Engineer.

All hardware shall be in accordance with standard commercial specifications and shall be approved by the Engineer.

Retroreflective sheeting shall conform to the requirements of Article M.18.09.

Materials Certificates shall be required confirming conformance to the requirements set forth in the plans and specifications for these barricades.

9.79.03—Construction Methods: The Contractor shall furnish a sufficient number of construction barricades required for the traffic patterns for all operations which are being undertaken concurrently. The barricades shall be constructed in a neat and workmanlike manner to the satisfaction of the Engineer.

Alternate stripes of white and orange Type III or Type VI retroreflective sheeting shall be applied to the horizontal members as shown on the plans. Only one type sheeting shall be used on a barricade and all barricades furnished on a construction project shall have the same type of retroreflective sheeting.

Any barricades that are missing, damaged, or defaced so that they are not effective, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor at no cost to the State.

When the barricades are no longer required on the project, they shall remain the property of the Contractor.

9.79.04—Method of Measurement: This work will be measured for payment by the number of construction barricades used on the project.

9.79.05—Basis of Payment: This item will be paid for at the contract unit price each for "Construction Barricade" of the type specified and used on the project. Each barricade will be paid for once, regardless of the number of times it is used on the project.

Pay Item	Pay Unit
Construction Barricade (Type)	ea. (ea.)

SECTION 9.80 CONSTRUCTION STAKING

9.80.01—Description: The work under this item shall consist of all construction layout and reference staking necessary for the proper control and satisfactory completion of all work on the project, except property lines, highway lines, or non-access lines.

9.80.02—Materials: All stakes used for control staking shall be of the same quality as used by the Department for this purpose. For slope limits, pavement edges, gutter lines, etc., where so-called "green" or "working" stakes are commonly used, other than standard Department quality stakes will be acceptable. Where laser grade control is used, a reference stake for verifying height of laser shall be required from the Contractor.

9.80.03—Construction Methods: The Department will furnish the Contractor such control points, bench marks, and other data as may be necessary for the construction staking and layout by qualified engineering or surveying personnel as noted elsewhere herein.

The Contractor shall be responsible for the placement and preservation of adequate ties to all control points, whether established by him or found on the project, necessary for the accurate re-establishment of all base lines or center lines shown on the plans.

All stakes, references, and batter boards including original, additional or replacement, which may be required for the construction operations, illumination work, signing and traffic control shall be furnished, set and properly referenced by the Contractor. He shall be solely and completely responsible for the accuracy of the line and grade of all features of the work. Any errors or apparent discrepancies found in previous surveys, plans, specifications or special provisions shall be called to the Engineer's attention by the Contractor for correction or interpretation prior to proceeding with the work.

The Contractor shall provide and maintain for the periods needed, as determined by the Engineer, reference stakes at 100-foot (30-meter) intervals outside the slope limits. Further, the Contractor shall provide and maintain reference stakes at 50-foot (15-meter) intervals immediately prior to and during the formation of subgrade and the construction of all subsequent pavement layers. These stakes shall be properly marked as to station, offset and shall be referenced to the proposed grade.

Upon request of the Engineer, the Contractor shall furnish copies of all data used in setting and referencing all stakes and other layout markings used by the Contractor.

When requested by the Engineer, the Contractor shall provide safe facilities for convenient access by Department forces to control points, batter boards, and references.

All staking shall be performed by qualified engineering or surveying personnel who are trained, experienced and skilled in construction layout and staking of the type required under the contract and who are acceptable to the Engineer. The personnel shall perform this staking under the direct supervision of a person, or persons, of engineering background experienced in the direction of such work and acceptable to the Engineer.

The Department may check the control of the work, as established by the Contractor, at any time as the work progresses. The Contractor will be informed of the results of these checks, but the Department by so doing in no way relieves the Contractor of his responsibility for the accuracy of the layout work. The Contractor shall, at his expense, correct or replace as required any deficient layout and construction work which may be the result of inaccuracies in his staking operations or of his failure to report inaccuracies in his staking operations or of his failure to report inaccuracies found in work done by the Department or by others. If, as a result of these inaccuracies, the Department is required to make further studies, redesign, or both, all expenses incurred by the Department due to such inaccuracies will be deducted from any monies due the Contractor.

The Contractor shall furnish all necessary personnel, engineering equipment and supplies, materials, transportation, and work incidental to the accurate and satisfactory completion of this work.

For roadways where the existing pavement markings need to be reestablished:

Prior to any resurfacing or obliteration of existing pavement markings, the Contractor and a representative of the Engineer must establish and document pavement marking control points from the existing markings. These control points shall be used to reestablish the positions of the lanes, the beginnings and endings of tapers, channelization lines for on and off ramps, lane use arrows, stop bars, and any lane transitions in the project area. The Contractor shall use these control points to provide appropriate premarking prior to the installation of the final markings.

The Contractor shall provide and maintain reference stakes and/or markings at 100-foot (30-meter) intervals immediately off the edge of pavement to be used to reestablish the existing pavement markings.

The Contractor shall also provide and maintain reference stakes and/or markings at any point where there is a change in pavement markings to reestablish the existing pavement markings.

9.80.04—Method of Measurement: Construction staking will be at the Contract lump sum for construction staking.

9.80.05—Basis of Payment: Construction staking will be paid for at the Contract lump sum price for "Construction Staking," which price shall include all materials, tools, equipment, labor and work incidental thereto.

Pay Item	Pay Unit
Construction Staking	l.s. (l.s.)

SECTION 9.81

42 INCH (1 METER) TRAFFIC CONE

9.81.01—Description: This item shall consist of furnishing 42-inch (1.07-meter) retroreflective traffic cones required on the project in conformance with the traffic control plans, as indicated in the "Maintenance and Protection of Traffic," as shown on the plans or as directed by the Engineer.

The Contractor shall have available on the project a sufficient number of traffic cones to fulfill all the requirements as specified in the contract and to replace those which have become damaged.

9.81.02—Materials: The traffic cone shall be manufactured of two-piece construction - cone and stabilizer base. The cone shall be constructed of impact-resistant orange plastic or rubber of a thickness able to withstand impact without damage to cones or vehicles. The bottom of the cone shall be 8 1/2 inches (216-millimeter) conical diameter tapering to the top of the cone which shall be 3 1/2 inches (89 millimeter) conical diameter. The design of the device will allow for the installation of a weighted stabilizer base. The stabilizer base shall not be round in shape. It shall have a hole in the middle to allow for quick placement over the cone. The base shall be constructed of impact-resistant black plastic or rubber ballasted to 18 pounds (8.2 kilograms).

The traffic cone shall have four retroreflective stripes attached alternately, two silver and two orange. The top stripe shall be a 6-inch (150-millimeter)-wide silver stripe attached 4 inches (100 millimeters) from the top of the cone and followed by 4-inch (100-millimeter) stripes spaced 2 inches (50 millimeters) apart.

Retroreflective stripes shall be fabricated from either Type III or Type VI retroreflective sheeting. All stripes shall be of one type of sheeting. The size of the stripes shall be as described above. Retroreflective sheeting shall conform to Article M.18.09.01.

9.81.03—Construction Methods: The stabilizer base shall be attached to the traffic cone in accordance with the manufacturer's instructions. The Contractor shall ensure that the devices are kept clean and bright.

9.81.04—Method of Measurement: This item will be measured for payment by the number of traffic cones used on the project.

9.81.05—Basis of Payment: This item will be paid for at the contract unit price for "42-inch (1-meter) Traffic Cone" used on the project. Each cone will be paid for once, regardless of the number of times it is used on the project.

Any traffic cones that are missing, damaged or defaced so that they are not effective, as determined by the Engineer, and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the contractor at no cost to the State.

When the traffic cones are no longer required on the project, they shall remain the property of the contractor.

Pay Item	Pay Unit
42-Inch (1-m)Traffic Cone	ea. (ea.)

**SECTION 9.99
DISPOSAL OF BUILDINGS**

9.99.01—Description: Under this item, the Contractor shall, if ordered by the Engineer, dispose of any or all buildings within the right of way or slope limits, or both, as shown on the plans and on the supplemental sheet entitled "Disposal of Buildings," which is made a part of the proposal. Upon written order of the Engineer to dispose of any building, said building shall become the property of the Contractor; and he shall, at his option, demolish, remove or otherwise dispose of said building. Upon receipt of said notice, the Contractor shall accept title and ownership of such buildings as listed thereon, also all risk of loss and any and all liability in connection therewith, and shall not rent or otherwise use them without written permission of the Engineer.

The Commissioner reserves the right to delete from the contract the removal of any of the buildings listed in the contract documents.

The Contractor's attention is called to the fact that buildings shown on the plans within the construction limits, and not included under this item, have been or will be removed by others at or about the time of beginning of construction work.

The State does not engage to protect any buildings against damage, in any form including loss of fixtures or equipment, or vandalism in the period between the bidder's inspection of such building and the time such building is formally released to him as described herein. The Contractor shall take this into account in placing his bid.

9.99.03—Construction Methods: The Contractor shall dispose of the buildings and, unless otherwise ordered by the Engineer, remove from the site all material resulting therefrom. He shall remove the structure to the top of the foundation elevation and shall break up any paved floors.

Upon receipt of the aforementioned written notice or notices, he shall as part of this item indemnify and save the State harmless for damages which might occur before, during or after the removal of the buildings and shall provide such shoring, bracing, barricades, fencing and other devices as may be necessary to protect adjacent properties and the public.

The Contractor shall arrange for the discontinuance or removal or both of all utility services at his own expense, unless otherwise provided.

Should the Contractor intend to move a building or have it moved, he shall advise the Engineer in writing at least ten days in advance of the move of his proposed method of operation and proposed location of the building.

Should the Contractor's progress be delayed for any reason, due to his decision to relocate or otherwise dispose of any structures, no claims for additional compensation or adjustment of time will be allowed by the Commissioner.

9.99.04—Method of Measurement: The Contractor shall submit a lump sum bid price for the disposal of all buildings on the project as shown on the supplemental sheet entitled "Item 999001A—Disposal of Buildings," attached to the Proposal and in accordance with the instructions shown on the sheet "Bidding Procedure" included with the Proposal. This lump sum shall be the total of the amounts shown by the Contractor on the above-mentioned list for each individual unit. This lump sum total shall be the difference between the "Plus (+)" and "Minus (-)" columns shown on the Supplemental Sheet entitled "Item #999001A—Disposal of Buildings." Should any unit so listed to be disposed of be deleted for any reason, the lump sum bid will be adjusted by the amount bid for the unit as shown on the supplemental sheet attached to the proposal.

9.99.05—Basis of Payment: This work will be paid for by the State or paid for by the Contractor at the contract lump sum for the "Disposal of Buildings" as adjusted in accordance with the provisions of the above paragraph, which price shall include all materials, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Disposal of Buildings	l.s. (l.s.)

**SECTION 10.00
GENERAL CLAUSES FOR HIGHWAY
ILLUMINATION AND TRAFFIC SIGNAL
PROJECTS**

10.00.01—General

10.00.02—Inspection of Work and Relief of Maintenance Responsibility for Highway Illumination Work

10.00.03—Plans

10.00.04—Materials and Equipment

10.00.05—Regulations, Permits, Fees

10.00.06—Protection of Equipment and Work

10.00.07—Maintenance of Completed and Existing Construction

10.00.08—Prosecution of Work

10.00.09—Removal of Rubbish and Cleaning Up

10.00.10—Tests: Preliminary and Final

10.00.11—Excavation and Miscellaneous Work

10.00.12—Negotiations with Utility Company

10.00.13—Service Installations

10.00.01—General: It is the intent of the plans, specifications, and special provisions to provide for a complete lighting system or traffic control signal installation, as the case may be, operating as designed and specified in the contract documents.

Where not specifically covered on plans, in specifications or special provisions, equipment shall be installed according to manufacturer's published recommendations.

10.00.02—Inspection of Work and Relief of Maintenance Responsibility for Highway Illumination Work: Upon completion of all work, the lighting system will be energized and a semi-final inspection held. The Engineer will submit an inventory of all unacceptable work. A 30-day test period will begin the day of the inspection. The lighting will be monitored, and any malfunctions or outages shall be attended to and corrected by the Contractor within 48 hours and to the satisfaction of the Engineer. Failure to comply or properly attend to reported problems will result in the test period being restarted. At the discretion of the Engineer, repetitive or recurring malfunctions may cause the test period to restart. After the successful completion of the 30-day test period, and if all corrective and clean-up work has been completed, a final inspection will be held in accordance with 1.08.12. The Contractor may then request relief of maintenance responsibility for the lighting system. Partial acceptance may be made in accordance with article 1.08.12.

10.00.03—Plans: The Contractor shall advise the Engineer of any change of measurement or layout from the plans submitted to him. He will be furnished two black and white prints of the plans on which to record all changes. These are to be delivered to the Engineer upon completion of the project. Also upon completion of the project, the Contractor shall deliver to the Engineer the following:

- (1) Four (4) paper prints of schematics and wiring diagrams of all cabinets, controllers and auxiliary equipment in accordance with the following requirements:
 - (a) Each separate wiring diagram shall list the Town and Location information in the lower right hand corner.
 - (b) Each and every cabinet wiring diagram copy must show the as built field wiring. No cross-outs, or separate lists will be accepted.
 - (c) Field hookups (signals, detector and coordination, etc.) must be shown on either the cabinet wiring diagram (face # G,Y,R, etc.) or separate hookup sheet.
 - (d) Auxiliary equipment drawings must be completely labeled (connection to connection). Auxiliary relays, coordination units and time switches, etc. must be accompanied with all necessary information such as manufacturer, voltage ratings and type of mounting base, etc.
 - (e) Special information such as controller start-up, controller overlap programming, controller sequence, PROM numbers, and conflict monitor programming, etc. must be plainly labeled on the cabinet wiring sheet.
- (2) A comprehensive service manual for each type controller, conflict monitor, detector amplifier, coordination equipment, pre-emotion equipment and all other auxiliary equipment furnished.
- (3) A comprehensive parts list detailing all replaceable components as to manufacturer's part number

and commercially available part number and manufacturer's net price each. This list may be referenced from the drawings supplied with the equipment.

The Contractor shall study plans and details and use them as a guide in determining location of illumination and traffic signal equipment. Any discrepancies shall be referred to the Engineer for settlement.

10.00.04—Materials and Equipment: All electrical equipment shall meet the requirements of the plans and specifications and shall conform to section 1.06 Control of Materials.

The warranties that the Contractor receives from each manufacturer of materials and equipment pertinent to the complete and satisfactory operation of the proposed system shall be turned over to the Engineer at the time of acceptance of the project at no cost to the State. Each warranty so furnished shall indicate its expiration date.

10.00.05—Regulations, Permits, Fees: All work shall be done in strict accordance with the latest edition of the NEC, rules and regulations of the State authorities having jurisdiction over such work, and regulations of the utility companies in force where work is being installed. On traffic signal projects, The MUTCD for Streets and Highways shall also govern. All permits shall be obtained and fees paid for by the Contractor.

10.00.06—Protection of Equipment and Work: The Contractor shall adequately protect all equipment, material, tools and work on the premises against theft, destruction by weather or other causes, and shall assume full responsibility for such protection until final acceptance of work by the Commissioner. All material shall be placed or stored in such location so that it will not be a hazard to the traveling public.

The Contractor shall provide adequate protection for his own forces and that of the public in the various locations and phases of the work. Barricades or covers shall be used where deemed necessary to promote safety.

10.00.07—Vacant:

10.00.08—Prosecution of Work: Prior to starting work, an "on-site" meeting shall be held between the Engineer, Contractor and other concerned parties. The purpose of this meeting shall be to coordinate work, review available facilities for work and storage areas, and prepare a preliminary schedule of the work.

Upon receipt of Notice to Proceed, the Contractor shall inform the Department at the District Office of the time at which he will begin actual contract work; and he shall do no work thereafter without knowledge of the Department.

All work shall be done by qualified and experienced mechanics of each labor class, as determined by the Engineer. All work shall be inspected and approved by the Engineer before concealment.

The Contractor will not be allowed to install traffic signals or pedestrian heads until the controllers are on hand and ready for installation. Once installation of this equipment commences, the Contractor shall complete this work in a most expeditious manner. At locations where existing steel span poles are utilized in the design, the Contractor shall remove the old signals before installing the new signals or install temporary anchors on the poles in order to prevent overloading.

10.00.09—Removal of Rubbish and Cleaning Up: The Contractor shall at all times keep the site free from accumulation of waste materials or rubbish caused by his employees or work; and at the completion of work shall dispose of all such rubbish and non-usable fill or rock from the site; and remove all his tools, equipment, and surplus materials. The Contractor shall leave the site and his work in a clean and orderly condition. Upon completion of his work, the Contractor shall clean all equipment of grease, dirt, etc.

10.00.10—Tests: Preliminary and Final

(1) **Highway Illumination Projects:** The Contractor shall perform all operational tests, in the presence of the Engineer. The Contractor at the Contractor's expense shall supply operational tests and testing equipment.

Upon request, the Contractor shall demonstrate that all ground rods shall have a resistance to earth of not more than 25 ohms. Also, upon request, the Contractor shall perform insulation testing which shall be a minimum of 1000 ohms per volt.

(2) **Traffic Signal Projects:** The Contractor shall arrange for and provide all the necessary field tests, as directed by the Engineer, to demonstrate that the installation is in proper working order and in accordance with the plans and specifications.

All tests and test equipment shall be supplied at the Contractor's expense.

All Acceptance Testing of Contractor furnished and installed hardware and software shall be conducted as described below. Tests that apply to the operation of the computer will not be required at intersections that are not under computer control.

Prior to acceptance of the work, the Contractor in the presence of the Engineer shall make the following tests.

(a) **Detector Acceptance Test:** Detector acceptance tests shall be conducted for all system and local detectors. The Contractor shall perform the tests and document the test results on a detector test chart that will provide the following information:

1. **Megger Test:** A 600-volt megger test shall be performed between each circuit and ground for each loop lead-in cable circuit. The cable shall maintain a resistance to ground of not less than 10 mega-ohms. Actual measured resistance shall be recorded.
2. **Loop Circuit Test:** Each loop and lead-in circuit shall be tested for continuity, resistance, and inductance. Resistance shall not exceed four ohms. Total inductance of segmented loops shall be between 70 and 400 micro-Henries. Actual measured resistance and inductance shall be recorded. The detector acceptance tests for all local actuation detectors installed at the intersection shall have been successfully completed prior to initiating the intersection acceptance test.
3. **Power Interruption Test:** Each detector shall be tested for power interruptions to assure that the sensor unit automatically re-tunes each channel when power is restored. The results of this test shall be recorded.

LOOP DETECTOR TEST DATA

PROJECT:

TOWN:

SHEET:

	Resistance		Inductance		Power
Loop	Ohms		Micro Henries		Interruption
Number	To Ground	Loop wire	Calculated	Measured	Pass/Fail

The calculated inductance is the sum of the loop (or segmented arrangement) and the lead-in cable.

Resistance to ground and loop circuit resistance shall be measured at the controller cabinet.

Loop circuit inductance shall be measured at the handhole where the loop or series spliced segmented arrangement is to be spliced to the lead in cable.

When the tests are completed, whether successful or not, the test results documentation shall be furnished to the Engineer.

(b) **Intersection Acceptance Test:** An intersection acceptance test shall be conducted and successfully completed prior to acceptance of each intersection.

The test is designed to demonstrate that the field equipment installed at each intersection is installed properly and that all functions are in conformance with the plans and specifications. The Department reserves the right to make adjustments to the timing of the controllers during and after test periods. These

timing adjustments shall not relieve the Contractor of any responsibility otherwise set forth in the Contract.

- 1. Visual Final Inspection:** All intersection-related construction such as controller, local actuation detectors, all cabinet accessories, and all cabinet wiring shall be complete and in place. This shall include space for, and the wiring harness for the Closed Loop Master Unit (CLMU) and the Closed Loop Local Coordination Unit (CLLCU). It is not required that the CLMU and the CLLCU be installed or that the closed loop system be operational for the test.

All signal display hardware including, but not limited to, support structures, signal heads, pedestrian push-button, conduit, junction boxes, etc., shall be complete and in-place. All intersection restoration work including items such as sidewalks, streets, curbs, gutters, and grassed areas, shall be completed, unless the Engineer grants an exception. All Signs and Markings specified shall be installed prior to placing the traffic signal in operation unless the Engineer grants an exception. Only when the visual intersection inspection is acceptable to the Engineer shall the second part of the test commence.

- 2. Preliminary Functional Test:** At locations where an existing traffic signal installation is to be revised/replaced, a preliminary functional test shall be conducted to allow the Contractor to transfer control of the intersection from the existing traffic control equipment to the new equipment. The Office of Traffic and the District Electrical Maintenance Office must be contacted when a preliminary functional test is scheduled. An engineer from the Office of Traffic does not have to be present during the preliminary test unless requested by the Engineer. However, a qualified representative of the traffic controller manufacturer or distributor, must be present to correct any technical malfunction that may occur. At that time the existing signal may be taken out of operation and removed. At no time shall the signal be left unattended in automatic operation unless authorized by an engineer from the Office of Traffic.

If the new signal is not operating properly, the old controller shall continue to operate the signal and the Contractor, at his own expense, shall make all necessary repairs, adjustments, changes or replacements promptly and to the satisfaction of the Engineer.

When all work is completed and the signal installation is operating properly, the new signal may be left on automatic operation and the existing signal may be taken out of operation and removed.

At locations where there is no existing traffic signal, the above preliminary functional test does not apply. The Engineer shall verify that the new traffic signal equipment is operating according to plan prior to scheduling the functional inspection.

- 3. Functional Inspection:** Upon completion of the installation and the above tests, the Engineer shall notify the Office of Traffic and the District Electrical Maintenance Office that the installation is complete and shall arrange a time for an engineer from the Office of Traffic and a representative from the District Electrical Maintenance Office to conduct the Functional Inspection and complete the Intersection Acceptance Test of the traffic signal. A qualified representative of either the traffic controller manufacturer or the distributor must also be present during the Functional Inspection. A punch list of traffic signal items shall be provided to the Contractor as a result of the Functional Inspection.

A 30-day test shall start at the successful completion of the Functional Inspection. All electronic and electromechanical equipment, including but not limited to the controller, conflict monitor, detector amplifiers, load switches and flasher, shall be tested for proper operation for 30 consecutive days. During this testing period, all equipment shall operate without failure of any type. The test shall begin anew each time a failure is identified. The 30-day working test period shall not start until an engineer from the Office of Traffic and a representative from the District Electrical Maintenance Office has inspected the installation. The Contractor shall be responsible for all equipment installed until the 30-day test is terminated and all punch-list items identified on the Visual Final Inspection and the Functional Inspection have been addressed and resolved. The 30-day working test period shall not be considered complete until final sets of cabinet wiring diagrams have been received by the Municipality or the Department of Transportation, Office of Maintenance, for each intersection under test. The 30-day working test period will not apply to any equipment furnished by the State and installed by the Contractor.

The Engineer may adjust any timing during this period to fully test the functional operation of the equipment installed. If any failures are identified, the Contractor shall replace or repair the defective equipment within 24 hours of notification by the Engineer.

All necessary corrections and adjustments shall be made promptly by the Contractor so as to make the installation satisfactory to the Engineer and at no additional cost to the State.

When both parts of the Intersection Acceptance Test are successfully completed and the 30-day test period

has passed, the intersection shall be accepted by the Engineer. It may be possible that all of the traffic signal controllers in the system have completed their 30-day functional test period before the traffic signal interconnect system has been completed.

The Engineer shall issue an acceptance letter to the Contractor, or permitter if the traffic signal has been installed by permit, stating the 30-day test start and completion dates and relieving the Contractor from maintenance responsibility of the traffic controller. All traffic signal punch list items, identified at the Functional Inspection, shall be resolved prior to issuance of the acceptance letter. The party who assumes ownership shall also receive a copy of the acceptance letter. Completion of the 30-day test period relieves the Contractor of normal maintenance responsibility including accidental damage or vandalism. The Contractor shall repair or replace any equipment found to be defective or damaged due to poor workmanship or the Contractor's operations.

- (c) **CLOSED MASTER UNIT (CLMU) AND CLOSED LOOP LOCAL COORDINATION UNIT (CLLCU) ACCEPTANCE TEST:** The CLMU and CLLCU shall be tested before the communications test and prior to performing the final acceptance test. The test shall be performed by installing the CLMU and the CLLCU in the controller cabinet and inhibiting all outputs to the controller. Units failing to successfully complete the test will be rejected. The Contractor shall submit a test plan of procedures required to test all major functions of the coordination equipment. All tests shall be performed and documented by the Contractor and copies of the test results furnished to the Engineer.
- (d) **Final Acceptance Test:** The final acceptance test shall consist of two sequential periods: **Intersection Pickup** and **Evaluation and Analysis**. When the requirements of each of the two periods have been met, the system shall be accepted. The requirements for each of the two periods are described below.

The Contractor shall make, and fully document, all modifications made to correct operations that are not in conformance to the special provisions.

The Engineer reserves the right to halt the test at any time, if in his sole judgment, errors or inconsistencies in the performance of any part of the system would lead to improper, inefficient, or unsafe operation of the traffic signal.

- 1. Intersection Pickup:** Intersection pickup will consist of performing actual on-line functions between the local coordination equipment and ConnDOT's Highway Operations Center in Newington. After the Intersection Acceptance Test has been performed at each location, the Engineer shall notify the Computer Systems Unit to schedule an Intersection Pickup test of the closed loop or UTCS system. The Contractor, in the presence of the Highway Operations Systems Engineer, shall perform and document the actual pickup testing of all functions associated with each intersection, in accordance with the timing plans.

It shall be the responsibility of the Contractor to correct any equipment malfunctions that caused a failure. The intersection pickup period shall continue until all intersections in the system have been completed.

- 2. Evaluation and Analysis Period:** The evaluation and analysis period shall commence when all intersections have been picked up. There shall be at least 7 days between the successful pickup of the final intersection and the beginning of the evaluation and analysis period. The evaluation and analysis period shall be 30 days in length.

During the evaluation and analysis period, the Engineer will be provided full access to the field equipment in order to evaluate the system for conformance with the Special Provisions. During this period of time, the Contractor will be required to continue maintenance of the signals and may perform any final clean-up, adjustments of the signals, etc., that are necessary and shall cooperate with the Engineer such that evaluation and analysis of the system may continue unimpeded. During this period of evaluation and analysis, the Contractor shall demonstrate any system function as requested.

The Engineer shall advise the Contractor in writing of any portions of the system that do not meet the requirements of the Special Provisions. The Contractor shall promptly make modifications that may be required to bring the system in conformance with the Project requirements. If changes are required to any hardware units that require a retrofit, the 30-day evaluation and analysis period shall begin anew after the hardware changes are completed on all units.

Failure conditions occurring during the evaluation and analysis period that require replacement of a major system element installed by the Contractor, shall cause the count of time for the evaluation and analysis to be discontinued until such time that the corrections have been made. The evaluation and analysis time will commence upon correction of the condition and will continue for the duration of the remaining time of the

evaluation and analysis period.

Final acceptance will occur at the successful completion of the 30-day evaluation and analysis period.

10.00.11—Excavation and Miscellaneous Work: All cuts in pavement, sidewalk surfaces, and concrete aprons shall be done in a neat and workmanlike manner, so as to cause the least possible damage. Any property damage caused by excavation shall be repaired as directed by and to the satisfaction of the Engineer at no additional compensation. Excavating shall not be performed until immediately before installation of conduit and other appurtenances. The material from the excavation shall be placed where directed by the Engineer at a location where the least damage and obstruction to vehicular and pedestrian traffic will occur and the least interference with surface drainage.

All excavated material shall be removed and disposed of by the Contractor in accordance with the provisions of Section 2.02. Excavations, after backfilling, shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

At the end of each day's work and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic.

All excavation shall be closed, and sidewalks, pavements and landscaping restored at each intersection prior to opening any other intersection, unless the Engineer otherwise approves it.

Excavations shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time unless otherwise directed by the Engineer.

Where excavations occur in sidewalks or other pedestrian ways, provisions shall be made to provide a safe orderly pedestrian passage around the excavation area, the use of which shall not subject the pedestrian to hazard from traffic or construction operations or to walk upon unsuitable and hazardous surfaces.

All cutting and patching shall be held to a minimum. Necessary cutting and patching shall be neatly done and in all patching, special care shall be given to water sealing and bonding. On exposed work, patching shall match adjacent areas. In sidewalk areas where foundations, handholes or conduit is required to be installed, the concrete sidewalk shall be sawcut to neat lines no larger than necessary for the installation of the foundation, handhole or conduit. The complete square of sidewalk shall be removed only if shown on the plans or directed by the Engineer.

Upon completion of excavation, the Contractor shall final grade, seed and fertilize in accordance with Section 9.50 all landscape grass areas disturbed by his construction.

Before the Contractor installs any cable, all conduit and junction boxes shall be cleaned and swabbed to allow cables to be freely installed. Pressure-sensitive vehicle detectors shall be cleaned and checked to see if in working condition. Foundations shall be checked for bolt circle dimensions where required.

All poles and pedestals shall be bonded to the conduit ends by means of a jumper running from bushings on the conduit ends to a grounding lug on the pole or pedestal. At the controller locations the grounding circuit shall be carried from the ground bushing on the conduit up into the controller cabinet. All conduit within junction boxes shall be bonded together.

All dimensions shall be verified on site, actual always taking precedence over scale dimensions, with every part of the plans fitted to actual conditions at the site.

Warning Markings for Underground Facilities shall be installed in accordance with Article 1.05.15.

10.00.12—Negotiations with Utility Company: The Contractor shall be responsible for all negotiations with and between the utility company.

The Contractor shall assume all charges and make all necessary arrangements with the power company for the required electrical services necessary for the energizing of the highway illumination and traffic signal installations, for the installation of wood poles, for signal messenger or span wire which runs between or to utility company poles and for anchors and anchor guys necessary on wood poles. The Contractor shall comply with the utility company regulations. The utility company will connect and disconnect the power as required. The Contractor shall pay any charges incurred.

When an entry into a service manhole or attachment to any utility company pole is required, the Contractor shall notify the utility company involved sufficiently in advance; and under no condition shall the Contractor enter any manhole or place an attachment to a utility company pole without a utility company representative present.

10.00.13—Service Installations: Service installations shall be in accordance with the NEC and with the requirements of the local utility company involved.

Service points shown on the plans are approximate only. The Contractor shall determine exact locations

from the serving utility.

The Contractor shall arrange with the serving utility to complete service connections.

The Contractor shall arrange for furnishing electrical energy. Energy used prior to completion of the contract will be charged to the Contractor except that the cost of energy used for public benefit, when the Engineer directs such operation, will be borne by the State.

**SECTION 10.01
TRENCHING AND BACKFILLING**

10.01.01--Description: Work under this item shall consist of trenching, backfilling and satisfactory disposal of all surplus excavated material, the removal of which is necessary for the proper installation of conduit or cable at the locations shown on the plans or as directed by the Engineer.

It shall also include the encasement of conduit or cable in sand, grading and placement of topsoil, fertilizing, seeding, and mulching, and the removal and reconstruction of riprap, crushed stone, pavement or bituminous concrete sidewalk structure of all disturbed areas within the maximum trenching limits shown on the plans.

10.01.02--Materials: The materials for this work for the encasement of conduit or cable, shall be bedding material, all of which passes a 3/8-inch (9.5-millimeter) sieve, and not more than 10% passes a No. 200 (75-micron) sieve.

Topsoil, fertilizer, seed and mulch shall conform to Section M.13.

Pavement and sidewalk shall conform to Sections M.02, M.03 and M.04.

Bituminous Concrete – Class 2 shall conform to Article M.04.01.

10.01.03--Construction Methods: Trenches shall be of the depth and cross-section shown on the plans. The sand for encasement shall be placed as shown on the plans.

After the excavation is completed, the Contractor shall notify the Engineer; and no conduit or cable shall be placed in the excavated area until the Engineer has approved the depth and cross-section of the excavation.

Suitable material removed in making the excavation shall be used for backfill. No stones or coarse material shall be placed adjacent to the conduit or cable. All surplus or unsuitable material shall be removed and disposed of as directed. Should additional material be required for backfilling, it shall be obtained from sources approved by the Engineer.

All backfill shall be placed in layers of not more than 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted by means of vibrators or by pneumatic tampers. Hand tampers shall be used only with permission of the Engineer. The backfill shall be brought to the surface of the surrounding ground and neatly graded, except that where excavation is required in existing lawn or grass areas, the backfill shall be brought to within 4 inches (100 millimeters) of the top of the trench; and the remainder shall be filled with topsoil to 3/4 inch (20 millimeters) above adjacent areas as directed by the Engineer. Marking tape shall be installed in the trench at the depth and to the requirements set forth in Article 1.05.15.

Where trenching occurs in riprap or crushed stone areas, the surface material shall be replaced in kind. Where trenching in bituminous concrete sidewalk or paved areas, the trench shall be sawcut and backfilled to within the depth from the surface required to replace the removed sidewalk or pavement structure, which shall then be replaced. The edges of all trenches in paved surfaces shall be sawcut to neat lines prior to paving. All trenches in existing paved surfaces, which parallel the curb, shall be no more than 1 1/2 feet (500 millimeters) from the curb, or when no curb is present, the apparent edge of road. The exception shall be to avoid existing appurtenances such as catch basins, water gates, manholes etc.

Where a trench is placed through a concrete sidewalk, the entire section of sidewalk between joints shall be replaced in accordance with Section 9.21, unless otherwise directed by the Engineer.

10.01.04--Method of Measurement: This work will be measured for payment by the number of linear feet (meters) of trenching and backfilling, complete and accepted. If rock, conforming to the description given under Article 2.05.01, is encountered, the Contractor shall strip it of sufficient overlying material to allow for proper measurement, and shall notify the Engineer that the rock surface is ready for measurement. If the Contractor fails to give such notice, the Engineer will presume the measurements taken at the time he first saw the material in question will give the true quantity of rock excavation.

For measurement where rock is encountered in trenching, payment lines shall be vertical and 2 feet (600 millimeters) in width.

10.01.05--Basis of Payment: This work will be paid for at the Contract unit price per linear foot (meter) for "Trenching and Backfilling," which price shall include all materials, tools, equipment and labor necessary to complete the excavation in conformity with the plans or as ordered.

It shall also include all sand encasement, backfilling, grading, seeding, fertilizing, mulching, disposal of surplus material, sawcutting sidewalks and paved areas, as well as furnishing and installing riprap, crushed stone, topsoil, sidewalk, pavement or structure, as the case may be.

When rock, conforming to the description given under Article 2.05.01 is encountered within the limits of trenching, its removal will be classified; and the accepted quantities of rock in trench excavation will be paid for at the Contract unit price per cubic yard (cubic meter) for "Rock in Trench Excavation."

Any backfill material required, whose source is other than the trenching excavation, will be paid for at the Contract unit price for the material being used or as extra work if no unit price has been established.

Any pavement or bituminous concrete sidewalk replaced beyond the maximum trench limits as shown on the plans and approved by the Engineer, will be paid for at the Contract unit price for the material being used, or as extra work, if no unit price has been established.

All concrete sidewalk replaced due to trench excavation, including that within the trench limits, shall be paid for at the Contract unit price for "Concrete Sidewalk".

Pay Item	Pay Unit
Trenching and Backfilling	l.f. (m)

SECTION 10.02
LIGHT STANDARD AND TRAFFIC CONTROL
FOUNDATIONS

10.02.01—Description: This item shall consist of furnishing and installing a light standard or traffic control foundation of the type called for at the location and to the dimensions and details shown on the plans or as directed by the Engineer and in conformity with these specifications. Rock, in so far as it applies to "Rock in Foundation Excavation," shall be defined as rock in definite ledge formation, boulders, or portions of boulders, cement masonry structures, concrete structures or Portland cement concrete pavement which has a cross-sectional area that exceeds 50% of the cross-sectional area of the designed foundation hole.

10.02.02—Materials: The materials for the work shall conform to the following:

- Article M.02.01 for Gravel Fill
- Article M.03.01 for Class "A" Concrete
- Article M.04.01 for Class 2 Bituminous Concrete
- Article M.06.01 for Bar Reinforcement
- Article M.08.02-4 for Precast Concrete
- Article M.13.01 for Topsoil
- Article M.13.03 for Fertilizer
- Article M.13.04 for Seed Mixture
- Article M.13.05 for Mulch Materials
- Article M.15.02 for Anchor Bolts
- Article M.15.03 for Rock Anchors
- Article M.15.09 for Electrical Conduit
- Article M.15.15-7 for Ground Rods

10.02.03—Construction Methods: The Light Standard and Traffic Control Foundations shall be constructed in accordance with the pertinent provisions of Article 6.01.03. Only the Type I Light Standard or Type I Traffic Control Foundation may be precast. The Engineer shall decide whether rock anchors shall be used or the rock shall be excavated. The finished elevation of the top of the foundation shall be as shown on the plans. The final elevation of the top of the light standard foundation shall be 1 1/2" (38 millimeters) above finished grade or as directed by the Engineer. The top of the foundation shall be level in all respects. Concrete for foundation shall be placed monolithically against undisturbed soil for poured in place foundations. Necessary electrical conduit, anchor bolts, ground rod sleeves and ground rods shall be placed in proper position and shall be held in place by means of a template. The concrete may be placed against the sides of the excavation, however, the exposed portion of the foundations shall be formed to the neat lines as shown on the plans. When in the judgment of the Engineer, unusual soil conditions prevent excavation to neat lines as shown on the plans, the complete foundation shall be formed.

After the forms have been completely removed, the entire excavation shall be backfilled in accordance with Section 2.14. All conduits shall be capped with standard pipe caps before placing the concrete and shall remain capped until the cable is installed. Electrical conduit of the size indicated shall extend 2 feet (600 millimeters) outside the foundation. All portions of the foundations which will remain exposed to view shall be finished to the satisfaction of the Engineer. Forms shall not be removed until after the concrete has hardened properly and not less than 24 hours after the concrete has been placed. The Contractor shall allow sufficient time for the foundation to cure before placing any strain on the foundation. Steel poles shall not be installed until a minimum of seven days after the concrete has been placed and a minimum of ten days before making span wire attachments thereto. Mast arm assemblies shall not be installed until 10 days after the concrete has been placed.

Where a foundation is placed within or adjacent to a concrete sidewalk, the entire section of sidewalk between joints shall be replaced in accordance with Section 9.21, unless otherwise directed by the Engineer.

10.02.04—Method of Measurement: Light Standard and Traffic Control Foundations of the type specified shall be measured for payment by the number of units installed and accepted. This measurement shall include the electrical conduit sweeps which shall extend 2 feet (600 millimeters) outside of the foundation.

The rock-in-foundation excavation will be measured from the top of rock to the bottom of rock excavation. Gravel will be measured in accordance with Article 2.13.04.

10.02.05—Basis of Payment: This work will be paid for at the Contract unit price each for Light

Standard or Traffic Control Foundation: of the type called for, which price shall include all materials, equipment, forms, excavation, disposal of surplus material, Class "A" concrete, electrical conduit sweeps, conduit caps, ground rod, sleeves, bonding bushings, anchor bolts, backfill, topsoil, grading, seeding, fertilizing, mulching, riprap, restoration of bituminous concrete sidewalk and pavement surfaces. All concrete sidewalk replaced due to foundation installation shall be paid for at the Contract unit price for "Concrete Sidewalk".

When rock is encountered within the limits of excavation, its removal will be paid for at the Contract unit price per vertical foot (vertical meter) for "Rock-in-Foundation Excavation," which price shall include any additional excavation to remove the rock and any additional concrete required to fill the excavation beyond the designed foundation hole dimensions.

Pay Item	Pay Unit
Light Standard Foundation (Type)	ea. (ea.)
Traffic Control Foundation (Type)	ea. (ea.)
Rock in Foundation Excavation	v.f. (v. m)

**SECTION 10.03
LIGHT STANDARDS**

10.03.01—Description: This item shall consist of furnishing and installing light standards of the type specified with removable transformer bases, brackets, dampers, grounding wire and connections, complete in place, at the locations and to the dimensions and details shown on the plans or as directed by the Engineer. It shall also include furnishing and installing light standards of the type specified with anchor bases, brackets, elastomeric leveling pads, handholes and covers, complete in place, at bridge or structure locations, and to the dimensions and details shown on the plans or as directed by the Engineer.

10.03.02—Materials: The materials for this work shall conform to the following requirements:

Light standard (aluminum), shall conform to the requirements of Article M.15.04.

10.03.03—Construction Methods: Light standards shall be fastened securely to the anchor bolts in the concrete light standard foundation, bridge, or structure. Light standards mounted on any bridge or structure shall have a vibration isolation pad installed between the pole base and the structure with four reinforced elastomeric washers installed on the top side of the base, between two standard galvanized flat washers. The completely assembled light standard shall be erected plumb with the aid of aluminum shims, if necessary. The mounting height shall be as called for on the plans, measured from the center of the light source to the pavement directly below. Brackets shall be erected with the bracket placed perpendicular to the centerline of the roadway.

The top of the shaft shall be drilled to accept three self-tapping screws. Pole caps shall be attached securely with three stainless steel set screws.

Each light standard shall be effectively grounded with #8 AWG ground wire attached to the light standard by an approved aluminum to copper lug and a stainless steel bolt, run to the ground rod, and connected with a square head bolt clamp.

Light standards shall be numbered with strip tags. These tags shall be reflective and not less than 1 3/8 inch x 1 7/8 inch (35 millimeters x 50 millimeters). The tags shall be located 8 feet (2.5 meters) above the grade on the road side of the light standard. In locations where light standards are mounted in the median, tags shall be located on both road sides. The town number will be the top number and the pole number will be the bottom number.

10.03.04—Method of Measurement: This work will be measured for payment by the number of light standards of the type specified, complete and accepted in place.

10.03.05—Basis of Payment: This work will be paid or at the Contract unit price each for "Light Standard" of the type specified, complete in place, which price shall include all materials, including dampers, shaft, brackets, transformer bases, washers, nuts, bolts, bolt covers, ground wire, strip tags, connections, elastomeric leveling pads, and all equipment, tools, labor incidental thereto, including pole certification and field-checking bolt circle diameters.

Pay Item	Pay Unit
Light Standard (Type-Size-Kind)	ea. (ea.)

SECTION 10.04
ROADWAY LUMINAIRE

10.04.01—Description: This item shall consist of furnishing and installing a luminaire of the type and size called for on the plans with integral ballast, lamp, fuses, fuse holders, and conductors from the luminaire to the distribution circuit, in accordance with these specifications.

10.04.02—Materials: The materials for this work shall conform to the requirements of Article M.15.05.

10.04.03—Construction Methods: The luminaire, with integral ballast, shall be installed at the end of the bracket and shall be leveled to the road surface, securely fastened, lamped, connected, cleaned and ready for operation. Socket shall be in position to provide the IESNA light distribution type called for on the plans.

Conductors shall be run from the ballast primary terminal in the luminaire to the breakaway fuse holders in the pole base or junction box. Each ungrounded leg shall have a fuse holder containing a 10-amp fuse. Each neutral conductor shall have a fuse holder with a white connecting nut containing a brass slug in place of a fuse.

10.04.04—Method of Measurement: This work will be measured for payment by the number of luminaires of the type and size specified, installed and accepted.

10.04.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Roadway Luminaire" of the type and size specified completed and accepted in place, which price shall include all materials, including luminaire, ballast, conductors, connectors, lamp, brass slug, fuses, fuse holders, identification sticker, photoelectric control where required, and all labor, tools, equipment and work incidental thereto.

Pay Item	Pay Unit
Roadway Luminaire (Type-Size)	ea. (ea.)

SECTION 10.06
UNDERBRIDGE LUMINAIRE

10.06.01—Description: This item shall consist of furnishing and installing a luminaire of the kind, type and size called for on the plans with necessary mountings, conduit, conductors, fuses, fuse holders, lamp and integral ballast as shown on the plans and details or as directed by the Engineer and in conformity with these specifications.

10.06.02—Materials: The materials for this work shall conform to the requirements of Article M.15.07.

10.06.03—Construction Methods: The underbridge luminaire shall be installed at the location and to the dimensions shown on the plans and details.

The wall or pendent mounted luminaire shall be installed as detailed on the plans. The pendent mounted luminaire shall provide the IESNA light distribution type called for on the plans.

Conduit shall be installed in accordance with Article 10.08.03.

Conduit shall be installed from the junction box or handhole to the luminaire on the surface of the bridge structure or along the top of the concrete piers or between the bridge girders.

The conductors shall be installed in the conduit from the luminaire to the junction box or handhole and connected to the lighting circuit with fuses and fuse holders.

10.06.04—Method of Measurement: This work will be measured for payment by the number of underbridge luminaires, complete and accepted in place.

10.06.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Underbridge Luminaire," complete in place, which price shall include all materials, including fuses, fuse holders, conduit, luminaire, ballast, reducers, lamp, mounting plate, conductors, all the hardware, fittings, expansion fittings, flexible conduit, straps, backspacers, conduit clamps, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Underbridge Luminaire (Kind-Type-Size)	ea. (ea.)

**SECTION 10.08
ELECTRICAL CONDUIT**

10.08.01—Description: This item shall consist of furnishing and installing conduit of the size and type specified with necessary fittings, where called for, at locations shown on the plans or as directed by the Engineer and in accordance with these specifications.

10.08.02—Materials: Materials for this work shall conform to the requirements of Article M.15.09.

10.08.03—Construction Methods: The conduit shall be installed in the locations and to the dimensions shown on the plans or as directed by the Engineer. All conduit runs shall be installed in a neat and workmanlike manner in accordance with recognized trade practices. Trenching and backfilling of conduit shall conform to Article 10.01. All conduit shall be installed in strict accordance with the current NEC. Where conduit is to be capped, a commercial pipe or conduit cap shall be used. An expansion fitting shall be used wherever required by an expansion joint in the structure. Upon completion of the work, all conduits shall be cleaned, swabbed and free from obstructions and burrs. For buried conduit, marking tape shall be installed in the trench at the depth and to the requirements as set forth in the Article 1.05.15. After all cable has been installed, U.L. approved duct sealing compound shall be installed in the ends of all conduit which terminates in foundations, handholes, junction boxes and manholes.

1. Conduit Surface: Beam clamps or conduit strips with back spacers shall be provided at intervals in accordance with the NEC. Expansion fittings shall be installed at all expansion joints. All surface mounted conduit on wood poles shall be bonded to a driven ground rod. Stand-offs shall be installed in accordance with serving utility company regulations.

2. Conduit in Trench: Trenches shall be of the depth and cross section shown on the plans or as directed by the Engineer. All conduit shall have a minimum covering of 2 feet (600 millimeters).

3. Conduit Under Roadway: Installations shall be such as to avoid pockets in runs. Conduit shall have a minimum cover of 2 feet (600 millimeters). Each end of conduit runs shall terminate with a cap in a concrete handhole as shown on the plans. The Contractor shall coordinate the placement of the conduit prior to the placement of the pavement.

Where conduit is to be installed under an existing roadway a trench shall be opened and conduit installed as shown on plans, or as directed by the Engineer. The trench shall be backfilled with suitable material and the surface shall be restored to original condition.

4. Conduit in Structure: It shall be the Contractor's responsibility to coordinate the setting of all conduit in structure prior to pouring concrete. Expansion fittings shall be installed at all expansion joints. Where shown on the plans, outlet boxes with the conduits properly connected and conduit hanger inserts with proper sized nuts installed, shall be accurately and securely placed in the forms for concrete. Care shall be taken during the placing of the concrete around these boxes and inserts to consolidate the concrete thoroughly, preventing voids and honeycomb and to prevent any material displacement of the boxes or inserts. Sealed bonding bushing shall be provided at each conduit outlet in all boxes.

5. Conduit Under Slope Protection: Conduit shall be installed in trench under bridge slope protection or between the slope protection and the edge of pavement at the locations and to the dimensions shown on the plans or as directed by the Engineer. The conduit shall have a minimum cover of two feet (600 millimeters) under finish grade and each end of the conduit shall extend 10 feet (3 meters) beyond the limits of the slope protection. All conduit shall terminate with a standard pipe cap and the trench shall be backfilled with suitable material. The Contractor shall coordinate the placement of the conduit prior to the placement of slope protection.

10.08.04—Methods of Measurement: Conduit will be measured for payment by the actual number of linear feet (meters) of the type and size installed and accepted. The measured length shall be from end to end along the centerline through all fittings.

10.08.05—Basis of Payment: This work will be paid for at the Contract unit price per linear foot (meter) for "(Size) (Kind) Conduit-(Type)."

This price shall include all materials required including expansion fittings, conduit fittings, locknuts, bonding bushings, bonding wire, hangers, clamps, duct seal, caps, inserts, equipment, tools, labor and work incidental thereto.

Trenching and backfilling shall be paid under Article 10.01.

No payment for trenching and backfilling will be made for conduit installed during construction under new pavement or in the fill area of new median barrier curb installations.

Pay Item	Pay Unit
(Size) (Kind) Conduit (Type)	l.f. (m)

SECTION 10.09
CAST IRON JUNCTION BOX

10.09.01—Description: This item shall consist of furnishing and installing cast iron junction boxes at locations shown on the plans or as directed by the Engineer and in accordance with these specifications.

10.09.02—Materials: Materials for this work shall conform to the requirements of Article M.15.10.

10.09.03—Construction Methods: The junction boxes shall be mounted as shown on the plans or as directed. All hardware used in conjunction with mounting of these boxes shall be rust and corrosion resistant.

Conduit knockouts shall be made in the junction box by an approved method. Diameter of the knockouts shall be no larger than the minimum diameter required to accept the size conduit specified on the plans. All conduits are to be secured to the junction box using the washers, locknuts, and bushings as detailed on the plans. An RMC drain pipe with outlet to free air shall be installed in the cast iron junction box as detailed on the plans, except where the junction box is located over a fill area such as in a wingwall.

All excess concrete shall be removed from the junction box cover, recessed bolt holes, and bolt heads.

10.09.04—Method of Measurement: The work for this item will be measured for payment by the number of cast iron junction boxes of the size specified, complete and accepted in place.

10.09.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Cast Iron Junction Box" of the size specified, complete in place, which price shall include all materials, box, cover, gasket, drain pipe, cover bolts, necessary fittings and hardware, including that necessary for mounting, removal of excess concrete, all equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Cast Iron Junction Box (Size)	ea. (ea.)

**SECTION 10.10
CONCRETE HANDHOLE**

10.10.01—Description: This item shall consist of furnishing and installing a concrete handhole of the type called for at the location and to the dimensions and details shown on the plans, or as directed by the Engineer and in conformity with these specifications. The concrete handholes may be precast or cast in place.

10.10.02—Materials: The materials for this work shall meet the required specifications in the following articles:

Bituminous Concrete	M.04
Class A Concrete	M.03.01
Class C Concrete	M.03.01
No. 6 Crushed Aggregate	M.01.01
Topsoil	M.13.01
Precast Concrete	M.08.02-4
Fertilizing	M.13.03
Seeding	M.13.04
Mulching	M.13.05-2
Galvanizing	M.06.03
Ground Wire	M.15.13

Handhole cover—The handhole cover shall be galvanized, non-skid floor plate steel which will have a minimum tensile strength of 50,000 pounds per square inch (345 megapascals).

Cast Iron Handhole Cover – The frame and cover shall be designed for H-20 loading. The cast iron shall conform to the requirements of AASHTO M105 Class 25. The cover shall be lettered “TRAFFIC.”

10.10.03—Construction Methods: Cast-in-place or precast handholes shall be constructed or installed as shown on the plans. Handholes that are cast-in-place shall be constructed in accordance with the pertinent provisions of Article 6.01.03.

The areas disturbed by the excavation for the handholes shall be neatly graded to conform to the adjacent contours. Where topsoil has been removed, it shall be replaced to its original depth (except that in no case shall this depth be less than 4 inches (100 millimeters) and the area shall be fertilized, seeded and mulched. The final elevation of the top of the concrete handhole shall be 1 1/2 inches (38 millimeters) above finished grade or as directed by the Engineer.

Where handholes are shown in bituminous concrete sidewalk or paved areas, the concrete handhole shall be set flush and the surrounding area shall be replaced with the same type of material as removed.

Where a handhole is placed within or adjacent to a concrete sidewalk, the entire section of sidewalk between joints shall be replaced in accordance with Section 9.21, unless otherwise directed by the Engineer.

Unless otherwise ordered by the Engineer, a handhole cover plate (galvanized steel) of the size specified, shall be installed on each handhole. The cover for concrete handhole shall be overlap type with the following exceptions: where the handhole is installed in a sidewalk, concrete median barrier or where concrete handhole type II is used, the cover shall be the recessed type. The handhole cover plate shall be bonded to ground wire and to all metal conduit within the handhole with No. 8 ground wire.

The Type II bank adapter shall be installed to the same contour of the embankment in which it is placed. The frame for the cast iron cover shall be held in place on the concrete handhole with cementitious grout. The cast iron handhole cover shall be flush with the surrounding surface.

The concrete handhole shall be set on crushed stone in accordance with the details, and a drain pipe shall be installed meeting the requirements of Section 10.11.

10.10.04—Method of Measurement: This work will be measured for payment by the number of handholes, Type II bank adapters, and cast iron handhole covers of the type specified, complete and

accepted in place.

10.10.05—Basis of Payment: This work will be paid for at the Contract price each for "Concrete Handhole" of the type called for, "Concrete Handhole Type II Bank Adapter" or "Cast Iron Handhole Cover", complete in place, which price shall include all materials, concrete, steel cover, grounding tab, crushed stone, excavating, backfilling and replacement of bituminous sidewalk and pavement, including grading and placing topsoil, seeding, fertilizing, mulching and all equipment, tools, labor and work incidental thereto. All concrete sidewalk replaced due to handhole installation shall be paid for at the Contract unit price for "Concrete Sidewalk". The ground wire (bonding wire) is included in the Contract unit price under Section 10.08 – Electrical Conduit.

Pay Item	Pay Unit
Concrete Handhole	ea.
Concrete Handhole Type II	ea.
Concrete Handhole Type II Bank Adapter	ea.
Cast Iron Handhole Cover	ea.
Concrete Handhole (Type)	ea.

SECTION 10.11

4-INCH (102-MILLIMETER) DRAIN PIPE

10.11.01—Description: Under this item the Contractor shall furnish and install 4-inch (100-millimeter) drain pipe (non-perforated) and fittings for the drainage of concrete handholes as shown on the plans or as directed by the Engineer.

10.11.02—Materials: Plastic drain pipe shall conform to the requirements of Subarticle M.08.01-25 or M.08.01-27.

10.11.03—Construction Methods: The drain pipe shall be installed in conformance with Article 6.51.03. Both ends of the drain pipe shall be covered with a 1/4-inch (6-millimeter) galvanized hardware fabric which shall be secured in place with an adjustable stainless steel band clamp.

Trenching and backfilling shall conform to Article 10.01.03. Only one type of 4-inch (100-millimeter) drain pipe will be used in each installation.

10.11.04—Method of Measurement: The 4-inch (102-millimeter) drain pipe shall be measured for payment by the number of linear feet (meters) installed, complete and accepted, measured in place, along the centerline of the pipe, including all fittings and wire screen.

Trenching and backfilling shall be measured for payment as specified in Article 10.01.04.

10.11.05—Basis of Payment: This work will be paid for at the Contract unit price per linear foot (meter) for "4-Inch (102-Millimeter) Drain Pipe," complete in place, which price shall include all materials, elbows, fittings, wire screens, and all equipment, tools and labor incidental thereto. Trenching and backfilling shall conform to and be paid for under Article 10.01.05.

Pay Item	Pay Unit
4 Inch (102 mm) Drain Pipe	l.f. (m)

SECTION 10.12
SINGLE CONDUCTOR

10.12.01—Description: This item shall consist of furnishing and installing conductors of the size and type specified, complete in place, as shown on the plans or as directed by the Engineer and in accordance with these specifications.

10.12.02—Materials: The materials for this work shall conform to the requirements of Article M.15.11.

10.12.03—Construction Methods: Conductors shall be installed as shown on the plans or as directed by the Engineer.

Installed conductors shall be free from any damage. Contractor shall install conductors using standard trade practices, tools and equipment. Sufficient slack for splices shall be provided in cast iron junction boxes, concrete handholes, and light standard bases in accordance with the details.

Splices shall be made only at approved locations and in accordance with NEC and insulated to maintain the voltage rating of the insulation of the conductor. All splices shall be made as shown on plans and details using approved waterproof devices and materials.

10.12.04—Method of Measurement: The quantity of single conductor, of the size and type specified, will be measured for payment by the actual number of linear feet (meters) of conductor installed and accepted.

10.12.05—Basis of Payment: This work will be paid for at the Contract unit price per linear foot (meter) for "Single Conductor" of the size and type specified, complete in place, which price shall include all materials, tools, connections, equipment, labor and work incidental thereto.

Pay Item	Pay Unit
Single Conductor (Size)	l.f. (m)

**SECTION 10.14
CABLE IN DUCT**

10.14.01—Description: This item shall consist of furnishing and installing pre-assembled cable in duct of the size, number, and type of conductors specified at locations shown on the plans or as directed by the Engineer, and in accordance with these specifications.

10.14.02—Materials: The materials for this work shall conform to the requirements of Article M.15.12.

10.14.03—Construction Methods: The cable in duct shall be installed in trench encased in sand, or in conduit as shown on the plans or directed by the Engineer, in one straight continuous piece with no couplings, between light standard bases, between light standard base and handhole, or between handholes. Marking tape shall be installed in the trench at the depth and to the requirements as set forth in Article 1.05.15. The cable in duct shall be cut by an approved cutting tool in a manner that will not damage the conductors. The cable shall be installed in a neat and workmanlike manner, free from any surface damage.

Sufficient slack for splices shall be provided in cast iron junction boxes, concrete handholes, and light standard bases in accordance with the details. Splices shall be made only at approved locations and in accordance with NEC and insulated to maintain the voltage rating of the insulation of the conductor. All splices shall be made as shown on plans and details using approved waterproof devices and materials.

10.14.04—Method of Measurement: The length of cable in duct to be included for payment shall be the amount accepted and measured from centerline to centerline of light standards or concrete hand holes, as the case may be, plus 8 feet (2.5 meters).

10.14.05—Basis of Payment: This work will be paid for at the Contract unit price per linear foot (meter) for "Cable In Duct" of the size, type, and number of conductors specified, complete in place, which price shall include all materials such as terminators, sealing compound, connections, grounding, disposal of surplus material, and all equipment, tools and labor incidental thereto.

Necessary excavation, including sand encasement will be paid for as "Trenching and Backfilling" in accordance with the provisions of Article 10.01.05.

Pay Item	Pay Unit
Cable In Duct (No.—Size)	l.f. (m)

**SECTION 10.15
GROUNDING CONDUCTOR**

10.15.01—Description: This item shall consist of furnishing and installing grounding conductor of the size specified in locations shown on the plans or as directed by the Engineer and in accordance with these specifications.

10.15.02—Materials: The materials for this work shall conform to the requirements of Article M.15.13.

10.15.03—Construction Methods: All grounding and bonding shall be in accordance with NEC. Grounding conductor shall be installed in trench with the cable in duct, in conduit, in light standard bases, in junction boxes, and in handholes as shown on the plans.

All conducting material and equipment shall be bonded.

10.15.04—Method of Measurement: The quantity of grounding conductor of the size specified will be measured for payment by the actual number of linear feet (meters) installed and accepted between the centerline of light standards or centerline of concrete handholes, as the case may be, with an extra allowance of 8 feet (2.5 meters). The grounding conductor required for the light standard items will not be measured for payment under this item.

10.15.05—Basis of Payment: This work will be paid for at the contract unit price per linear foot (meter) for "Bare Copper Grounding Conductor" of the size specified, complete in place, which price shall include all materials, tools, connections, equipment, labor and work incidental thereto.

Pay Item	Pay Unit
Bare Copper Grounding Conductor (Size)	l.f. (m)

SECTION 10.17
SERVICE ENTRANCE AND CABINET

10.17.01—Description: This item shall consist of furnishing and installing a service entrance and cabinets of the type specified as detailed on the plans at the location shown on the plans or as directed by the Engineer and in accordance with these specifications. Included in this work, where called for, are service entrance cabinet, lighting control cabinet, electrical components, service entrance conductors and conduit, foundations, transformer pad, fence, metering provisions and utility work.

10.17.02—Materials: The materials for this work shall conform to the requirements of Article M.15.15.

10.17.03—Construction Methods: All work shall be constructed as shown on the plans or as required by the utility company and directed by the Engineer. The Contractor shall give adequate notice to the utility company for scheduling of work by utility.

The installation of the service conduit of the size and type specified, and all the conduit required in the concrete pad or concrete foundation, shall conform to the provisions of Article 10.08.03 for the type of installation required. Where service entrance conductors are provided by the utility company, the Contractor shall provide pull wire.

Trenching and backfilling for conduit shall conform to the provisions of Article 10.01.03.

The concrete pad and concrete foundations shall be constructed in conformance with Article 10.02.03. Conduit, inserts, sleeves and fittings shall be placed in proper positions and shall be so held until the concrete sets. Forms shall not be removed until the concrete has hardened properly and not less than 24 hours after the concrete has been placed. All portions of the pad and foundation that will remain exposed to view shall be neatly finished in conformance with the requirements for "Float Finish" as outlined in Article 6.01.03-21.

The transformer pad may be precast per utility company specifications. Pedestal foundations may be precast.

The electrical components shall be mounted to the plywood back panel in each cabinet, and wired as shown on the plans or as directed.

The Contractor shall label all circuits in each cabinet.

The photoelectric control shall be located as indicated on the plans. The cell shall be positioned according to the manufacturer's recommendations. No. 12 conductors shall be run from the cell to the service cabinet and the necessary connections made for proper operation.

10.17.04—Method of Measurement: This work will be measured for payment as a unit by the number of services installed and accepted.

10.17.05—Basis of Payment: This work will be paid for at the Contract unit price for "Service Entrance and Cabinet," of the type called for, complete and accepted in place, which price shall include all materials including all electrical components, concrete pad, service entrance cabinet, lighting control cabinet, main disconnect safety switch, concrete foundation, gravel fill, conduits, conductors, control transformer, circuit breakers, meter socket, photoelectric control, transformer pad, receptacle, contactor, convenience light, pedestal, fence, pull wire, manual switch, fuses, fuse holders, ground rod, grounding conductor, trenching and backfilling, fittings, standoffs, and all equipment, tools, labor and work incidental thereto including excavation, clearing or removal of brush, backfill, grading, topsoil, sodding or turf establishment, and all utility company charges.

Where rock is encountered in excavation, it will be paid for as "Rock in Trench Excavation" in accordance with the provisions of Article 10.01.05.

Pay Item	Pay Unit
Service Entrance and Cabinets (Type)	ea. (ea.)

SECTION 10.18
NAVIGATION LIGHT

10.18.01—Description: This work shall consist of furnishing and installing a permanent navigation light with all necessary components as shown on the plans and details or as directed by the Engineer, and in conformity with these specifications.

10.18.02—Materials: The materials for this work shall conform to the requirements of Article M.15.16.

10.18.03—Construction Methods: The navigation light shall be installed as shown on the plans and details, and shall be easily accessible for maintenance purposes. The circuit for the navigation light shall be as shown on the plans and details.

The Contractor shall submit a wiring diagram, installation drawing and list of equipment to be furnished for approval prior to starting his electrical work. All electrical work shall be strictly in accordance with the requirements of the NEC. Installation shall be strictly in accordance with the requirements of the United States Coast Guard.

10.18.04—Method of Measurement: This work will be measured for payment by the number of navigation lights furnished, installed and accepted in place.

10.18.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Navigation Light," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Navigation Light	ea. (ea.)

**SECTION 11.01
POLE ANCHOR**

11.01.01--Description: This work shall consist of furnishing and installing a pole anchor of the type specified on a new or an existing pole at the location shown on the plans or as directed by the Engineer. The quantity of pole anchors shown on the plans are approximate only. The actual number and location of anchors shall be such as to provide adequate support for those poles to which the span is being attached as determined in the field.

11.01.02--Material: The materials for this work shall conform to the pertinent requirements of Article M.16.04.

11.01.03--Construction Methods: A lead of approximately 20 feet (6 meters) should be maintained from the pole when placing the anchor. The hole for the anchor shall be mechanically dug, and the diameter will be the nominal size of the unexpanded diameter of the anchor. A slot shall be cut in the side of the hole to permit the anchor rod to line up with the guy strand. The anchor rod shall extend above the ground not less than 6 inches (150 millimeters) nor more than 12 inches (300 millimeters). Prior to installation, the anchor shall be locked in its expanded position. This shall be done by marking the expanding bar end away from the anchor, with the anchor in the expanded position. The Contractor shall collapse the anchor tie plates and install in the hole with the expanding bar, and expand into undisturbed earth with several heavy blows on the expanding bar. The anchor will be fully expanded when the mark on the expanding bar is opposite the top of the anchor rod. All backfill is to be thoroughly tamped as it is being placed. When required on wood poles, a wet porcelain strain insulator shall be installed on the guy strand as shown on the installation detail sheet. Care shall be exercised in placing anchors in the vicinity of private property. Where necessary state forces will establish property lines.

11.01.04--Method of Measurement: This work will be measured for payment by the number of anchors completed and accepted in place.

11.01.05--Basis of Payment: This work will be paid for at the Contract unit price each for "Pole Anchor," complete in place, which price shall include all materials, anchor, anchor rod, anchor guy strand wire, anchor guy protector, excavation and backfilling, and all necessary fittings, hardware, tools, labor and work incidental thereto. Only those anchors installed on existing poles will be paid for under this item. When new wood poles are installed the required anchor is paid for in the price of the pole.

Pay Item	Pay Unit
Pole Anchor	ea. (ea.)

**SECTION 11.02
PEDESTALS**

11.02.01—Description: This item shall consist of furnishing and installing a pedestal of the type and size specified on a prepared foundation at locations and to the details shown on the plans, or as ordered, and in accordance with these specifications.

11.02.02—Materials: The materials for this work shall conform to the requirements of Article M.16.03.

11.02.03—Construction Methods: The complete unit shall be erected vertically, mounted plumb, and shall be securely bolted to the foundation. All pedestals shall be effectively grounded using a 5/8-inch x 10-foot (16-millimeter x 3-millimeter) copper ground rod with #8 AWG solid, bare, tinned copper wire attached to the pedestal by a stainless steel bolt and to the ground rod by a square head bolt clamp.

11.02.04—Method of Measurement: This work will be measured for payment by the number and type of pedestals specified, completed and accepted in place.

11.02.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Pedestal" of the type and size specified, which price shall include all materials, pedestal base, shaft, ground wire, paint, painting, labor, tools, equipment, miscellaneous fittings and work incidental thereto.

Pay Item	Pay Unit
Pedestal (Type and Size)	ea. (ea.)

SECTION 11.03 SPAN POLE

11.03.01—Description: This item shall consist of furnishing and installing a steel span pole, as indicated on the plans in conformity with these specifications or as directed by the Engineer.

This item shall also include furnishing a wood span pole and installing it at the location designated on the plans, or as indicated by the Engineer, and in conformity with these specifications.

11.03.02—Materials: The materials for this work shall conform to the requirements of Article M.16.04.

11.03.03—Construction Methods:

1. Steel Pole: Each pole shall be securely bolted to its base, electrically grounded, and installed per the manufacturer's specifications. The pole shall be oriented so the handhole is away from traffic. The steel pole shall be raked by means of a double nut construction. The opening between the steel pole base and the concrete foundation shall be grouted and neatly finished with a non-shrinkable, non-stainable grout that conforms to the requirements of Article M.03.01-12. The mast arm anchor bolts are specified in M.15.02.3.

Installation Procedure:

A. Install leveling nuts onto anchor bolts with the approximate pole "rake."

B. Install steel pole base plate onto leveling nuts and tighten the anchoring nuts loosely.

C. The unloaded pole shall be "raked" back according to manufacturer's specifications by adjusting the nuts as necessary. Upon completion the "rake" should give the pole a plumb look under load.

D. Tighten up the anchoring nuts to a "snug-tight" condition, while insuring that the leveling nuts are always in firm contact with the base plate. A "snug-tight" condition is defined as the tightness attained by the full effort of a person using a spud wrench.

E. Check all nuts for looseness after the traffic lights and other loads are in place, paying special attention to the leveling nuts on the tension bolts. Retighten any loose nuts to a "snug-tight" condition. Upon completion each pole shall be securely bolted to its base and have a plumb appearance.

F. Grout underneath base plate.

G. Install handhole cover, anchor bolt covers, and pole cap.

2. Wood Pole: The hole into which the pole is to be placed shall be mechanically dug, and its diameter shall be only large enough to accept the pole and the tamper and shall be 6 feet (1.8 meters) deep.

A lead of approximately 20 feet (6 meters) should be maintained from the pole when placing the anchor. The hole for the anchor shall be mechanically dug, and the diameter will be the nominal size of the unexpanded diameter of the anchor. A slot shall be cut in the side of the hole to permit the anchor rod to line up with the guy strand. The anchor rod shall extend above the ground not less than 6 inches (150 millimeters) nor more than 12 inches (300 millimeters).

Prior to installation, the anchor shall be locked in its expanded position. This shall be done by marking the expanding bar end away from the anchor, with the anchor in the expanded position. The Contractor shall collapse the anchor tie plates and install in hole with expanding bar, and then expand into undisturbed earth with several heavy blows on the expanding bar. The anchor will be fully expanded when the mark on the expanding bar is opposite the top of the anchor rod. All backfill is to be thoroughly tamped as it is being placed. A wet porcelain strain insulator shall be installed on the guy strand at a minimum height of 8 feet (2.4 meters). The installation of the guy strand will be as shown on the installation detail sheet.

3. Combination Steel Pole: Specifications for steel poles in Subarticle 1 apply to combination steel poles including the following specifications.

When illumination service is underground, a nylon pull rope shall be installed from the end of the luminaire bracket to the pole base. At combination poles where service is overhead, a separate rigid service clevis, 2-inch (50-millimeter) entrance fitting and weatherhead shall be installed. A nylon pull rope shall be installed from the end of the bracket to the clevis. The luminaire bracket shall be attached to the pole shaft perpendicular to the centerline of the roadway as shown on the plans. Clamp-type brackets are permissible for ease and adjustment. The mounting height shall be a nominal 30 feet (9 meters) measured from the center of the light source to the pavement directly below. It shall be the responsibility of the Contractor to arrange with the utility company for installation of the luminaire on the bracket and secondary service to the luminaire.

11.03.04—Method of Measurement: This work will be measured for payment by the number of poles of the type specified, completed and accepted in place.

11.03.05—Basis of Payment: This work will be paid for as follows:

1. Steel Span Pole: This work shall be paid for at the contract unit price each for "Steel Span Pole" or "Combination Steel Span Pole" of the type specified, which price shall include all materials, pole, pole cap,

handhole, handhole cover, ground wire, grounding nut, anchor bolt covers, entrance fittings, service clevis, span clamps, paint, painting, grouting, labor, tools, luminaire bracket, miscellaneous hardware, and work incidental thereto.

2. Wood Span Pole: This work will be paid for at the contract unit price each for "Wood Span Pole," complete in place, which price shall include all materials, pole, anchor, anchor rod, anchor guy strand wire, anchor guy protector, neutral bracket, excavating and backfilling, and all necessary fittings, hardware, tools, labor and work incidental thereto.

Pay Item	Pay Unit
(Type) Steel Span Pole	ea. (ea.)
(Type) Steel Combination Span Pole (Bracket Type)	ea. (ea.)
Wood Span Pole	ea. (ea.)

**SECTION 11.05
TRAFFIC SIGNALS**

11.05.01—Description: This item shall consist of furnishing and installing a traffic control signal, of the type specified, at the location shown on the plans or indicated by the Engineer and in conformity with these specifications.

11.05.02—Materials: The materials for this work shall conform to the requirements of Article M.16.06.

11.05.03—Construction Methods: Each completely assembled traffic signal unit shall normally be installed as follows:

Each traffic signal head shall consist of the appropriate number of sections and faces, terminal blocks and mounting equipment, as indicated. Signal heads shall be erected vertically in accordance with the specific type of mountings shown on the installation plan. A balance adjuster shall be installed between the span wire clamp and the wire entrance to provide a plumb appearance for the signal assemblies that are unbalanced.

No signal head shall be erected until the controller for that signal is installed.

All traffic signals shall be mounted in the manner as shown on the plans, using fittings and attachments standard to the trade.

When traffic signals are span-mounted, they shall be installed so the lowest part of the signal head is not less than 16 feet (4.9 meters) or more than 17 feet (5.2 meters) above the pavement grade beneath the signal head.

If couplings are used in "nipping down" a traffic signal or in the construction of signal heads, they shall be drilled, tapped, and furnished with a set screw, or spot welded to eliminate twisting. Entrance fittings and locking nuts shall also be furnished with set screws to eliminate twisting. Signal ways consisting of more than three sections shall be assembled with appropriate numbers of one-way, one-section units.

When adding sections to existing or new signal heads the contractor shall provide all necessary mounting equipment, including new brackets if required, to adapt to the existing heads.

11.05.04—Method of Measurement: The quantity to be paid for under this item will be the number of completed, installed and accepted traffic signal units of the type specified.

11.05.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Traffic Signal" of the type specified which price shall include all materials, housing, brackets, conduit, visors, tunnel visors, louvers, back plates, optical unit, lamp socket, lens, mountings, balance adjuster, paint, painting and necessary equipment, tools, labor and work incidental thereto.

No direct payment will be made for furnishing and installing visors or lenses required on existing traffic signals, but the cost thereof shall be included in the costs of the various traffic signal items.

Pay Item	Pay Unit
Traffic Signal (Type)	ea. (ea.)

**SECTION 11.06
PEDESTRIAN SIGNAL**

11.06.01—Description: This item shall consist of furnishing and installing a pedestrian signal of the type specified at locations shown on the plans or as indicated by the Engineer in conformity with these specifications.

11.06.02—Materials: The materials for this work shall conform to the requirements of Article M.16.07.

11.06.03—Construction Methods: Each completely assembled pedestrian signal unit shall be installed as follows:

Each pedestrian signal shall be erected vertically in accordance with the specific type of mountings shown on the plans. Each signal face shall be pointed in the direction of the approaching pedestrian traffic it is intended to control.

During construction, and until the signals are placed in actual operation, the signal housing shall be hooded. Every part of the signal head shall be at least 12 inches (300 mm) behind outer edge of the shoulder of the road.

The audible pedestrian signal shall be attached to a traffic signal assembly, using standard hardware as shown on the plan. The volume shall be adjusted to a minimum sound level that can be heard throughout the intersection, or as directed by the Engineer. The 120 VAC signal output shall be connected to a conflict monitor input and shall conflict against all opposing movements.

11.06.04—Method of Measurement: The quantity to be paid for under these items will be the number of completed, installed and accepted pedestrian signals of the type specified.

11.06.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Pedestrian Signal," of the type specified which price shall include all materials, housing, optical unit, visor, miscellaneous fittings and parts, equipment, paint and painting, labor and work incidental thereto.

Pay Item	Pay Unit
Pedestrian Signal (Type)	ea. (ea.)

SECTION 11.07
PEDESTRIAN PUSH BUTTON

11.07.01—Description: This item shall consist of furnishing and installing pedestrian push buttons of the type specified at the location shown on the plans or as indicated by the Engineer and in conformity with these specifications.

11.07.02—Materials: The materials for this work shall conform to the requirements of Article M.16.08.

11.07.03—Construction Methods:

A push button advisory sign 9 inches x 12 inches (230 millimeters x 300 millimeters) shall be attached to the saddle as indicated in the case of a pole or pedestal mounted push button or directly to the controller cabinet in the case of a surface mounted push button installed on the side of a controller cabinet. The push button and sign shall be installed on the crosswalk side of a pole or pedestal perpendicular to the direction of walking. On a controller cabinet, the push button and sign shall be surface mounted on the side of the controller cabinet nearest to the crosswalk.

A 1/8-inch (3-millimeter) aluminum backing plate measuring 9 inches x 12 inches (230 millimeters x 300 millimeters) shall be used with all pole or pedestal-mounted advisory signs that have a push-button casting which is smaller in dimension than the 9-inch x 12-inch (230-millimeter x 300-millimeter) sign that is being attached. The backing plate shall conform exactly to the shape of the sign.

When the push button casting is as large as the 9-inch x 12-inch (230-millimeter x 300-millimeter) sign being attached, the aluminum backing plate will not be required.

When surface mounted on a controller cabinet, the sign shall be attached by drilling and tapping four holes, corresponding to the holes in the sign, for 10-32 machine screws, and mounting the sign with four 1/2-inch (13- millimeter) 10-32 brass or stainless steel machine screws. Care is to be taken in drilling and tapping not to damage any wiring or equipment in the cabinet, including the terminal blocks. The push button shall be similarly mounted, using machine screws of proper size and length to conform with the requirements of the push button. A suitable hole, properly reamed or smoothed to eliminate rough edges, shall be drilled in the cabinet to match the comparable opening in the back of the push button base through which the lead wires are run.

All buttons shall be furnished with enough No. 16 AWG THWN or THHN stranded wire to make a connection in the walk fixture or in the base of the 4-foot 4-inch (1.3-meter) aluminum pedestal whichever applies.

11.07.04—Method of Measurement: The quantity to be paid for under this item will be the number of pedestrian push buttons, of the type specified installed, operating and accepted.

11.07.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Pedestrian Push Button and Sign, Pole-Mounted," "Pedestrian Push Button and Sign, Pedestal Mounted," or "Pedestrian Push Button and Sign, Surface-Mounted," as the case may be, which price shall include push button, advisory sign, saddle, wire, all material, equipment, paint, painting, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Pedestrian Push Button and Sign (Type)	ea. (ea.)

**SECTION 11.08
CONTROLLERS**

11.08.01—Description: This item shall consist of furnishing and installing a pre-timed traffic controller, of the type specified for controlling the operation of the traffic signals as indicated on the sequence and timing chart on the plans, and all necessary auxiliary equipment required for satisfactory operation of the signal, at the location indicated on the plans or indicated by the Engineer and in conformity with these specifications.

This item shall also consist of furnishing and installing an Actuated Controller, which shall be a completely digital solid state unit, for controlling the operation of the traffic signals, as indicated on the sequence and timing chart on the plans, and all necessary auxiliary equipment required. The control equipment shall be installed at the location shown on the plans or as directed by the Engineer, and in conformance with these specifications.

11.08.02—Materials: The materials for this work shall conform to the requirement of Article M.16.09.

11.08.03—Construction Methods: The controller, mounted in controller cabinet, shall be installed at the locations shown on the plans in the following manner:

The pole-mounted controller cabinet shall be attached to the face of the pole with the use of saddle measuring 3 inches x 16 inches x 7/8 inches (76 millimeters x 406 millimeters x 22 millimeters). The pole shall be drilled and tapped to accept two 3/8-inch x 1 1/2-inch (10-millimeter x 38-millimeter) round head, cadmium-plated, machine screws, to fasten the controller cabinet to the pole. The saddle shall have two 1/2-inch (13-millimeter) diameter guide holes for 3/8-inch (10-millimeter) screws for fastening the controller cabinet. A hole shall be drilled in the pole, using a hole saw, to accept a 2 1/2-inch (63.5-millimeter) coupling, which is to be welded to the pole. A 90° pull box shall be attached to the coupling with a standard pipe nipple, the bottom of the cabinet shall have an opening for cable entrance and four holes to fasten the flange of the 90° pull box.

The cabinet, when pedestal-mounted, shall be mounted with the use of a standard 4-inch (100-millimeter) pedestal adapter as shown on the installation detail sheet.

The base mounted cabinet shall have the base casting attached to the foundation and leveled before the cabinet proper is bolted to the base. A mastic type compound conforming to ASTM C-647 shall be used between the cabinet proper and the base casting to make the two units rain-tight.

11.08.04—Method of Measurement: This work will be measured for payment by the number of each type controller completed, operating, and accepted in place.

11.08.05—Basis of Payment: This work will be paid for as follows:

1. Pre-timed controller will be paid for at the Contract unit price each for "Pre-timed Controller" of the type specified, which price shall include cabinet, timer, timing dial, unit motor, signal-switching unit, panel board, flasher, jack-mounted relays, auxiliary equipment, paint and painting, and all materials, equipment, tools and labor incidental thereto.

2. Actuated controller will be paid for at the Contract unit price each for "Actuated Controller" of the type specified, which price shall include controller, controller cabinet, wiring, flasher unit, radio line filter, necessary fittings for mounting, miscellaneous fittings, auxiliary equipment, paint and painting, and all materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Pre-timed Controller (Type)	ea. (ea.)
Actuated Controller (Type)	ea. (ea.)

**SECTION 11.11
LOOP VEHICLE DETECTOR AND SAWCUT**

11.11.01—Description: These items shall consist of:

1. **Furnishing and installing a loop vehicle detector** in conformity with these specifications.
2. **Furnishing and installing Sawcut** to be used with a loop vehicle detector as shown on the plans and in conformity with these specifications.

11.11.02—Materials: The materials for this work shall conform to the requirements of Article M.16.12.

11.11.03—Construction Methods:

1. **The loop vehicle detector** shall be mounted in the controller cabinet. Wiring shall be done in a neat manner, and each wire shall be fitted with a spade lug and attached to the proper terminal.

A loop identification tag shall be permanently attached to each loop amplifier harness. The tag shall be pre-printed by the manufacturer so that the Contractor can record the pertinent information on the tag. The following information shall be recorded legibly on the tag by the Contractor, with indelible ink, in the order shown.

CT D.O.T.

LOOP NO.:
PHASE CALL:
FIELD LOCATION:
LOCAL DET. NO.:
SYSTEM DET. NO.:
CABINET TERMINALS:

Field location shall include the route number or street name, the direction (such as Northbound), and the lane (left, center, right).

Each system detector shall be connected to the corresponding system sensor input of the local computer communications unit (either the C.I.C.U. or the C.L.L.C.U.).

Example: S.D. 1 connected to System Sensor 1
 S.D. 2 connected to System Sensor 2

2. **Loop detectors** installed in new or resurfaced pavements shall have the slots saw cut in the pavement base course and the loop wires placed and sealed before the placing of the pavement wearing course.

No loop detector saw cut shall be placed over a patched trench or existing pavement without the approval of the Engineer. The Contractor shall remove the existing pavement and replace it with new pavement for installation of the loop detectors, at the direction of and within the limits prescribed by the Engineer, where the condition of the existing pavement is not suitable for installation. The work shall be performed under the items "Removal of Bituminous Surface," "Cut Bituminous Concrete Pavement," "Material for Tack Coat," and "Bituminous Concrete Class 1." The existing pavement shall be removed a minimum of 3 inches (75 millimeters) in depth. The replaced pavement shall be overlaid as directed. The loop detector shall be installed in the new pavement, under the overlay.

The size of the loop shall be as shown on the plans and shall be made using a power saw having an abrasive or diamond blade 3/8 inch (9.5 millimeters) wide. The depth of the slot shall be 1 3/4 inches to 2 inches (45 millimeters to 50 millimeters) and shall extend from the loop to the location shown on the plan. The cuts shall overlap at the corners of the loop and at any angles in the saw cut to the controller to ensure full depth. The corners are to be rounded off by drilling a 1 1/4-inch (32-millimeter) diameter hole to eliminate kinking of the wire. When the cutting has been completed, the slot shall be cleaned of all cutting dust and grit with oil-free compressed air. The slot shall be completely dry before inserting the wire. The entire loop and lead-in shall consist of 1 continuous #14 stranded wire encased in tubing, unless otherwise shown on the plans. The lead-in wires shall be twisted together with at least 5 turns per foot (16 turns per meter) and taped at 2-foot (0.6-meter) intervals, beginning at a point where the wire leaves the saw cut and enters the plastic conduit to the terminals in the controller cabinet, or when spliced to a 2-conductor lead-in cable. The twisted wire shall remain together and shall not be coiled at any point. Splices will not be permitted at any point of the loop or lead-in unless otherwise indicated on the plans or as directed by the Engineer.

At the time of installing the loop wire, the ends of the tubing shall be sealed to prevent any entrance of

moisture into the tubing. When splices are required in handholes or junction boxes, they shall be made in accordance with the installation details. The saw cuts on all lead-ins shall be as shown on the plans or as directed by the Engineer. The number of turns of wire for each loop shall be as shown on the plans. After installation, the wire shall be checked for slack or raised portions in the saw cut slot. A paint mix stock or similar blunt instrument shall be used to push the wire in the slot. The wire shall be held in the slot with wooden pegs or by inserting wedges formed from 1-inch (25-millimeter) sections of the plastic tubing, folded before insertion. The loop should be tested prior to sealing the saw cut. An unacceptable loop installation would consist of leakage to ground below 10 megohms or an open circuit. The saw cut shall then be filled with plastic compound to a level of approximately 1/16 inch (2 millimeters) below the pavement surface. In no case shall the plastic compound overflow the saw cut and all excess material shall be removed. The plastic compound shall be applied in accordance with the manufacturer's recommendations. The plastic compound shall adhere to the sides of the saw cut and not show a separation when pressure is applied by a blunt instrument.

Each pair of lead-in wires in the cabinet shall be tagged and identified to determine phase and geographical location of each loop, Example:- "Phase 4—East End Bank St.—Right Lane."

When a 1-part urethane elastomeric compound is used to seal the sawcut the manufacturer's installation procedure shall be followed.

The sawcut, complete and tested with wire installed and retained with plastic wedges, shall be filled with the elastomeric compound from the bottom up. The sawcut shall be filled to 0.125 inch (3 millimeters) from the surface of the pavement. The elastomeric compound shall not be applied if the pavement surface temperature is less than 40°F or more than 100°F (4°C or more than 38°C).

11.11.04—Method of Measurement: This work will be measured for payment as follows:

1. Loop vehicle detectors will be measured for payment by the number of loop vehicle detectors of the type specified, completed, operating and accepted in place.

2. Loop Detector Saw Cut: The quantity to be paid for under this item shall be the actual number of linear feet (meters) of saw cut, measured along the center of the cut, with #14 Stranded Wire encased in tubing completely installed, tested and accepted in place. #14 Stranded Wire encased in tubing shall not be measured for payment separately but shall be included in the measurement for saw cut.

11.11.05—Basis of Payment:

1. Loop vehicle detector will be paid for at the Contract unit price each for "Loop Vehicle Detector" of the type specified, which price shall include connecting cable, sensor unit, all materials, labor and work incidental thereto.

2. Loop detector saw cut will be paid for at the Contract unit price per linear foot (meter) of "Loop Detector Saw Cut," which price shall include; saw cut, #14TW stranded wire (including that to handholes, traffic control foundations or controller cabinets), necessary fittings, flexible plastic tubing, plastic compound, splicing and connecting, equipment, labor, materials and work incidental thereto.

Pay Item	Pay Unit
Loop Vehicle Detector (Type)	ea. (ea.)
Loop Detector Saw Cut	l.f. (m)

SECTION 11.12
MAGNETIC VEHICLE DETECTOR

11.12.01—Description: This item shall consist of furnishing and installing a magnetic vehicle detector of the type specified at the location shown on the plans, or as indicated by the Engineer and in accordance with these specifications.

11.12.02—Materials: The materials for this work shall conform to the requirements of Article M.16.13.

11.12.03—Construction Methods: The magnetic detector shall be installed in a 4-inch (102-millimeter) polyvinyl chloride conduit. A joint shall be made to the control cable in the concrete handhole. Joints shall be made in conformance with Article 11.13.03.

The single lane magnetic detector shall be placed in a roadway excavation made only large enough to permit the pavement box and conduit to be lowered into place. Reinforcing rods in concrete need only to be removed within 5 inches or 6 inches (125 millimeters or 150 millimeters) of the detector housing.

Remove the detector coil unit and other parts from the pavement box, replace the cover and install the conduit using pipe joint compound to prevent the entrance of moisture.

The pavement box and conduit assembly will be suspended in the excavation using 4 bolts and 2 inch x 4 inch (50 millimeter x 100 millimeter) wood pieces as temporary supports. The cover of the box should be 3 inches (75 millimeters) below the finished surface of the roadway. Plug up the unused conduit entrances with pipe plugs. Spread a handful of sand over the cover to prevent concrete from getting into the cracks. Pour concrete in the excavation up to the level of the top surface of the box. After the concrete has hardened, the cover shall be removed and the coil unit placed in the box with the "arrow" pointing toward the intersection.

After the coil connections have been made, a silicone compound shall be applied to the terminals. The conduit entrances shall be sealed with oakum or equivalent and fill the entire pavement box with melted petrolatum (Vaseline) or equivalent.

The cover shall then be secured in place and the road resurfaced to its original level.

11.12.04—Method of Measurement: This work will be measured for payment by the number of magnetic vehicle detectors of the type specified, completed, operating and accepted.

11.12.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Magnetic Vehicle Detector," of the type specified, which price shall include detector, detector-amplifier, all materials, labor, tools and work incidental thereto.

Pay Item	Pay Unit
Magnetic Vehicle Detector (Type)	ea. (ea.)

SECTION 11.13 CONTROL CABLE

11.13.01--Description: This item shall consist of furnishing and installing electrical cable and appurtenances of the type specified at the locations shown on the plans or as indicated by the Engineer, in accordance with these specifications.

11.13.02--Materials: The materials for this work shall conform to the requirements of Article M.16.14.

11.13.03--Construction Methods: All wiring shall conform to the appropriate requirements for the NEC and shall be insulated for 600 volts. Wire splicing will not be permitted in conduit or outside of junction boxes, hand holes, poles or pedestals, unless otherwise indicated on the plans.

All cables shall contain the required number of conductors as shown on the plans. The substitution of several cables to attain the required number of conductors will not be permitted. Cable to be installed in conduit shall be pulled with a minimum of dragging on the ground or pavement. This shall be accomplished by means of reels mounted on jacks or approved devices conveniently located for unreeling cable directly into the conduit. Powdered soapstone, talc, or other approved lubricants shall be used when inserting cable into the conduit. Cable shall be pulled through conduit by means of a cable or cables. Wiring within junction boxes and cabinets shall be neatly arranged.

Conductors entering the controller cabinet shall be neatly dressed and laced along the base and back of the cabinet to the terminal board mounted in the cabinet. When three or more conductors are attached to the same terminal in the controller cabinet, they shall not be twisted together, but shall be attached with a set-screw type lug of the correct size. When less than three conductors are attached to the same terminal, in the controller cabinet, a separate spade type connector shall be attached to each conductor. Spare conductors shall be tied together with their ends taped. All splices are to be of an approved type and made in such a manner that the connection will be moisture-proof. All aerial splices shall be accomplished as shown on the plans using a cable closure. At least 2 feet (600 millimeters) of slack shall be left for each conductor at each standard and at least 1 foot (300 millimeters) of slack at each pull box.

All splicing in junction boxes, hand holes, poles and pedestals can be accomplished by one of the following methods:

1. Splices can be made by soldering with the pouring or dipping method.

2. Non-insulated butt-type pressure connectors shall be seamless and be U.L. approved for aluminum or copper wire. The butt-type pressure connector shall be connected to the wire with an installing tool that is designed for butt-type pressure connectors. After crimping, all detector cable splices shall also be soldered. Each butt-type connector shall be insulated separately by applying layers of thermoplastic electrical insulating tape. The thermoplastic tape shall extend 1/2 inch (13 millimeters) beyond the conductor insulation and be lapped at 1/4-inch (6-millimeter) intervals. The entire completed splice shall have an application of layers of 30 mil high voltage rubber self-fusing tape well lapped over and equal to the original insulation. The splice shall then be covered with layers of thermoplastic electrical insulating tape not over 0.007 inch (200 microns) thick conforming to MIL-7798 and a coating of flexible insulating paint approved by the Engineer.

At least 1 foot (300 millimeters) of slack shall be left for each conductor at each splice. An approved type of water-tight splicing box may be used in lieu of the aforementioned, providing the box has sufficient number of terminals to accommodate the number of conductors to be spliced in the box.

When conductors and cables are pulled into conduits, all ends of conductors and cables shall be taped to exclude moisture, and shall be so kept until the splices are made or terminal appliances attached.

3. Cable closures shall be installed as shown on the plans or as directed by the Engineer. The cable closure shall be attached to the span or messenger with suspension brackets. After the cables have been installed, each opening shall be sealed with sealing tape. When using cable less than 0.6 inches (15 millimeters) in diameter, a cone-shaped collar shall be formed with sealing tape, to seal off the space between the cable and closure nipple. 2 turns of sealing tape will then be placed over the closure nipple and the cable. The cable shall be attached to the terminal blocks as shown on the typical installation details.

The terminals shall then be securely wrapped with electrical tape. Connectors shall not extend beyond the end of the terminal post. The terminals and connectors shall not be in contact with the closure cover at any point.

11.13.04--Method of Measurement: This work will be measured as follows:

1. The quantity of control cable to be paid for under these items shall be the actual number of linear feet (meters) measured along the center of the cable specified, installed, tested and accepted in place with the necessary connections.

2. Cable closures will be measured for payment by the number of cable closures of the type specified, completed and accepted in place.

11.13.05--Basis of Payment:

1. Control cable shall be paid for at the Contract unit price per linear foot (meter) for "(No.) Conductor #() (Type)" which price shall include installation, splicing, connecting, necessary fittings, equipment, labor, all materials and work incidental thereto.

2. Cable closure will be paid for at the Contract unit price for "Cable Closure" complete, in place, which price shall include all materials, sealing tape, terminal blocks and all equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
(No.) Conductor #()(Type)	l.f. (m)
Cable Closure	ea. (ea.)

SECTION 11.14
MESSENGER AND SPAN WIRE

11.14.01—Description: Work under this item shall consist of furnishing and installing span wire or messenger, whichever is applicable, at the locations indicated on the plans or as directed by the Engineer in accordance with the following requirements.

11.14.02—Materials: The materials for this work shall conform to the requirements of Article M.16.15.

11.14.03—Construction Methods:

1. Span Wire used for the suspension of traffic signals shall be attached to the supporting poles at such a level as to make the lowest part of the signal head not less than 16 feet 0 inches (4.9 meters), nor more than 17 feet 0 inches (5.2 meters) above the pavement grade beneath the signal head.

A normal sag of not more than 5% of the total span shall be permitted. Wire secured to the pole bands shall be protected from sharp bends by a thimble clevis. Thimble eyebolts, nuts and washers shall be used instead of eyebolts. Ends of cable shall be fastened to the standing part by 6-inch (150-millimeter) clamps and shall be wrapped with galvanized wire. A wet porcelain strain insulator shall be used at locations where the messenger or span wire is attached between steel and wood poles. Traffic signal control cable shall be suspended from the span wire by means of 2-inch or 3-inch (50-millimeter or 75-millimeter) rings as required by the number and size of the cables installed, spaced not more than 18 inches (450 millimeters) apart. The traffic signal cable may be suspended from the messenger with the use of 2-inch (50-millimeter) rings, or by a spiral wrapping of 3/32-inch (2.4-millimeter) galvanized steel wire, applied by a machine in a uniform spiral with a lay or pitch of no more than 18 inches (450 millimeters). All overhead conductors shall have an 8-inch (200-millimeter) drip loop at the junction with a pole or signal head. At all electrical cable turns and drops, plastic tie wraps shall be used to insure against any change in physical relationship between the electrical cable and the span wire.

Service wires between a power supply and controller cabinet on a pole shall be connected to the pole by an approved cable grip and enter the poles by means of a wire inlet with a bushing. An 8-inch (200-millimeter) drip loop shall be formed in the wires at the entrance of the wire inlet. The installation of span wire shall be as shown on the plans.

2. Messenger for carrying signal cable between poles shall be installed as shown on the plans.

The suspension of cable shall conform to either the 2-inch or 3-inch (50-millimeter or 75-millimeter) ring or spiral wrapping methods, which are covered elsewhere in this specification.

11.14.04—Method of Measurement: Work under these items will be measured for payment by the actual number of linear feet (meters) of steel wire cable, of the type specified, installed and accepted in place with necessary appurtenances.

11.14.05—Basis of Payment: This work will be paid for at the Contract unit price per linear foot (meter) for "Messenger" or "Span Wire," whichever applies, which price shall include messenger or span wire, wet porcelain insulators, pole bands, thimble eyebolts, nuts, washers, cable rings, all materials, tools, equipment, labor and work incidental thereto.

Pay Item	Pay Unit
Messenger Wire	l.f. (m)
Span Wire	l.f. (m)

SECTION 11.16
ILLUMINATED SIGNS

11.16.01—Description: This item shall consist of furnishing and installing an illuminated sign, of the type specified, at the location shown on the plans or as directed by the Engineer, and in conformity with these specifications.

11.16.02—Materials: The materials for this work shall conform to Article M.16.18.

11.16.03—Construction Methods: Erection of the sign shall be accomplished in a manner so as not to cause twisting, bending, deforming, or scratching of the sign or sign face. They shall be level, correctly aligned as indicated on the plans and shall be properly fastened to the structure or supports with the necessary hardware as indicated on the plans. Any sign panel damaged shall be repaired at the Contractor's expense.

11.16.04—Method of Measurement: This work will be measured for payment by the number of illuminated signs of the type and size specified, completed in place, accepted and operating.

11.16.05—Basis of Payment: This work shall be paid for at the Contract unit price each for "Illuminated Sign" complete in place, which price shall include mounting brackets, hardware, fittings, snap switch, all materials, equipment, paint, tools, labor, and work incidental thereto. Cable to the sign shall be paid under Article 11.13.

Pay Item	Pay Unit
Overhead Illuminated "Stop Ahead" Sign	ea. (ea.)
Internally Illuminated Sign	ea. (ea.)

SECTION 11.17

ALTERNATE FLASHING SIGNALS FOR WARNING SIGNS

11.17.01—Description: Work under this item shall consist of furnishing and installing alternate flashing signals for warning signs at the location shown on the plans or as directed by the Engineer, and in conformance with these specifications.

11.17.02—Materials: The materials for the work shall conform to the following:

- Article M.15.09 for Rigid Metal Conduit
- Article M.16.06 for Traffic Signals
- Article M.16.09 for Painting
- Article M.16.10 for Cabinet
- Article M.16.14 for Control Cable

11.17.03—Construction Methods: All internal wiring shall be #14 AWG stranded drawn copper. All wiring shall be neat and firm. All flasher inputs and outputs shall be wired to a terminal block. The signal indications and flasher cabinet shall be mounted on the sign supports in accordance with the dimensions and details shown on the plans.

11.17.04—Method of Measurement: This work will be measured for payment by the number of alternate flashing signals for warning signs completed and accepted in place. The conduit and cable installed on the line side of the cabinet will not be included for payment under this item.

11.17.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Alternate Flashing Signals for Warning Signs," which price shall include cable, signals, conduit, fittings, hardware, flasher cabinet complete with all necessary equipment, ground rod, armored ground cable, paint and painting, and all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Alternate Flashing Signals for Warning Signs	ea. (ea.)

SECTION 11.18
REMOVAL AND/OR RELOCATION OF TRAFFIC
SIGNAL EQUIPMENT

11.18.01—Description: Work under this item shall consist of removal and, where required, relocation of existing traffic signal equipment at the location shown on the plans or as directed by the Engineer and in conformity with these specifications.

11.18.02—Materials: All materials required for this work shall conform to the requirements of these specifications or the special provisions for the material in question; or if not so specified, they shall be of a quality satisfactory to the Engineer.

11.18.03—Construction Methods: Existing traffic signal equipment shall be carefully removed together with all fittings and attachments in such a manner as to safeguard all parts from damage or loss. The Contractor shall replace, at his own expense, all equipment which becomes damaged due to his operations.

Removal of existing signal and control equipment shall be coordinated with the installation of new signal and control equipment so as to maintain uninterrupted traffic signal operation at each intersection. The Contractor shall furnish and install signals, supports or other equipment necessary to provide for uninterrupted signal operation as directed by the Engineer.

Traffic signal equipment, fittings, wires, cable, conduit and all other materials shall be reinstalled and extended where necessary to maintain satisfactory operations.

Where attachment points for span wire or other signal equipment are on a utility pole, the Contractor shall secure from the owning utility company the permission to remove or install such attachments in accordance with their requirements.

Equipment shall be removed in such a manner as to cause no hazard to pedestrians, traffic or property. If necessary, flagmen shall be used to halt traffic briefly while work is in progress. When plans call for relocation of existing equipment, the work shall be accomplished with a minimum of down time.

All removed equipment, including wire and cable that is not reused at the location, is to be returned to the State depot as designated by the Engineer. Material, such as concrete foundations, etc. shall be removed to a suitable dump. When poles, foundations, etc. are removed, the hole shall be backfilled with clean fill material, which shall be compacted and the ground restored to a grade and condition compatible with the surrounding area. Topsoil to a minimum depth of 4 inches (100 millimeters) shall be applied and seeded with perennial grass seed. If in a sidewalk area, the surfacing shall be with material compatible with the rest of the sidewalk. Where pressure sensitive vehicle detectors are to be removed, the entire detector frame shall be removed, the hole shall be backfilled and the pavement restored, in accordance with the appropriate sections of the Standard Specifications.

11.18.04—Method of Measurement: This work shall be at the Contract lump sum price for the completion of all work specified.

11.18.05—Basis of Payment: This work will be paid for at the Contract lump sum price for the "Removal and/or Relocation of Traffic Signal Equipment" which price shall include all removals, all relocations, all material, equipment and labor incidental to completion of this item.

Pay Item	Pay Unit
Removal and/or Relocation of Traffic Signal Equipment	l.s. (l.s.)

SECTION 11.30
HIGH MOUNTED INTERNALLY ILLUMINATED
FLASHING ARROW

11.30.01—Description: This item shall include furnishing and maintaining a high mounted internally illuminated flashing arrow sign, either on a trailer assembly or truck, as shown on the traffic control plans or as ordered by the Engineer and in accordance with these specifications.

11.30.02—Materials: The flashing arrow shall conform to the requirements of Part VI of the MUTCD, Advance Warning Flashing Sequencing Arrow Panels, Type C. The panel shall have the capability of both sequential and flashing operations. The bottom of the panel shall not be less than 7 feet (2.1 meters) above the pavement. Lamp voltage shall be dimmed by 50% for nighttime use automatically.

11.30.03—Construction Methods: The Contractor shall furnish, place, operate, maintain and relocate the sign as required. When the need no longer exists for a sign, the Contractor shall dispose of it. Any signs that are missing, damaged, defaced, or improperly functioning so that they are not effective, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor at no cost to the State.

11.30.04—Method of Measurement: This work will be measured for payment by the number of calendar days that the sign is in place and in operation. When a sign is in operation for less than a day, such a period of time shall be considered to be a full day regardless of actual time in operation.

11.30.05—Basis of Payment: This work will be paid for at the Contract unit price per day for "High Mounted Internally Illuminated Flashing Arrow," which price shall include all costs for furnishing, maintaining and disposing of a sign and all materials, labor, tools and equipment incidental thereto.

Pay Item	Pay Unit
High Mounted Internally Illuminated Flashing Arrow	day (day)

**SECTION 11.31
CHANGEABLE MESSAGE SIGN
REMOTE CONTROLLED CHANGEABLE
MESSAGE SIGN**

11.31.01—Description: Work under this item shall include furnishing and maintaining a trailer-mounted, Changeable Message Sign or Remote Controlled Changeable Message Sign, whichever is applicable, at the locations indicated on the plans or as directed by the Engineer.

11.31.02—Materials: The internally illuminated variable message sign shall consist of a magnetically operated matrix, LED, fiber optic, or lamp matrix message board; a diesel engine driven generator power supply; hardware for connection to a 110 volt power source; and a computer operated interface, all mounted on a towable, heavy duty trailer.

The sign shall have a 3-line message panel with 8 characters per line and a minimum horizontal dimension of 115 inches (2920 millimeters). The letter height shall not be less than 18 inches (460 millimeters). The sign shall rotate a complete 360 degrees atop the lift mechanism.

In the raised position, the bottom of the sign shall be at least 7 feet (2.1 meters) above the pavement surface. The sign shall be clearly legible for a distance of 900 feet (274 meters).

The sign shall be controlled by an on-board computer. The sign shall automatically change to a pre-selected default message upon failure. That default message shall remain on display until the problem is corrected.

The Remote Controlled Changeable Message Sign unit shall be equipped with a security system to prevent unauthorized access. The security system shall allow access only through use of a code or password unique to that sign. If the proper code or password is not entered within 60 seconds of initial telephone contact, the call will be terminated. Remote control for the Remote Controlled Changeable Message Sign shall be by cellular telephone and touch tone modem decoder.

Each element in a magnetically operated matrix message board shall consist of a moveable flap operated by an electromagnet, which shall be positioned so that by changing polarity the flap is reversed. When closed, the black side shall be exposed. When opened, the colored section shall be exposed.

The lamp matrix, LED or fiber optic sign, shall be equipped with a top-mounted photocell for automatic sign dimming during nighttime use.

The sign shall be capable of storing 100 pre-programmed messages and be able to display any one of those messages upon call via the trailer-mounted terminal for both the Changeable Message Sign and the Remote Controlled Changeable Message Sign or through the cellular telephone hookup for the Remote Controlled Changeable Message Sign.

11.31.03—Construction Methods: The Contractor shall furnish, place, operate, maintain and relocate the sign as required. When the sign is no longer required, it shall be removed and become the property of the Contractor. The cellular telephone required for the Remote Controlled Changeable Message Sign shall be provided to the Engineer for his use, and subsequently returned to the Contractor. When the sign is not in use, it shall either be turned off or turned from view.

Any signs that are missing, damaged, defaced or improperly functioning so that they are not effective, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor at no cost to the State.

11.31.04—Method of Measurement: This work will be measured for payment for each changeable message sign or remote controlled changeable message sign, whichever applies, furnished and installed, for the number of calendar days that the sign is in place and in operation, measured to the nearest day. When a sign is in operation for less than a day, such a period of time shall be considered to be a full day regardless of actual time in operation.

11.31.05—Basis of Payment: This work will be paid for at the Contract unit price per day for each "Changeable Message Sign" or "Remote Controlled Changeable Message Sign," which price shall include placing, maintaining, relocating and removing the sign and its appurtenances and all material, labor, tools and equipment incidental thereto. Additionally, for the "Remote Controlled Changeable Message Sign," the cellular telephone service and telephone charges shall be included.

Pay Item	Pay Unit
Changeable Message Sign	day (day)
Remote Controlled Changeable Message Sign	day (day)

SECTION 12.00

GENERAL CLAUSES FOR HIGHWAY SIGNING

12.00.01—General: It is the intent of the plans, specifications, and special provisions to provide for a complete signing system. The work shall include the furnishing of all materials incidental to the fabrication and erection of all signs and sign supports.

12.00.02—Shop Drawings: Before fabricating any portion of the Overhead and/or Cantilever Sign Supports, the Contractor shall submit shop drawings drawn to scale for approval in accordance with Subarticle 1.05.02-3. These drawings shall include but not be limited to the following information.

1. All pertinent dimensions.
2. Complete details of the Overhead and/or Cantilever Sign Supports including camber and material designations.

12.00.03—Buried Cable: The Contractor is hereby cautioned that within the limits of any Project an illumination contract may be in force or have been completed, in which case buried cable may be present at or near the proposed locations for overhead sign support foundations and the cable may be energized. Any damage to existing buried cable shall be repaired in a satisfactory manner at no additional cost to the State.

12.00.04—Negotiations with Utility Company: Article 10.00.12 is supplemented by the following:

The Contractor shall make all necessary arrangements with the District Electrical Maintenance Supervisor for locking and unlocking of the circuits on which any work is to be done, through the Engineer.

12.00.05—Sequence of Operations: Whenever a new or relocated sign, of any kind, is replacing an existing sign, the replaced sign shall be removed immediately after the new installation.

**SECTION 12.01
OVERHEAD SIGN SUPPORT**

12.01.01--Description: Work under this item shall consist of furnishing, fabricating, transporting and erecting galvanized overhead sign supports of the type specified, at the locations indicated, in conformity with the requirements of the plans or as ordered, and in conformance with these specifications.

12.01.02--Materials: Materials for this work shall conform to the requirements of Articles M.18.01, M.18.02 and Subarticle M.03.01-12.

12.01.03--Construction Methods: Prior to the start of fabrication of the overhead sign supports, the Contractor shall, in the field, verify the location of the foundations and establish and verify all elevations, dimensions and longitudinal grades.

All welding shall conform to the requirements of the current AWS Structural Welding Code.

All connections using high-strength bolts shall conform to the requirements of Subarticle 6.03.03-19.

Camber shall be interpreted as the curvature induced into the overhead sign support truss to offset the anticipated deflections when the truss is in its erected position and to provide for the permanent camber as indicated on the plans. Cambers shall be measured in this erected position and failure to meet the required amount of camber may be cause for rejection.

Prior to assembly, the top and bottom surface of the base plate shall be planed, or else the plate shall be hot straightened. The post shall be faced at the bottom end.

The top leveling nuts and the grout-leveling template shall be removed prior to placing the base plate and post assembly upon the foundation.

The base plate and post assembly shall be installed upon the foundation pedestal in accordance with the requirements of Article 6.03.03-15.

After placing the base plate and post assembly upon the foundation, the anchoring nuts shall be installed "snug tight" and then tightened additionally in accordance with Article 6.03.03-19(c)(3), modified as follows: Nut rotation from the snug tight condition shall be one quarter (1/4) turn.

The posts shall have a removable top cap, complete with set screws for proper attachment. The cap shall be provided with a weatherproof ventilation passageway to the interior of the post.

The galvanized Overhead Sign Support shall not be painted except that any damaged galvanized areas shall be given two coats of zinc paint conforming to the requirements of the FS TT-P-641-b(2).

12.01.04--Method of Measurement: This work will be measured for payment by the number of units of "Overhead Truss Sign Supports" or "Overhead Cantilever Sign Supports" of the type specified, installed and accepted.

12.01.05--Basis of Payment: This work will be paid for at the contract unit price each for "Overhead Truss Sign Support" or "Overhead Cantilever Sign Support" of the type specified, complete in place, which price shall include all materials, equipment, labor, tools, and work incidental thereto.

Pay Item	Pay Unit
Overhead Truss Sign Support Type ()	ea. (ea.)
Overhead Cantilever Sign Support Type ()	ea. (ea.)

SECTION 12.02
OVERHEAD SIGN SUPPORT FOUNDATION

12.02.01—Description: Work under this item shall consist of the construction of foundations for overhead sign supports including the removal and satisfactory disposal of all materials required for excavation for the foundations, and backfilling with suitable material, in conformity with the requirements of the plans or as ordered, and in conformance with these specifications.

12.02.02—Materials: Class "A" Concrete shall conform to the requirements of Sections 6.01 and M.03. Non-shrink, non-staining grout shall conform to the requirements of M.03.01-12.

Reinforcing steel shall conform to the requirements of Section 6.02 and Article M.06.01.

Rigid metal conduits, ground rod sleeves and related hardware shall be as shown on plans.

Anchor bolts shall conform to the requirements of ASTM A 449.

Leveling nuts and nuts for anchor bolt assemblies shall conform to the requirements of Article M.18.02.

Pedestal Grout Leveling Templates shall conform to the requirements of Article M.18.02.

12.02.03—Construction Methods: Prior to start of construction of the foundations the Contractor shall, in the field, verify the location of the foundations and establish and verify all elevations and dimensions.

Excavation for the footings shall conform to the neat lines of the base as shown on the plans. All steel reinforcement shall be accurately placed in the position shown on the plans and firmly held during placing and setting of concrete.

The footing of the concrete foundation shall be placed without forms except where unusual soil conditions prevent excavation to neat lines as shown on the plans. Where unusual soil conditions make the use of forms necessary, in the opinion of the Engineer, the cost thereof shall be considered included in the cost of the foundations.

Where rock ledge or large boulders are exposed before excavation has attained the required depth, the Engineer may order rock anchors installed.

Where rock anchors are required, they shall be paid for in conformance with Article 1.04.05.

After the concrete for the footing has sufficiently set, in the opinion of the Engineer, the portion of the concrete foundation, hereinafter designated as the stem, shall be formed to conform to the details shown on the plans. The forms shall include a template to hold the required anchor bolt assemblies, ground rod sleeve and conduit in their correct position.

Anchor bolt assemblies shall conform to the requirements shown on the plans and shall be embedded in the concrete which shall be placed to within the minimum distance of the finished surface of the stem as shown on the plans forming a construction joint for the non-shrink grout. Each bolt of the anchor bolt assembly shall be fitted with two leveling nuts.

Construction joints other than those shown on the plans will not be permitted.

The top and bottom surfaces of the grout-leveling template shall be planed, or else the plate shall be hot straightened.

The grout-leveling template shall be clamped in position by 2 leveling nuts at each anchor bolt. These leveling nuts shall be adjusted to assure a truly level finished foundation surface at the proper elevation.

The space between the grout-leveling template and pedestal concrete shall be grouted with non-shrink, non-staining grout. The grout shall be forced by rodding or by other suitable means from one side of the template until it flows freely out at the opposite side. Care shall be taken to eliminate voids underneath the template.

Before grouting, the concrete areas that will be in contact with the grout shall be cleaned of all loose or foreign material that would in any way prevent bond between the grout and concrete surfaces. These concrete surfaces shall be kept thoroughly moistened until the surface is completely saturated prior to placing the grout. The grout shall be moisture cured for 7 days. No load shall be allowed on the grout that has been in place for less than 7 days unless otherwise approved by the Engineer.

The grout-leveling template shall remain in place for a minimum of 2 days after placement of the grout.

All conduits shall be capped with insulated bushings before placing the grout. Where the signs are not to be illuminated, the caps shall be made fully watertight. The number of conduits in the foundation will be determined by the Engineer.

The concrete shall be finished in conformance with the pertinent requirements of Subarticle 6.01.03-21. Backfill shall be placed and thoroughly tamped to the elevation shown on the plans.

12.02.04—Method of Measurement: This work will be measured for payment by the number of foundation units, of the type specified, completely installed and accepted. Each overhead cantilever sign support shall have 1 foundation unit and each overhead truss sign support shall have 2 foundation units.

12.02.05—Basis of Payment: The work will be paid for at the Contract unit price each for "Overhead Sign Support Foundation," of the type specified, complete in place, which price shall include all materials, excavation, backfill, equipment, labor, tools and work incidental thereto including rigid metal conduits and ground rod sleeve with 5/8 inch x 12 feet (16 millimeters x 3.7 meters) ground rod driven in position as directed by the Engineer.

Pay Item	Pay Unit
Overhead Truss Sign Support Foundation (Type)	ea. (ea.)
Overhead Cantilever Sign Support Foundation (Type)	ea. (ea.)

SECTION 12.03

SIDE MOUNTED SIGN FOUNDATION

12.03.01—Description: Work under this item shall consist of all necessary excavation including rock excavation, backfill, when necessary, and the construction of side mounted sign foundations conforming to the details shown on the plans.

12.03.02—Materials: Concrete shall be Class 'A' Concrete conforming to the pertinent requirements of Sections 6.01 and M.03.

Reinforcing steel shall conform to the pertinent requirements of Section M.06.01.

Stub post assemblies shall be steel conforming to ASTM A36 and shall be galvanized after fabrication in accordance with ASTM 123.

All other material shall conform to the requirements shown on the plans.

12.03.03—Construction Methods: Excavation for the foundation shall conform to the neat lines as shown on the plans.

The concrete foundation shall be placed without forms except where unusual soil conditions prevent excavation to neat lines as shown on the plans. The forms shall be fastened in place before the placing of any concrete so that the resulting foundation will be monolithic.

The anchor bolts or stub post assembly and reinforcing steel shall be fabricated and preset as shown on the plans. After presetting the stub post, concrete shall be carefully placed and consolidated around the post.

12.03.04—Methods of Measurement: This work will be measured for payment by the number of units completely installed and accepted.

12.03.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Side-Mounted Sign Foundation," which price shall include all material, excavation including rock excavation, stub post assembly, breakaway coupling system, forms when necessary, labor and work incidental thereto.

Pay Item	Pay Unit
Side-Mounted Sign Foundation	ea. (ea.)

SECTION 12.04
SIGN PANEL OVERLAY

12.04.01—Description: Work under this item shall consist of furnishing and installing a plywood overlay of the type specified to cover an existing sign where shown on the plans or where directed by the Engineer.

12.04.02—Materials: Plywood paneling shall have a minimum thickness of 1/4 inch (6 millimeters) and shall be exterior grade A-C as designated by the APA.

Wood preservative shall be a penetrating solution having a minimum of 20% of copper or zinc naphthanate.

Primer shall conform to the requirements of FS TT-P-25.

The paint to be used for the finish coat shall conform to Article M.18.08.

Copy shall conform to the requirements contained in M.18.09 or M.18.10, as specified in the plans.

12.04.03—Construction Methods: The plywood overlay shall completely cover the sign including the exit crown panel. The plywood sheets shall be joined together to form a single sign covering by means of 1 inch x 4 inches (25 millimeters x 100 millimeters) construction grade fir wood battens securely fastened to adjoining panels by means of 1 inch (25 millimeters) galvanized wood screws. The battens shall be fastened to the back face of the overlay.

Before assembly and before painting, all wood shall be treated with a coat of wood preservative on all sides. The wood preservative shall be of a type which will have no adverse effect on paint adhesion and will not cause future paint discoloration.

The entire sign shall be painted with one coat of primer and one coat of enamel.

The completed sign overlay shall be fastened to the erected sign by means of approved steel "C" clamps. A minimum of 1 "C" clamp shall be used for every 2 feet (0.6 meters) of sign perimeter. The "C" clamps shall be tightened to insure the plywood sign covering will remain in place.

All work fabricating and clamping the plywood sign panel overlay shall be done to insure that no damage occurs to the sign.

12.04.04—Method of Measurement: Sign panel overlay of the type specified will be measured for payment by the actual number of square feet (square meters) installed and accepted.

12.04.05—Basis of Payment: This work will be paid for at the Contract unit price per square foot (square meter) for "Sign Panel Overlay," of the type specified complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Sign Panel Overlay—Plain	s.f. (s.m)
Sign Panel Overlay—with Copy	s.f. (s.m)

**SECTION 12.05
DELINEATORS**

12.05.01—Description: This item shall consist of furnishing and installing delineators of reflective material and delineator posts or bridge rail mountings in conformance with the requirements of the plans or as ordered and in accordance with these specifications.

12.05.02—Materials: The materials for delineators shall conform to Articles M.18.07 and M.18.13. Reflective sheeting shall conform to either Subarticle M.18.09.01 (Type V) or M.18.09.02.

12.05.03—Construction Methods: Delineators shall be mounted on the posts or bridge rail mountings with fastening devices conforming to the details shown on the plans. The spacing and color of the delineators shall be in conformance with the plans or as directed by the Engineer.

The delineator post shall be driven or the hole augered and the backfill thoroughly tamped. The posts shall be plumb above ground, and any post bent or otherwise damaged to the extent that it is, in the opinion of the Engineer, unfit for use, shall be removed from the site and replaced by the Contractor at its own expense. The delineator reflective units shall be positioned to be clearly visible for a distance of 1,000 feet (300 meters) during the hours of darkness, under normal weather and atmospheric conditions, when illuminated by the upper beams of standard automobile headlights when the vehicle is located in the adjacent traffic lane approaching the delineator.

12.05.04—Method of Measurement: This work will be measured for payment by the number of delineators of the type specified, installed and accepted.

12.05.05—Basis of Payment: This work will be paid for at the Contract unit price each for "Delineator," of the type specified, complete in place, which price shall include the delineator, delineator post or bridge rail mounting and materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Type DE-() Delineator	ea. (ea.)

**SECTION 12.06
REMOVAL OF EXISTING SIGNING
REMOVAL OF EXISTING OVERHEAD SIGNING**

12.06.01—Description: This work shall consist of removing designated side-mounted signs, supports and foundations; plywood and/or sheet aluminum regulatory, warning and guide signs and metal sign posts; delineators and delineator posts; overhead signs, supports and foundations; and structure mounted sign and supports where indicated on the plans or as directed by the Engineer.

12.06.02—Vacant

12.06.03—Construction Methods: Signs constructed of plywood and the hardware used for attachment to the supports shall be removed and disposed of by the Contractor.

Signs constructed of aluminum and the hardware used for attachment to the supports shall be removed and disposed of by the Contractor, unless otherwise specified in the Special Provisions.

Delineators and delineator posts shall be removed and disposed of by the Contractor.

Sign supports and sign illumination appurtenances shall be removed and disposed of by the Contractor unless otherwise specified in the Special Provisions.

When signs and supports are to be delivered to a location specified in the Special Provisions, the Contractor shall transport and carefully unload the signs and supports where directed by the storekeeper.

Overhead sign support foundations shall be removed to a depth of 6 inches (150 millimeters) below finished grade. Anchor bolts shall be cut approximately flush with the top of the remaining portion of foundation. The concrete and portions of the anchor bolts removed from the foundation shall be disposed of by the Contractor.

For-side-mounted sign foundations, the stub post or anchor bolts and concrete foundations shall be removed to a depth of 6 inches (150 millimeters) below finished grade. The portion of stub posts or anchor bolts and the concrete removed shall be disposed of by the Contractor. Where sign support foundations exist without stub posts or anchor bolts, the Contractor will have the option of removing the concrete foundation in its entirety or remove the concrete and post to a depth of 6 inches (150 millimeters) below finished grade. Whichever option the Contractor chooses, the Contractor shall remove the excavated material from the site.

After removal of all concrete, stub post portions and anchor bolt portions, top soil shall be placed to 1 inch (25 millimeters) above finished grade, then fertilized and seeded. Fertilizing and seeding shall be in accordance with pertinent provisions of Section 9.45. Where necessary, backfill shall be placed to 6 inches (150 millimeters) below grade before topsoil is placed.

Supports located in bituminous concrete or Portland cement concrete areas shall be removed flush with the surrounding area and disposed of by the Contractor. Posts attached to bridge parapets or railings shall be unbolted and the anchor bolts removed flush with the bridge parapet and all material shall be disposed of by the Contractor.

12.06.04—Method of Measurement: Payment under Removal of Existing Signing and Removal of Existing Overhead Signing shall be at the contract lump sum price, which will include all signs, sign supports and foundations, if applicable, and delineators designated for removal in the Contract.

12.06.05—Basis of Payment: This work will be paid for at the Contract lump sum price for "Removal of Existing Signing" and "Removal of Existing Overhead Signing" complete including the disposal of material unless otherwise specified, and all equipment, material, tools and labor incidental thereto. The price shall also include the transporting and careful unloading of salvaged material at the location designated in the Special Provisions and all equipment, material, tools and labor incidental thereto.

Pay Item	Pay Unit
Removal of Existing Signing	l.s. (l.s.)
Removal of Existing Overhead Signing	l.s. (l.s.)

SECTION 12.07
SIGN FACE - EXTRUDED ALUMINUM
(TYPE III REFLECTIVE SHEETING)

12.07.01—Description: This item shall consist of furnishing and installing sign face extruded aluminum with the Type III reflective sheet facing at locations indicated on the plans or as ordered and in conformance with the plans and these specifications.

12.07.02—Materials: Materials for this work shall conform to the requirements of Articles M.18.09, M.18.10, M.18.11 and M.18.12.

Structural steel shall conform to the requirements of ASTM A36. All members shall be galvanized after fabrication in accordance with the requirements of ASTM A123.

Zinc paint shall conform to the requirements of FS TT-P-641 Type 1.

12.07.03—Construction Methods: Erection of completed sign panels shall be accomplished in a manner so as not to cause twisting, bending or deforming of sign panels or scratching of the sign face. Any sign panel damaged shall be repaired or replaced at the Contractor's expense. They shall be level, correctly aligned as indicated on the plans, and shall be properly fastened to the structure or supports with the necessary hardware as indicated on the plans.

Reflective sheeting shall be applied in such a manner that the finished sign will be wrinkle and bubble free. No splices of the reflective sheeting will be permitted on any sign face less than 30 square feet (2.7 square meters) in area with one dimension of 4 feet (1.2 meters) or less and no more than one splice will be permitted on any one sign without the approval of the Engineer.

Extruded aluminum signs shall be attached to existing supports with new post clip assemblies consisting of post clips, bolt, nut and washer as shown on the plans. All other hardware used for attachment of the overhead signs to the supports may remain in use and be relocated on the structure as required. Check and tighten all bolts and nuts for attachment hardware which is to remain in use.

New extruded aluminum signs shall be vertically centered on existing supports. Overhead sign support brackets (Z bar, I bar, channel shape or angle iron) that project beyond the top or bottom of a new sign shall be cut to fit even with the edge of the new sign, preferably at the bottom. If necessary, cuts may be made at both ends.

Where overhead signs having a vertical dimension exceeding the length of the existing sign support brackets, the existing brackets shall be removed and replaced with new vertical brackets having the length equal to the sign height.

All galvanized areas damaged by field cuts or welds shall receive zinc paint that is brush applied to achieve a dry film thickness from 3 to 6 mils.

All overhead sign erections shall be made immediately upon removal of the sign being replaced.

12.07.04—Method of Measurement: This work will be measured for payment by the number of square feet (square meters) of sign face-extruded aluminum of the type specified installed and accepted.

12.07.05—Basis of Payment: This work will be paid for at the Contract unit price per square foot (square meter) for "Sign Face-Extruded Aluminum" of the type specified complete in place, which price shall include all materials, equipment, labor and work incidental thereto. Also included shall be any additional vertical sign support brackets required to attach new signs to existing supports.

Pay Item	Pay Unit
Sign Face - Extruded Aluminum (Type III Reflective Sheeting)	s.f. (s.m)

SECTION 12.08
SIGN FACE - SHEET ALUMINUM

12.08.01—Description: This item shall consist of furnishing and installing sign face-sheet aluminum signs of the type specified, metal sign posts, span-mounted sign brackets, mast arm-mounted sign brackets or parapet-mounted sign supports at locations indicated on the plans or as ordered and in conformance with the plans and these specifications.

12.08.02—Materials: Reflective sheeting shall conform to the requirements of Article M.18.09.01, Type I, II or III.

Sheet aluminum sign blanks shall conform to the requirements of Article M.18.13.

Silk screening of Type I, Type II or Type III reflective sheeting shall conform to the requirements specified by the reflective sheeting manufacturer.

Metal sign posts and parapet mounted sign supports shall conform to the requirements of Article M.18.14.

Sign mounting bolts shall conform to the requirements of Article M.18.15.

12.08.03—Construction Methods: Placement and dimensions of copy, border and mounting holes shall conform to details of the Department of Transportation for Regulatory Warning and Guide signs which are available for inspection at the Department of Transportation office. Non-reflective copy, border and background shall be applied by the silk-screen process in a manner specified by the reflective sheeting manufacturer. The silk screening of all copy, border and background on Type III reflective sheeting shall be accomplished prior to the application of the reflective sheeting to the finished aluminum sign blank. Type III reflective sheeting shall be of the heat activated adhesive type and shall be applied in a manner specified by the reflective sheeting manufacturer.

Reflective sheeting shall be applied in such a manner that the finished sign will be wrinkle and bubble free. No splices of the reflective sheeting will be permitted on any sign face under 30 square feet (2.7 square meters) in area with one dimension of 4 feet (1.2 meters) or less and no more than one splice will be permitted on any one sign without the approval of the Engineer.

Direct application of cutout Type I, Type II or Type III reflective sheeting copy and border shall conform to the requirements specified by the reflective sheeting manufacturer. Cutout copy and border shall be applied directly to clean, dust free reflective sheeting background panels. Borders shall be cut neatly and butt-joined at corners and panel joints. Type I or Type II reflective sheeting used for direct applied cutout copy and border shall be uniform in brightness and color.

The fabrication of aluminum sign blanks including cutting to size and shape and the punching of mounting holes shall be completed prior to metal degreasing and the application of reflective sheeting. Aluminum sign blanks shall be free of buckles, warp, dents, cockles, burrs and defects resulting from fabrication. Span-mounted sign brackets and mast arm-mounted sign brackets shall be installed as shown on the plans.

After complete fabrication of the sign as indicated on the plans and in conformance with the requirements contained in the specifications, the sign shall be mounted on the type of support designated on the plans after the support has been satisfactorily installed at its proper location. The reinforcing plate shall be installed as shown on the plans.

Metal sign posts shall be driven or the holes augered and the backfill thoroughly tamped after the posts have been set level and plumb. Parapet-mounted sign supports shall be installed as shown on the plans and shall be level and plumb.

12.08.04—Method of Measurement: This work will be measured for payment by the number of square feet (square meters) of sign face-sheet aluminum of the type specified, installed and accepted.

12.08.05—Basis of Payment: This work will be paid for at the Contract unit price per square foot (square meter) for "Sign Face-Sheet Aluminum" of the type specified complete in place, which price shall include the completed sign, metal sign post(s), span-mounted sign brackets and mast arm-mounted brackets or parapet-mounted sign support, mounting hardware, including reinforcing plates, and all materials, equipment, labor and work incidental thereto.

Pay Item	Pay Unit
Sign Face—Sheet Aluminum (Type)	s.f. (s.m)

SECTION 12.09
PAINTED PAVEMENT MARKINGS

12.09.01—Description: This item shall consist of furnishing and installing painted pavement markings, hot applied painted pavement markings and painted legend, arrows and markings, of the type and color specified at the locations indicated on the plans and in conformity with the plans, these specifications, and as directed by the Engineer.

Painted legend, arrows, and markings includes paint installed with a hand striping machine such as: stop bars, crosswalks, parking stalls, lane arrows, legends, markings within gore areas, and painting of paved islands or medians.

Painted pavement markings and hot applied painted pavement markings include paint installed with a truck-mounted painting machine such as center lines, lane lines and shoulder lines.

The exact location for passing zones will be determined by the Engineer prior to the application of the pavement markings. The Engineer shall be notified a minimum of two weeks before the anticipated date of painting, to allow time for the determination of the passing zone locations.

12.09.02—Materials: Materials for this work shall conform to the requirements of Article M.07.20 for waterborne pavement marking paint, Article M.07.21 for hot-applied waterborne pavement marking paint and Article M.07.30 for glass beads.

12.09.03—Construction Methods: Pavement areas to be painted shall be dry and sufficiently cleaned of sand and road debris so as to provide an acceptable bond between the paint and the pavement.

Paint shall be applied at a rate of 100 to 115 square feet per gallon (2.5 to 2.8 square meters per liter), with glass beads applied at a rate of 6 pounds per gallon (0.72 kilograms per liter) of paint for painted pavement markings and painted legend, arrows, and markings, and 8 pounds per gallon (0.96 kilograms per liter) of paint for hot-applied painted pavement markings.

Hot-applied paint shall be applied at a temperature of 130°F to 145°F (54°C to 63°C) at the spray gun.

All painting shall be performed in a neat and workmanlike manner. The lines shall be sharp and clear with no feathered edging or fogging and precautions shall be taken to prevent tracking by tires of the striping equipment. Paint shall be applied parallel to the centerline or as shown on the plans with no unsightly deviations.

After application, the paint shall be protected from crossing vehicles for a time at least equivalent to the drying time of the paint.

12.09.04—Method of Measurement: Painted pavement markings and hot-applied pavement markings will be measured for payment by the number of linear feet (meters) of paint applied by a truck-mounted painting machine on the pavement and accepted. Painted legend, arrows and markings will be measured for payment by the number of square feet (square meters) of paint installed with a hand striping machine on the pavement and accepted.

12.09.05—Basis of Payment: This work will be paid for at the Contract unit price per square foot (square meter) for "Painted Legend, Arrows and Markings" and per linear foot (meter) of paint for "Painted Pavement Markings" and "Hot-Applied Painted Pavement Markings," of the width and color specified, installed on the pavement and accepted. This price shall include all pre-marking layout, cleaning off pavement, paint, glass beads, application of paint and glass beads, protection during drying and all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Painted Legend, Arrows and Markings	s.f. (s.m)
Painted Pavement Markings (Width) (Color)	l.f. (m)
Hot-Applied Painted Pavement Markings (Width) (Color)	l.f. (m)

SECTION 12.10
EPOXY RESIN PAVEMENT MARKINGS, SYMBOLS AND LEGENDS

12.10.01--Description

12.10.02--Materials

12.10.03--Construction Methods

12.10.04--Method of Measurement

12.10.05--Basis of Payment

12.10.01--Description: This item shall consist of furnishing and installing retroreflective white and yellow epoxy resin pavement markings of the width and color specified and epoxy resin pavement markings, symbols and legends at the locations indicated on the plans and in conformity with the plans, these specifications and as directed by the Engineer.

Epoxy resin pavement markings includes epoxy resin installed with a truck-mounted machine such as center lines, lane lines, and shoulder lines.

Epoxy resin pavement markings, symbols and legends include stop bars, crosswalks, parking stalls, lane arrows, legends, and markings within areas such as paved islands, gore areas and paved medians.

The exact location for passing zones will be determined by the Engineer prior to the application of the pavement markings. The Contractor shall notify the Engineer of the anticipated date of installation at least two weeks prior to that date, to allow time for the determination of the passing zone locations.

12.10.02--Materials: Materials for this work shall conform to the requirements of Article M.07.22.

12.10.03--Construction Methods:

1. Equipment: Equipment furnished shall include an applicator truck of adequate size and power, together with (a) remote application equipment designed to apply an epoxy resin material in a continuous pattern and (b) portable glass bead applicators, one for each size bead, designed to provide uniform and complete coverage of the epoxy binder by a controlled free-fall method. Pressurized glass bead application shall not be used. Before epoxy color is changed, equipment shall be cleaned out sufficiently to ensure that the color of material applied will be correct.

When working on a highway with more than one lane in either direction, the applicator truck (striper) shall have a permanently mounted direction variable illuminated arrow board, fully operational and visible to approaching traffic. There will be no additional payment for the arrow board. Its cost shall be included in the bid price for this item.

For markings applied on pavements over one year old, equipment furnished shall also include a power washing machine capable of cleaning the pavement with a pressure of 2,400 to 2,800 psi (16 550 to 19 300 kilopascals,) with water heated to 180°F - 195°F (82°C – 90°C). No chemicals shall be added to the water used in the process. The power washer shall be equipped with a turbo blast tip with an oscillating head and shall be capable of supplying a minimum of 5 gallons/minute (19 liters)/minute) gun.

All guns on the spray carriages shall be in full view of the operator(s) during operation.

Each vehicle furnished shall include at least one experienced operator, who shall be fully knowledgeable about all equipment operations and application techniques.

The Contractor shall also furnish one technical expert, who shall be fully knowledgeable about all equipment operations and application techniques, to oversee the project operation.

2. Procedures: Pavement markings shall be applied in accordance with the details shown on the plans and the control points established by the Contractor and approved by the Engineer.

The road surface shall be cleaned at the direction of the Engineer just prior to application. Pavement cleaning shall consist of power washing using clean water heated to 180°F - 195°F (82°C – 90°C) at a pressure of 2,240 - 2,800 psi (16,550 – 19,300 kilopascals.). The areas to be power washed shall include all areas where epoxy marking symbols and legends (including stop bars and crosswalks) are to be applied and at least 1 inch (25 millimeters) beyond the area to be marked. The surface shall be cleaned to the satisfaction of the Engineer. For other pavement areas, cleaning shall consist of brushing with rotary broom (non-metallic), and any additional work as recommended by the material manufacturer and acceptable to the Engineer. New Portland cement concrete surfaces shall be cleaned by abrasive blasting to remove any surface treatments and/or laitance. New bituminous concrete surfaces are not to be power washed.

All surfaces that are power washed shall be allowed to dry sufficiently prior to the application of the epoxy markings. The areas to be marked shall be broom cleaned immediately prior to the application of

the epoxy markings. Glass beads shall be applied immediately after application of the epoxy resin marking to provide an immediate no-track system.

The Contractor will place necessary "spotting" at appropriate points to provide horizontal control for striping and to determine necessary starting and cutoff points. Broken line intervals will not be marked. Longitudinal joints, pavement edges and existing markings shall serve as horizontal control when so directed.

A tolerance of 0.25 inch under or 0.25 inch over (6 millimeters under or 6 millimeters over) the specified width shall be allowed for striping provided the variation is gradual and does not detract from the general appearance. Alignment deviations from the control guide shall not exceed 2 inches (50 millimeters) provided the variation is gradual and does not detract from the general appearance. Material shall not be applied over a longitudinal joint. Establishment of application tolerances shall not relieve the Contractor of the responsibility to comply as closely as practicable with the planned dimensions.

Operations shall be conducted only when the road surface temperatures is 40°F (10°C) or as allowed by the Engineer. They shall be discontinued during periods of rain, and shall not continue until the Engineer determines that the pavement surface is dry enough to achieve adhesion.

Glass beads conforming to the requirements of Grading "B" (larger beads) shall be applied at a rate of 12 pounds per gallon (1.44 kilograms/liter) of epoxy pavement marking material, immediately followed by a second drop of glass beads conforming to the requirements of Grading "A" (smaller beads) applied at a rate of 13 pounds per gallon (1.55 kilograms/liter) of epoxy pavement marking material. Traffic cones or some other acceptable method shall be used to protect the pavement markings until cured.

Time to No-Track: The material shall be in "no-tracking" condition within 15 minutes, or as allowed by the Engineer. The no-tracking time shall be determined by passing over the line with a passenger car or pickup truck in the simulated passing maneuver. A marking showing no visual deposition of the material to the pavement surface when viewed from a distance of 50 feet (15 meters) shall be considered as showing "no-tracking" and conforming to this requirement for time to no-track.

When stencils are used during the application of epoxy markings, care must be used when removing the stencils so that the epoxy resin does not drip on the road, sidewalk, grass, etc., and so that the applied markings have edges which are clean, straight and neat.

Epoxy resin pavement markings may be applied over existing painted markings provided they are sufficiently worn to allow adequate adhesion. If required by the Engineer, existing plastic, thermoplastic, epoxy or freshly painted markings shall be removed prior to the application of epoxy markings. Payment for removal will be made under the item "Removal of Pavement Markings."

3. Performance and Warranty: In order to be accepted, the applied markings must meet the following minimum retroreflectivity reading as measured using an LTL 2000 Retrometer with 30-meter geometry 1 to 2 weeks after installation:

White Epoxy 250 millicandelas per square foot per foot candle (millicandelas per square meter per lux)
Yellow Epoxy 175 millicandelas per square foot per foot candle (millicandelas per square meter per lux)

WARRANTY:

The Contractor shall warrant for the period and percentage level indicated below that the installation shall remain intact and serviceable. The installed material shall show no fading, lifting, shrinking, tearing, rollback, distortion or chipping due to vehicular traffic or normal maintenance activities including snow plowing. Although some wear is expected, the markings shall not wear out for the period and percentage level indicated below.

	<u>First Year</u>
Epoxy Resin Pavement Markings	95% linear feet (meters)
Epoxy Resin Pavement Markings, Symbols and Legends	95% square feet (square meters)

In addition, the epoxy resin pavement markings shall be warranted to retain a minimum retroreflective value of 150 millicandelas per foot candle (lux) per square foot (square meter) one year after installation. The measurements shall be made utilizing an LTL 2000 Retrometer with 30-meter geometry.

Determination of percentages of serviceability and minimum retroreflective values will be made jointly at the end of 1 year by the Contractor's representative and by the Engineer. The decision of the Engineer shall be final. The term "percentage of serviceability" shall be defined as follows: The percentage of

serviceability of the markings shall apply to the total linear feet (meters) for Epoxy Resin Pavement Markings and total square feet (square meters) for the Epoxy Resin Pavement Markings, Symbols and Legends measured on the project for payment.

The Contractor shall replace, entirely at the Contractor's expense, such amount of markings, if any, required to meet the above stated percentage. The Engineer will indicate the areas and lines to be replaced to meet the above stated percentages. The Contractor shall also replace those markings that fail the minimum value for retroreflectivity. Replacement under either situation shall include all materials, equipment, labor and work incidental thereto.

The Contractor shall provide to the State, at no extra cost, any manufacturer's warranties or guarantees that exceed the minimum requirements stated previously, that are normally provided by the manufacturer.

These written warranties shall be provided when the documentation for the product is provided. These warranties will be retained by the Department.

4. Crosswalks: Only glass beads conforming to the requirements of Grading "A" (smaller beads) shall be applied at a rate of 25 pounds per gallon (3.0 kilograms/liter) of epoxy pavement marking material.

12.10.04--Method of Measurement: Epoxy resin pavement markings shall be measured for payment by the actual number of linear feet (meters) of epoxy resin pavement markings installed on the pavement and accepted by the Engineer. Epoxy resin pavement markings, symbols and legends will be measured for payment by the actual number of square feet (square meters) of epoxy resin pavement markings, symbols and legends installed on the pavement and accepted by the Engineer.

12.10.05--Basis of Payment: This work shall be paid for at the contract unit price per linear foot (meter) for "Epoxy Resin Pavement Markings" of the width and color specified, and/or the contract unit price per square foot (square meter) for "Epoxy Resin Pavement Markings, Symbols and Legends" installed on the pavement and accepted. This price shall be for all the work required by this section and all materials, equipment, tools and labor incidental thereto. Payment will not be made for pavement markings affected by Contractor error and ordered removed.

Pay Item	Pay Unit
(Width) (Color) Epoxy Resin Pavement Markings	l.f. (m)
Epoxy Resin Pavement Markings, Symbols And Legends	s.f. (s.m)

SECTION 12.11
REMOVAL OF PAVEMENT MARKINGS

12.11.01—Description: This item shall consist of removal of pavement markings, of the type specified, as called for on the plans or as directed by the Engineer.

12.11.03—Construction Methods: Pavement markings shall be removed from the pavement by any method that does not materially damage the surface or texture of the pavement. Any damage to the pavement surface caused by pavement marking removal shall be repaired by the Contractor at its expense by methods acceptable to the Engineer. Sand or other material deposited on the pavement as a result of removing pavement markings shall be removed as the work progresses. Accumulations of sand or other material which might interfere with drainage or might constitute a hazard to traffic will not be permitted. Protection of the work area shall be as indicated in the Specification for "Maintenance and Protection of Traffic."

12.11.04—Method of Measurement: Work under this item will be measured for payment by the actual number of square feet (square meters) of pavement markings removed.

12.11.05—Basis of Payment: This work shall be paid for at the contract unit price per square foot (square meter) for "Removal of Pavement Markings" of the type specified, which price shall include all materials, equipment, tools and labor incidental thereto. Payment will not be made for pavement markings installed by Contractor error and ordered removed by the Engineer.

Pay Item	Pay Unit
Removal of Pavement Markings (Type)	s.f. (s.m)

SECTION 12.12

TEMPORARY PLASTIC PAVEMENT MARKING TAPE

12.12.01—Description: This item shall consist of furnishing, installing and removing temporary plastic pavement marking tape of the color and width specified at the locations shown on the plans or as directed by the Engineer.

12.12.02—Materials: Materials for this work shall be commercially available pavement marking tape designed and suitable for the purpose intended and readily removable, when required. The tape shall be reflective with the use of glass beads throughout the pigments.

The marking tape shall be readily visible during daylight and when viewed with vehicular headlights at night. The marking tape shall be durable, flexible, formable and following application shall remain in contact with the pavement surface. The tape shall be reinforced by a non-metallic medium and pre-coated with a pressure sensitive adhesive.

12.12.03—Construction Methods: Installation of the pavement markings shall be performed in a neat and workman-like manner. The markings shall be applied parallel to the centerline or as shown on the plans or where directed by the Engineer with no unsightly deviations. The Contractor will pre-mark the pavement prior to application of the marking and use a string line if required to produce a neat appearing line.

Removal shall be accomplished without the use of heat, solvents, grinding or sandblasting and in such a manner that no damage to the pavement results.

12.12.04—Method of Measurement: This work will be measured for payment by the actual number of linear feet (meters) of temporary plastic pavement marking tape acceptably installed on and removed from the pavement when it is no longer applicable or when its removal is directed by the Engineer.

12.12.05—Basis of Payment: This work will be paid for at the Contract unit price per linear foot (meter) for "Temporary Plastic Pavement Marking Tape" of the width and color specified, acceptably installed on and removed from the pavement. This price shall include all pre-marking layout, cleaning of pavement, application, removal and all materials, equipment, tools and labor incidental thereto. Payment will not be made for pavement markings installed by Contractor error and ordered removed by the Engineer.

Any lines which are no longer effective, in the opinion of the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor at no cost to the State.

Removed markings shall become the property of the Contractor and shall be removed from the Project.

Pay Item	Pay Unit
Temporary Plastic Pavement Marking Tape (Width) (Color)	l.f. (m)

SECTION 12.14

PREFORMED BLACK LINE MASK PAVEMENT MARKING TAPE

12.14.01—Description: This item shall consist of furnishing, installing, and removing preformed, patterned, black line mask pavement marking tape of the width specified to temporarily cover existing pavement markings in accordance with this section and in conformance with the plans and as directed by the Engineer.

The preformed, patterned, black line mask pavement marking tape shall be a highly durable, skid resistant, non-reflective, pliant polymer tape designed for the temporary covering of existing pavement markings. The black line mask pavement marking tape shall be removed when no longer needed, unless directed otherwise by the Engineer.

The black line mask pavement marking tape, when applied according to the recommendations of the manufacturer, shall provide a neat, durable masking that will not flow or distort. The black line mask pavement marking tape shall be weather resistant and, through normal traffic wear, shall show no lifting or shrinkage which will significantly impair the intended usage of the tape throughout its useful life and show no significant tearing or other signs of poor adhesion.

12.14.02—Materials: Materials for this work shall conform to the requirements of Article M.07.24.

12.14.03—Construction Methods: The patterned, black line mask pavement marking tape shall be applied in accordance with the manufacturer's recommendations, and shall mask the existing markings being covered.

12.14.04—Method of Measurement: Preformed black line mask pavement marking tape shall be measured for payment by the actual number of linear feet (meters) furnished, installed and removed.

12.14.05—Basis of Payment: This work shall be paid for at the contract unit price per linear foot (meter) for "Preformed Black Line Mask Pavement Marking Tape" of the width specified. This price shall be for all the work required by this section including the cleaning and preparing of the pavement surface, installation and removal, and all materials, equipment, tools and labor incidental thereto.

Any masking tape which is no longer effective, in the opinion of the Engineer, shall be replaced by the Contractor at no cost to the State.

Removed masking tape shall become the property of the Contractor and shall be removed from the Project.

Pay Item	Pay Unit
(Width) Preformed Black Line Mask Pavement Marking Tape	l.f. (m)

SECTION 12.16
BLACK EPOXY RESIN PAVEMENT MARKINGS
BLACK EPOXY RESIN SYMBOLS AND LEGENDS

12.16.01—Description: This item shall consist of furnishing and installing black epoxy resin pavement markings of the width specified and black epoxy resin symbols and legends to cover existing markings in accordance with this section and in conformance with the plans or as directed by the Engineer.

The black epoxy resin pavement markings and black epoxy resin symbols and legends shall be a highly durable, skid resistant, non-reflective material designed to cover existing pavement markings.

The black epoxy resin pavement marking material, when applied according to the recommendations of the manufacturer, shall provide a neat, durable masking that will not flow or distort. The black epoxy resin pavement marking material shall be weather resistant and, through normal traffic wear, shall show no wearing which would significantly impair the intended usage.

12.16.02—Materials: Materials for this work shall conform to the requirements of Article M.07.25.

12.16.03—Construction Methods: The black epoxy resin pavement markings and black epoxy resin symbols and legends shall be applied strictly in accordance with the manufacturer's recommendations and installed as shown on the plans and to the control points as established by the Engineer.

The areas to be covered shall be dry and sufficiently cleaned of sand and debris so as to provide an acceptable bond. All surfaces which are power washed shall be allowed to dry sufficiently prior to the application of the epoxy markings. The areas that have been pre-marked shall be broom cleaned immediately prior to the application of the epoxy markings.

Operations shall be conducted only when the road surface temperatures are 32°F (0°C) or greater. Operations shall be discontinued during periods of rain, and shall not continue until the Engineer determines that the pavement surface is dry enough to achieve adhesion.

Black aggregate shall be applied at a rate of 100 pounds per gallon (12 kilograms per liter) of black epoxy pavement marking material. The black aggregate shall be applied using a double drop bead system, with each drop distributing 50 pounds per gallon (6 kilograms per liter) of black epoxy pavement marking material.

The black epoxy resin pavement markings shall extend approximately 1 inch (25 millimeters) beyond the edges of the existing markings which are to be covered.

After application, the pavement markings shall be protected from crossing vehicles for a time at least equivalent to the drying time of the material, as specified by the manufacturer.

12.16.04—Method of Measurement: Black epoxy resin pavement markings shall be measured for payment by the actual number of linear feet (meters) of black epoxy resin pavement markings installed and accepted by the Engineer. Black epoxy resin symbols and legends shall be measured for payment by the actual number of square feet (square meters) of black epoxy resin symbols and legends installed and accepted by the Engineer.

12.16.05—Basis of Payment: This work shall be paid for at the contract unit price per linear foot (meter) for "Black Epoxy Resin Pavement Markings" of the width specified and/or the contract unit price per square foot (square meter) for "Black Epoxy Resin Symbols and Legend" installed on the pavement and accepted. This price shall be for all the work required by this section including the cleaning and preparing of the pavement surface, and all materials, equipment, tools, and labor incidental thereto.

Any black epoxy pavement marking material which is not effective, in the opinion of the Engineer, shall be replaced by the Contractor at no cost to the State.

Pay Item	Pay Unit
(Width) Black Epoxy Resin Pavement Markings	l.f. (m)
Black Epoxy Resin Symbols and Legends	s.f. (s.m)

SECTION 12.20
CONSTRUCTION SIGNS —
TYPE III REFLECTIVE SHEETING

12.20.01—Description: Under this item the Contractor shall furnish sheet aluminum or plywood construction signs and their required portable supports or metal sign posts on the Project to conform to the signing requirements stated in the item "Maintenance and Protection of Traffic," as shown on the plans and/or as directed by the Engineer. The Contractor shall furnish a sufficient number of signs to provide the signing patterns for all operations which are being undertaken concurrently.

12.20.02—Materials: All sign faces shall be reflectorized. Reflective sheeting shall conform to the requirements of Article M.18.09 (Type III). Sheet aluminum sign blanks, metal sign posts and silk screening of sign faces shall conform to the requirements of Article 12.08.02 and 12.08.03. For this item, a Materials Certificate shall be required.

12.20.03—Construction Methods: The signs and their portable supports or metal posts shall conform to the requirements as shown on the plans and the latest edition of the "Manual on Uniformed Traffic Control Devices." Drawings of the signs, showing placement and dimensions of legend and border, are available for inspection at the Division of Traffic, Connecticut Department of Transportation.

Various types of portable sign supports may be used. These portable supports shall be fabricated in such a manner as to minimize the possibility of the signs being blown over or displaced by the wind from passing vehicles and are to be of a yielding type to withstand impact with minimal damage to the signs, supports, or vehicles. Portable sign supports shall be approved by the Engineer before they are utilized on the Project.

Signs in other than good condition shall be replaced with acceptable signs as determined by the Engineer.

Suitable attachments shall be provided so that the signs can be firmly attached to the portable sign supports or metal posts without causing damage to the signs.

12.20.04—Method of Measurement: These signs will be measured for payment by the number of square feet (square meters) of construction signs—Type III reflective sheeting delivered and used on the Project.

12.20.05—Basis of Payment: This item will be paid for at the Contract unit price per square foot (square meter) for "Construction Signs—Type III Reflective Sheeting," delivered and used on the Project, which price shall include the signs, portable sign supports, metal sign posts and all hardware required to attach the sign to the support or posts. Each sign and support or posts furnished will be paid for once, regardless of the number of times it is utilized on the Project. Any signs that become damaged, de-utilized or illegible so that they are not effective, in the opinion of the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices," shall be replaced by the Contractor at no cost to the State.

When the signs and their portable sign supports or metal posts are no longer required on the Project, they shall remain the property of the Contractor.

Pay Item	Pay Unit
Construction Signs - Type III Reflective Sheeting	s.f. (s.m)

SECTIONS 13.00, 14.00, 15.00, 16.00

UTILITIES

Utilities paid under Sections 13.00, 14.00, 15.00 and 16.00 without a Special Provision will conform to the requirements of the pertinent sections of the Standard Specifications for the specified item.

SECTION 18.00
GENERAL CLAUSES –
IMPACT ATTENUATION SYSTEMS

18.00.01—Description: This work shall consist of furnishing and installing a vehicular impact attenuation system in accordance with the Specifications and in conformity with the Plans or as directed by the Engineer. This work shall also include construction of related structures required for the system.

18.00.02—Performance Criteria: These devices shall have approval in writing from FHWA conforming to the requirements of the NCHRP Report 350.

18.00.03—Materials: All materials for permanent systems shall be furnished new. If a temporary system is not furnished new, the Contractor shall document or demonstrate to the Engineer that the system meets the specification. The Contractor shall submit a materials certificate for each system in accordance with Article 1.06.07.

18.00.04—Failure to Comply: In the event that, in the judgement of the Engineer, impact attenuation systems are not maintained adequately and safely on any part of the Project, or the Contractor does not move or relocate impact attenuation systems to meet construction requirements for the safety of the public when directed to do so by the Engineer, on any day, the sum of \$1500.00 per system per day will be deducted from any money due the Contractor as a charge for failure to comply with this Specification.

18.00.05—Delineation of Impact Attenuation Systems: All impact attenuation systems shall have a delineator attached to the front of the system.

SECTION 18.02

TYPE A — IMPACT ATTENUATION SYSTEM

18.02.01—Description: Work under this item shall consist of furnishing and installing permanent sand inertial barrier modules of the size and configuration shown on the Plans or as directed by the Engineer.

18.02.02—Materials: The system modules shall be chosen from the Department's Approved Products List. The color of the modules shall be yellow.

The sand shall meet the requirements of Subarticle M.05.02-2, have a maximum moisture content of 3% and be thoroughly mixed with 20% sodium chloride by weight. Sodium chloride shall meet the requirements of AASHTO, M 143, Type 1, and Grade 1.

Delineators shall meet the requirements of Section M.18.

18.02.03—Construction Methods: The modules shall be assembled in conformance with the manufacturer's recommendations and installed at the location on the Plans or as directed by the Engineer.

Modules shall be installed on surfaces not exceeding a 10:1 slope. The Contractor shall paint each module's weight on the pavement surface in the pattern designed. The Contractor shall fill each module with the sand-salt mixture to the specified weight shown on the Plans ± ten pounds (4.5 kilograms) and shall secure the lid.

18.02.04—Method of Measurement: Sand inertial barrier modules will be measured for payment by the number of modules for each specified weight installed and accepted by the Engineer.

Article 18.02.05—Basis of Payment: Sand inertial barrier modules will be paid for at the Contract unit price for each "Type A Impact Attenuation Module" of the specified weight, which price shall include the delineator, all materials, equipment, tools and labor incidental to complete the installation.

Pay Item	Pay Unit
Type A Impact Attenuation Module (Weight) (Mass)	ea. (ea.)

SECTION 18.04
TYPE C and NC — IMPACT ATTENUATION
SYSTEMS

18.04.01—Description: Work under this item shall consist of furnishing and installing a Connecticut Impact Attenuation System (CIAS) or a Narrow Connecticut Impact Attenuation System (NCIAS) in conformance with the plans, or as directed by the Engineer. The CIAS and NCIAS shall consist of a reinforced Portland cement concrete pad and backup wall, crushable steel cylinders, steel rails and vinyl-coated nylon fabric cover.

18.04.02—Materials: All materials shall conform to the requirements shown on the plans or as directed by the Engineer. A materials certificate as defined in Article 1.06.07 shall be submitted for each system supplied. Notarized mill test reports shall be submitted for all steel items.

Subbase shall meet the requirements of Article M.02.02.

Delineators shall meet the requirements of Section M.18.

18.04.03—Construction Methods: At the locations of the attenuation system shown on the plans, or as directed by the Engineer, the site shall be graded in accordance with Article 2.02.03. Subbase shall be installed in accordance with Article 2.12.03. The Portland cement concrete and backup wall shall be constructed in accordance with the details on the plans and in accordance with Article 6.01.03.

Steel Cylinders shall be placed on the rails, positioned and fastened in accordance with the plans. The interior of all cylinders shall be free of foreign matter.

The vinyl-coated nylon fabric cover shall be positioned and centered over the cylinders with the reinforcing belts on the top such that it is taut throughout. Three rear clips shall be anchored to the top of the backup wall with lag screws and expansion shields. All other clips shall be fastened to the respective cylinders with wide-flange aluminum pop rivets.

18.04.04—Method of Measurement: This item will be measured for payment by the number of each complete Type C or Type NC-Impact Attenuation Systems installed in conformance with the plans and the specifications and accepted by the Engineer.

18.04.05—Basis of Payment: This item will be paid for at the Contract unit price for each "Type C or Type NC Impact Attenuation System" complete in-place which price shall include all materials, site preparation, grading, subbase, delineator, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
TYPE C Impact Attenuation System	ea. (ea.)
TYPE NC Impact Attenuation System	ea. (ea.)

SECTION 18.06
TYPE D PORTABLE IMPACT ATTENUATION
SYSTEM

18.06.01—Description: This item shall consist of furnishing, installing, operating, maintaining, and relocating Truck Mounted Impact Attenuators (TMA) in accordance with the Contract, plans or as directed by the Engineer.

18.06.02—Materials: Prior to using a new TMA, the Contractor shall submit to the Engineer a materials certificate in accordance with Article 1.06.07 for each system supplied and a copy of the FHWA Letter of Acceptance issued to the manufacturer documenting that the device conforms to NCHRP Report 350 (TL-3).

If the system is not furnished new, the Contractor shall document and demonstrate to the Engineer's satisfaction that the system conforms to the requirements of a new system, or NCHRP Report 230 or NCHRP 350 (TL-2) and may be used until the end of the attenuation device's useful service life.

The attenuation device shall be mounted on a truck or service vehicle similar in size and weight to the truck that was used in the crash testing that was submitted and approved by the FHWA. In addition, the truck shall have a minimum weight (mass) of 15,000 pounds (6,800 kilograms) and a maximum weight (mass) in accordance with the manufacturer's recommendations. Any ballast used to obtain the minimum weight requirement, or any other object that is placed on the vehicle shall be anchored so that it will be retained on the vehicle during an impact.

The truck shall be equipped with an internally illuminated flashing arrow visible from the rear. The bottom of the illuminated arrow sign shall be installed a minimum of seven feet (2.2 meters) above the ground. The illuminated arrow shall conform to the requirements of Section 11.30.

The truck shall be equipped with a minimum of two amber strobe type flashers mounted above the internally illuminated flashing arrow.

The TMA unit shall have a chevron pattern that covers the rear face of the unit. The standard chevron pattern shall consist of stripes, alternating non-reflective black and Type III retro-reflective yellow sheeting, slanted at 45 degrees in an inverted "V" pattern, centered on the rear of the unit. The width of the stripes shall be between 4 - 8 inches (100 - 200 millimeters).

18.06.03—Construction Methods: The Contractor shall maintain each TMA in a fully operable condition at all times. Any TMA that is not fully functional will not be permitted at the Project site.

1. Use of the TMA, as a stationary barrier vehicle shall be under the control of the Engineer at all times, and in conformance with the following:
 - A. The TMA shall be positioned so that traffic does not pass any other object within the protected area (i.e. equipment, personnel, and vehicles) before reaching the TMA.
 - B. Each TMA in use shall be positioned between 25 feet (8 meters) and 100 feet (30 meters) before the area to be protected.
 - C. Each TMA shall be provided for use an assigned driver, who shall be available to reposition the TMA within a 15-minute time frame.
2. Use of the TMA as a shadow protection vehicle for mobile or stop and go operations shall be under the control of the Engineer at all times, and in conformance with the following:
 - A. The TMA shall be positioned so that approaching traffic does not reach or overtake any object before passing the TMA.
 - B. Each TMA in use shall be positioned between 50 feet (15 meters) and 200 feet (60 meters) from the rear of the next vehicle in the mobile array when the array is in a stopped position. When the array is in motion, the maximum distance between vehicles may extend to 500 feet (150 meters), depending on the type and speed of the operation, road conditions, traffic volumes, etc.
 - C. Each TMA in use shall have an assigned driver, who must remain in the service vehicle at all times that the portable impact attenuation system is in use.

The disposal of crushed or damaged systems is the responsibility of the Contractor. The disposal method employed shall be approved by the Engineer.

18.06.04—Method of Measurement: This item will be measured for payment by the actual number of hours that the Type D Portable Impact-Attenuation System is used. Subject to the approval of the Engineer, Type D Portable Impact Attenuation Systems may be used as a High Mounted Internally Illuminated Flashing Arrow. If the Attenuation System is used as a Flashing Arrow, then it will be paid for under the item "High Mounted Internally Illuminated Flashing Arrow."

18.06.05—Basis of Payment: This item shall be paid for at the Contract unit price per hour for "Type D

Portable Impact Attenuation System”, which shall include the furnishing and use of the specified vehicle and a driver, attenuation device, flashers, illuminated arrow, and all equipment, materials, tools, labor, disposal of damaged systems components and work incidental thereto.

Pay Item	Pay Unit
Type D Portable Impact Attenuation System	hr (hr)

SECTION 18.07

TEMPORARY IMPACT ATTENUATION SYSTEMS

18.07.01—Description: Work under this item shall consist of furnishing, installing, removing, repairing, and relocating temporary impact attenuation systems and modules of the type and size specified on the plans or as directed by the Engineer.

18.07.02—Materials: Temporary Type A impact attenuation modules shall conform to the material requirements of Article 18.02.02.

Material for other temporary systems shall conform to the manufacturer's specifications. A materials certificate as defined in Article 1.06.07 shall be submitted for each system supplied.

The delineator shall meet the requirements of Section M18.

18.07.03—Construction Methods: Temporary impact attenuation systems and modules shall be installed at the locations shown on the plans according to the manufacturer's specifications, or as directed by the Engineer.

The Contractor shall relocate temporary impact attenuation systems and modules to locations within the Project limits shown on the plans or as directed by the Engineer.

The Contractor shall remove all temporary impact attenuation systems and modules that are no longer needed on the Project.

The temporary impact attenuation system and modules shall be maintained by the Contractor during all stages of construction.

When required, the Contractor shall furnish replacement parts and repair the temporary impact attenuation system or modules as necessary, but in no case more than 72 hours after notification from the Engineer. Once the Contractor has begun repairs, the area shall remain protected and the work shall continue until all repairs are complete. The repaired temporary impact attenuation system or modules, when completed shall conform to the manufacturer's specifications for a new system. The Contractor shall be responsible for the removal and the proper disposal of all damaged material and debris.

18.07.04—Method of Measurement: Temporary Type A impact attenuation modules will be measured for payment by the number of each module installed and accepted by the Engineer. Other temporary impact attenuation systems will be measured for payment by the number of each system installed and accepted by the Engineer.

Temporary Type A impact attenuation modules that are relocated to a new location shown on the plans or directed by the Engineer, including to and from the storage area, will be measured for payment by the number of each module relocated and accepted by the Engineer.

Other temporary impact attenuation systems that are relocated to a new location shown on the plans or directed by the Engineer, including to and from the storage area, will be measured for payment by the number of each system relocated and accepted by the Engineer.

Adjustment or realignment of any part of the system or modules for Contractor's access or convenience will be done at the Contractor's expense.

The sum of money shown on the estimate and in the itemized proposal as "Estimated Cost" for repair of temporary impact attenuation systems or modules will be considered the price bid even though payment will be made only for actual work performed. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded and the original price will be used to determine the total amount bid for the contract.

18.07.05—Basis of Payment: Temporary Type A impact attenuation modules will be paid for at the Contract unit price for each "Temporary Impact Attenuation System Type A Module (Weight) (Mass)" specified complete in place. This price shall include furnishing, installation, removal, and all materials, maintenance, transportation, delineator, equipment, tools and labor incidental thereto.

Other temporary impact attenuation systems will be paid for at the Contract unit price for each "Temporary Impact Attenuation System (Type)" specified complete in place. This price shall include furnishing, installation, removal, and all materials, maintenance, transportation, delineator, equipment, tools and labor incidental thereto.

Relocation of temporary Type A impact attenuation modules will be paid for at the contract unit price for each "Relocation of Temporary Type A Impact Attenuation Module" specified. This price shall include all materials, transportation, equipment, tools and labor incidental thereto.

Relocation of other temporary impact attenuation systems will be paid for at the contract unit price for each "Relocation of Temporary Impact Attenuation System (Type)" specified. This price shall include all

materials, transportation, equipment, tools and labor incidental thereto.

Repair of temporary impact attenuation systems or modules will be paid for in accordance with Article 1.09.04 as required to restore the system or module to its full working condition in conformance with the Manufacturer's recommendations or as directed by the Engineer. There will be no payment for maintenance and protection of traffic for work associated with this item unless, in the opinion of the Engineer, the sole purpose of the maintenance and protection of traffic is for repair of the attenuation system or module.

Pay Item	Pay Unit
Temporary Impact Attenuation System Type A Module (Weight) (Mass)	ea. (ea.)
Temporary Impact Attenuation System (Type)	ea. (ea.)
Relocation of Temporary Type A Impact Attenuation Module	ea. (ea.)
Relocation of Temporary Impact Attenuation System (Type)	ea. (ea.)
Repair of Temporary Impact Attenuation System	est. (est.)

**DIVISION III
MATERIALS SECTION
SECTION M.01
GRADATION OF AGGREGATE**

M.01.01—Gradation table for sizes of crushed or broken stone, crushed and uncrushed gravel and reclaimed miscellaneous aggregate.

PERCENT PASSING BY WEIGHT (MASS) NAME							
Square Mesh Sieves	No. 3	No. 4	No. 6	No. 67	No. 8	Screenings	Dust
2 1/2" (63 mm)	100						
2" (50 mm)	90-100	100					
1 1/2" (37.5 mm)	35-70	90-100					
1" (25 mm)	0-15	20-55	100	100			
3/4" (19 mm)		0-15	90-100	90-100			
1/2" (12.5 mm)	0-5		20-55		100		
3/8" (9.5 mm)		0-5	0-15	20-55	85-100	100	
No. 4 (4.75 mm)			0-5	0-10	10-30		100
No. 8 (2.36 mm)				0-5	0-10	60-100	40-100
No. 16 (1.18 mm)					0-5		

Reclaimed miscellaneous aggregate shall only be used where authorized in the specifications.

SECTION M.02
GRANULAR FILL
SUBBASE
GRANULAR BASE AND SURFACES
STONE BASE
PERVIOUS STRUCTURE BACKFILL
FREE-DRAINING MATERIAL
CRUSHER-RUN STONE

M.02.01—Granular Fill

M.02.02—Subbase

M.02.03—Granular Base, Rolled Bank Gravel Surface and Traffic Bound Gravel Surface

M.02.04—Gravel Shoulders

M.02.05—Pervious Structure Backfill

M.02.06—Gradation, Plasticity, Resistance to Abrasion and Soundness Requirements

M.02.07—Free-Draining Materials

M.02.01—Granular Fill: For this purpose, the material shall consist of broken or crushed stone, gravel, reclaimed miscellaneous aggregate or a mixture thereof.

1. Broken or crushed stone shall be the product resulting from the artificial crushing of rocks, boulders or large cobblestones, substantially all faces of which have resulted from the crushing operation. Broken or crushed stone shall consist of sound, tough, durable stone, reasonably free from soft, thin, elongated, laminated, friable, micaceous or disintegrated pieces, mud, dirt or other deleterious material and shall be sized to meet the requirements of grading "A," Article M.02.06.

2. Bank or crushed gravel shall consist of sound, tough, durable particles of crushed or uncrushed gravel, free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall meet Grading "A" and the requirements for plasticity and resistance to abrasion indicated in Article M.02.06. Crushed gravel shall be the manufactured product resulting from the deliberate mechanical crushing of gravel with at least 50% of the gravel retained on the No. 4 (4.75-millimeter) sieve having at least one fractured face.

3. Reclaimed Miscellaneous Aggregate material shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious materials and contain no more than 2% by weight (mass) of asphalt cement.

This reclaimed miscellaneous material shall meet Grading "A" and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06. It shall be tested for soundness in accordance with M.02.06 when directed by the Director of Research and Materials.

M.02.02—Subbase: Materials for this work shall conform to the following requirements:

1. Bank or crushed gravel shall consist of sound, tough, durable particles of crushed or uncrushed gravel, free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be hard and durable enough to resist weathering, traffic abrasion and crushing. It shall be subject to testing for soundness in accordance with Article M.02.06 when directed by the Director of Research and Materials. It shall meet Grading "B" and the requirements for plasticity and resistance to abrasion indicated in Article M.02.06.

2. Crusher-Run Stone shall consist of sound, tough, durable broken stone. It shall be reasonably free from soft, thin, elongated, laminated, friable, micaceous or disintegrated pieces, mud, dirt or other deleterious material.

(a) Loss on Abrasion: The crusher-run stone shall show a loss on abrasion of not more than fifty percent using AASHTO Method T 96.

(b) Grading: The crusher-run stone shall meet Grading "A" and the requirements for plasticity indicated in Article M.02.06.

3. Reclaimed Miscellaneous Aggregate shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free from soft, disintegrated pieces, mud, dirt, glass or other injurious material, and contain no more than 2% by weight (mass) of asphalt cement.

This reclaimed miscellaneous material shall meet Grading "B" and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06. It shall be tested for soundness in accordance with M.02.06 when directed by the Director of Research and Materials.

M.02.03—Granular Base, Rolled Bank Gravel Surface and Traffic Bound Gravel Surface: The

materials for the "Rolled Granular Base" shall consist of sound, tough, durable particles of bank or crushed gravel, or reclaimed miscellaneous aggregate, or mixtures thereof with the resultant uniform blend containing no more than 2% by weight (mass) of asphalt cement. The materials for the Rolled Bank Gravel Surface and Traffic-Bound Gravel Surface shall consist of sound, tough, durable particles of bank or crushed gravel. All materials shall be free from thin or elongated pieces, lumps of clay, loam, or vegetable matter. Binder may be added and incorporated by approved methods as specified elsewhere. It shall meet Grading "A" except that the top course of the rolled bank gravel surface shall conform to Grading "C." It shall be subject to testing for soundness in accordance with Article M.02.06 when directed by the Director of Research and Materials. It shall also meet the requirements for plasticity and resistance to abrasion which, with grading, are indicated in Article M.02.06.

M.02.04—Gravel Shoulders: The materials for this work shall consist of sound, tough, durable particles of crushed or uncrushed gravel free from soft, thin, elongated or laminated pieces, vegetable or other deleterious substances. Gravel shall meet Grading "A" except that the upper 3 inches (75 millimeters) shall conform to Grading "C." It shall be subject to testing for soundness in accordance with Article M.02.06 when directed by the Director of Research and Materials. It shall also meet the requirements for plasticity and resistance to abrasion which, with grading, are indicated in Article M.02.06.

M.02.05—Pervious Structure Backfill: Pervious structure backfill shall consist of broken or crushed stone, broken or crushed gravel, or reclaimed miscellaneous aggregate containing no more than 2% by weight (mass) of asphalt cement or mixtures thereof.

Materials for this work shall conform to the following requirements:

1. Broken or crushed stone shall consist of sound, tough, durable stone, reasonably free from soft, thin, elongated, friable, laminated, micaceous or disintegrated pieces, mud, dirt or other deleterious material and shall be sized to meet the requirements of Grading "B," Article M.02.06. It shall meet the requirements of loss on abrasion indicated in Subarticle M.02.02-2(a).

2. Bank or crushed gravel shall consist of sound, tough, durable particles of crushed or uncrushed gravel free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be subject to testing for soundness in accordance with Article M.02.06 when directed by the Director of Research and Materials. It shall meet Grading "B" and the requirements for plasticity and resistance to abrasion indicated in Article M.02.06.

3. Reclaimed Miscellaneous Aggregate shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious material, and contain no more than 2% by weight (mass) of asphalt cement. It shall meet Grading "B" and the requirements for plasticity, resistance to abrasion and soundness indicated in M.02.06.

M.02.06—Gradation, Plasticity, Resistance to Abrasion and Soundness Requirements:

1. Gradation:

	Grading		
	<u>A</u>	<u>B</u>	<u>C</u>
Square Mesh Sieves	Percent passing by weight (mass)		
Pass 5 inch (125 mm)		100	
Pass 3 1/2 inch (90 mm)	100	90-100	
Pass 1 1/2 inch (37.5 mm)	55-100	55-95	100
Pass 3/4 inch (19 mm)			45-80
Pass 1/4 inch (6.3 mm)	25-60	25-60	25-60
Pass #10 (2.0 mm)	15-45	15-45	15-45
Pass #40 (425 µm)	5-25	5-25	5-25
Pass #100 (150 µm)	0-10	0-10	0-10
Pass #200 (75 µm)	0-5	0-5	0-5

The grading percentages specified in the above table shall apply to the material after it has been delivered to the construction site as well as when tested at the pit or other source of supply.

When the fraction of the dry sample passing the No. 100 (150- μ m) mesh sieve is greater than 8% by weight (mass), the sample will be washed as indicated. The amount obtained from washing shall be added to that obtained by dry sieving; and the total amount passing each sieve shall meet the above gradation.

2. Plasticity:

(a) When the fraction of the dry sample passing the No. 100 (150- μ m) mesh sieve is 4% or less by weight (mass), no plastic limit test will be made.

(b) When the fraction of the dry sample passing the No. 100 (150- μ m) mesh sieve is greater than 4% and not greater than 8% by weight (mass), that fraction shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO Method T 90.

(c) When the fraction of the dry sample passing the No. 100 (150- μ m) mesh sieve is greater than 8% by weight (mass), the sample will be washed; and the additional material passing the No. 100 (150- μ m) mesh sieve shall be determined by AASHTO Method T 146, except that the No. 100 (150- μ m) mesh sieve will be substituted for the No. 40 (425- μ m) mesh sieve where the latter is specified in AASHTO Method T 146. The combined materials that passed the No. 100 (150- μ m) mesh sieve shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO Method T 90.

3. Test for Resistance to Abrasion. Gravel materials shall show a loss on abrasion of not more than 50% using AASHTO Method T 96.

4. Soundness: When tested with magnesium sulfate solution for soundness using AASHTO Method T 104, coarse aggregate shall not have a loss of more than 15% at the end of five cycles.

M.02.07—Free-Draining Materials: Free-draining material shall consist of sand, gravel, rock fragments, quarry run stone, broken stone, reclaimed miscellaneous aggregate containing no more than 2% by weight (mass) of asphalt cement or mixtures thereof. This material, or the material from any one source of a mixture, shall not have more than 70%, by weight (mass), passing the No. 40 (425 μ m) mesh sieve and not more than 10%, by weight (mass), passing the No. 200 (75 μ m) mesh sieve.

**SECTION M.03
PORTLAND CEMENT CONCRETE**

M.03.01—General Composition of Concrete Mixes

M.03.01—General Composition of Concrete Mixes: Portland cement concrete shall consist of an intimate mixture of Portland cement, other approved cementitious material (when used), fine aggregate, coarse aggregate, water, and admixtures, if ordered or permitted by the Engineer, proportioned in accordance with the following requirements:

TYPE	28-day Minimum Compressive Strength psi (megapascals)	Water / Cement; or Water / Cement plus other approved Cementitious Material (by weight (mass)) Maximum	Minimum Cementitious Material Required pounds/ cubic yard (kilograms/ cubic meter)
Class "A"	3000 (21)	0.53	615 (365)
Class "C"	3000 (21)	0.53	658 (390)
Class "F"	4000 (28)	0.44	658 (390)
Pavement	3500 (25)	0.49	615 (365)
Slope Paving	2000 (14)	0.69	455 (270)

These proportions are based on the weight (mass) of the cementitious material and surface dry aggregates and on bulk specific gravity for fine and coarse aggregates.

At the option of the Contractor, other approved cementitious material may be used to replace a portion of the required Portland cement in accordance with the requirements of Subarticle M.03.01-13.

When a Contractor proposes to use other approved cementitious material as a partial replacement for Portland cement, he shall notify the Engineer, in writing, prior to the start of work, of the identity of the other approved cementitious material and the percentage of the required Portland cement in the concrete mix which he proposes to replace with the other approved cementitious material.

The materials shall conform to the following requirements:

1. Coarse Aggregate: Coarse aggregate shall be broken stone, gravel, or reclaimed concrete aggregate defined as mortar-coated rock, consisting of clean durable fragments of uniform quality throughout. It shall be free from soft, disintegrated pieces, mud, dirt, organic or other injurious material and shall not contain more than one percent of dust by mass, as determined by the testing method used by the Laboratory.

Reclaimed concrete aggregate shall not be used in prestressed concrete members.

Coarse aggregate of a size retained on a 1-inch (25 mm) square opening sieve shall not contain more than 8% of flat or elongated pieces, whose longest dimension exceeds five times their maximum thickness.

(a) **Soundness:** When tested with magnesium sulfate solution for soundness, using AASHTO Method T 104, coarse aggregate shall not have a loss of more than 10% at the end of five cycles.

(b) **Loss on Abrasion:** When tested by means of the Los Angeles Machine, using AASHTO Method T 96, coarse aggregate shall not have a loss of more than 40%.

(c) **Grading:** Grading of the various stone sizes shall conform to the gradation table of Article M.01.01.

Class "A": The mix shall be designed utilizing a nominal maximum size of No. 4 aggregate.

Class "C": The mix shall be designed utilizing a nominal maximum size of No. 6 aggregate.

Class "F": The mix shall be designed utilizing a nominal maximum size of No. 6 aggregate.

Pavement: The mix shall be designed utilizing a nominal maximum size of No. 4 aggregate.

Slope Pavement: The mix shall be designed utilizing a nominal maximum size of No. 3 aggregate.

(d) **Samples:** Samples for tests of coarse aggregate will be taken from the bins at the quarry or from approved storage piles at the site of quarry or from approved storage piles at the batch plant.

(e) **Chloride content:** When reclaimed concrete aggregate is used, it shall be tested for chloride content prior to being mixed with virgin aggregate. The test used to determine chloride content shall be that outlined in the FHWA Report No. FHWA-RD-77-85. No aggregate will be accepted if the chloride content as determined from this test exceeds 0.5 pound/cubic yard (0.3 kilogram/cubic meter).

2. **Fine Aggregate:** Fine aggregate shall be sand consisting of clean, hard, durable, uncoated particles of quartz or other rock, free from lumps of clay, soft or flaky material, loam, organic or other injurious material. In no case shall sand containing lumps of frozen material be used.

(a) **Fine Material:** Fine aggregate shall contain not more than 3% of material finer than a #200 (75 µm) sieve, using AASHTO T 11.

(b) **Organic Impurities:** Fine aggregate subjected to the colorimetric test shall not produce a color darker than Gardner Color Standard No. 11, using AASHTO T 21. If the fine aggregate fails to meet this requirement, the provisions of AASHTO M 6, Section 5.2, will govern.

(c) **Gradation:** Fine aggregate shall be uniformly graded from coarse to fine and shall meet the following gradation requirements.

**SQUARE MESH SIEVES
TOTAL PERCENT PASSING BY WEIGHT (MASS)**

3/8" (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18 mm)	No. 30 (600 µm)	No. 50 (300 µm)	No. 100 (150 µm)
100	95-100	80-100	50-85	25-60	10-30	2-10

The above gradation represents the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus determination will be made upon representative samples from any source. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample will be rejected.

(d) **Samples:** Samples for tests of fine aggregate will be taken from approved storage piles at the site of the batch plant or from approved storage piles at the producing pit.

3. **Cement:** Cement having a temperature exceeding 160°F (71°C) at the time of delivery to the mixer shall not be used in the concrete.

Types I, II, and III Portland cement shall conform to the requirements of AASHTO M 85.

Type IS, Portland blast-furnace slag cement and Type IP, Portland-pozzolan cement shall conform to the requirements of AASHTO M 240. The use of other approved cementitious material as a partial replacement for Type IS or Type IP cement will not be permitted.

Type I and Type III Portland cement shall be used only when required or expressly permitted by the Contract or the Engineer.

Ordering: Before starting work, the Contractor shall notify the Engineer, in writing, of the name of the manufacturer, mill, and the name of the brand of cement which he proposes to use on the work. Different brands of cement, or the same brand from different mills shall not be used on any project except with the approval of the Engineer.

All cement, except in lots of 200 bags or less, shall be shipped from bins approved by the Department.

Testing: All cement, except in lots of 200 bags or less, shall be sampled at the mill. All cements shall be tested by a laboratory, whose methods and equipment are regularly inspected by the CCRL.

When a mill applies for permission to provide cement by certification, a copy of the last two (2) inspection reports by the CCRL shall be submitted for review by the Engineer. Reports of subsequent inspections shall also be submitted as received.

The mill shall provide the Materials Testing Laboratory with 3 copies of Certified Test Reports of all cement which is being used by the ConnDOT for projects in Connecticut. The certified test report shall

conform to Article 1.06.07.

4. Water: The water shall be reasonably clean, shall not be salty or brackish, and shall be free from oil, acid and injurious alkali or vegetable matter. The water shall be tested as prescribed by AASHTO Method T 26.

Water shall not be taken from shallow or muddy sources. In cases where sources of supply are relatively shallow, they shall be so enclosed as to exclude silt, mud, grass, etc.; and the water in the enclosure shall be maintained at a depth of not less than 2 feet (610 millimeters) under the intake of the suction pipe.

5. Transverse Joints for Concrete Pavement and Joint Filler for Concrete Curbing: These joints shall consist of corrosion resistant load transfer devices, poured joint seal and in addition, in the case of expansion joints, expansion joint filler conforming to the following requirements:

(a) The corrosion resistant load transfer device shall be coated steel or sleeved steel or be made of corrosion resistant material. The dimensions of any devices used shall be as shown on the plans, exclusive of any coating or sleeving. Core material of coated or sleeved metallic devices shall be steel meeting the requirements of AASHTO M 255M/M 255 Grade 520, or steel having equal or better properties and approved by the Engineer. Nonmetallic devices shall meet the various strength requirements applicable to metallic devices as well as all other requirements stated herein.

All coated load transfer devices shall conform to the requirements of AASHTO M 254. Uncoated or sleeved load transfer devices shall meet the applicable physical requirements of AASHTO M 254. The use of field applied bond breakers will not be permitted.

The basis of acceptance for corrosion resistant load transfer devices shall be the submission by the Contractor of a minimum of two samples accompanied by certified test reports conforming to the requirements of Article 1.06.07 demonstrating that the load transfer device conforms to the requirements of AASHTO M 254 for the type of device supplied.

The Engineer reserves the right to reject any load transfer device which he deems unsatisfactory for use.

(b) The type of expansion joint filler shall be either preformed expansion joint filler or wood joint filler as indicated on the plans and shall conform to the following requirements:

- (1) Preformed expansion joint filler shall be the bituminous cellular type and shall conform to the requirements of AASHTO M 213.
- (2) Boards for wood joint filler shall be planed on two sides and shall be either redwood, cypress or white pine. Redwood and cypress boards shall be of sound heartwood. White pine boards shall be of sound sapwood.

Occasional small, sound knots and medium surface checks will be permitted provided the board is free of any defects that will impair its usefulness for the purpose intended. The joint filler may be composed of more than one length of board in the length of the joint, but no board of a length less than 6 feet (1.9 meters) may be used; and the separate boards shall be held securely to form a straight joint. Boards composed of pieces that are jointed and glued shall be considered as one board.

Dimensions shall be as specified or shown on the plans; and tolerances of plus 1/16-inch (1.6-millimeter) thickness, plus 1/8-inch (3.2-millimeter) depth and plus 1/4-inch (6.4-millimeter) length will be permitted.

All wood joint filler boards shall be given a preservative treatment by brushing with a creosote oil conforming to AASHTO M 133. After treatment, the boards shall be stacked in piles, each layer separated from the next by spacers at least 1/4 inch (6.4 millimeters) thick; and the boards shall not be used until 24 hours after treatment.

Prior to concreting, all exposed surfaces of the wood filler shall be given a light brush coating of form oil.

Testing of board expansion joint filler shall be in accordance with pertinent sections of AASHTO T 42.

6. Longitudinal Joint Devices: The metal used in the fabrication of longitudinal joint devices shall conform to ASTM requirements for each type of metal used. The dimensions shall be as shown on the plans.

7. Expansion Joint Fillers for Structures:

- (a) Preformed expansion joint filler for bridges shall conform to the requirements of AASHTO M 153, Type I and Type II.
- (b) Pre-molded expansion joint filler for bridge bearings shall conform to the requirements of AASHTO M 33.

8. Joint Sealants:

(a) **Joint Sealer for Pavement:** The joint sealer for pavement shall be a rubber compound of the hot-poured type and shall conform to the requirements of AASHTO M 173 unless otherwise noted on the plans or in the special provisions.

(b) **Joint Sealer for Structures:** The joint sealer for structures shall be as noted on the plans or as required by the special provisions.

9. Admixtures: When data is required that an admixture shall perform the desired function without injurious effects upon the concrete, this data shall be in the form of a certified statement from a recognized laboratory. The certified statement shall contain evidence based upon tests pertinent to the admixture made in the recognized laboratory by the use of concreting materials and by methods that meet the requirements of current standards of AASHTO and ASTM. Tests may be made upon samples taken from a quantity submitted by the Contractor for use on the project, or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied. A "recognized" laboratory is any cement and concrete laboratory approved by the Engineer and inspected regularly by the CCRL, sponsored by the ASTM and the NIST.

(a) **Air-Entraining Admixtures:** In the event an air entraining admixture is required, evidence based on tests made in a recognized laboratory shall be submitted to show that the material conforms to the requirements of AASHTO M 154 for 7 and 28-day compressive and flexural strengths and resistance to freezing and thawing. Tests for bleeding, bond strength and volume change will not be required.

An exception to the preceding requirement is the case of admixtures which are manufactured by neutralizing Vinsol resin with caustic soda (sodium hydroxide). When the Contractor proposes to use such an admixture, he shall submit to the Engineer a certification concerning the admixture in the following form:

This is to certify that the product (trade name) as manufactured and sold by the (company name) is an aqueous solution of Vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to Vinsol resin is one part of sodium hydroxide to (number) parts of Vinsol resin. The percentage of solids based on the residue resulting from evaporation and subsequent drying at 221°F (105°C) is (number). No other additive or chemical agent is present in this solution.

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit to the Engineer a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to, or at any time during construction, the Engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. When so tested, 7-day compressive strength of concrete made with the cement and aggregates in the proportions to be used in the work, and containing admixture under test in an amount sufficient to produce from 4% to 6% entrained air in the plastic concrete, shall be not less than 85% of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixture.

The percentage reduction in strength shall be calculated from the average strength of at least 5 standard 6-inch x 12-inch (150-millimeter x 300-millimeter) cylinders of each class of concrete.

Specimens will be made and cured in the laboratory in accordance with the requirements of AASHTO T 126 and will be tested in accordance with the requirements of AASHTO T 22. The percentage of entrained air will be determined in accordance with the requirements of AASHTO T 152.

(b) **Retarder Admixtures:** The admixtures may be in liquid or powder form, and of one of the following types:

- (1) A calcium, sodium, potassium or ammonium salt of lignosulfonic acid.
- (2) A hydroxylated carboxylic acid or its salt.
- (3) A carbohydrate.

Mix Requirements: The properties of retarded concrete prepared with the admixture under test shall be compared with those of a reference concrete prepared without the admixture. The cement, water and aggregates for both concretes shall be drawn from common sources or stockpiles and the mixes shall have the following composition:

Cement Content, bags per cubic yard (meter)	.....	6.0± 0.1 (7.9 ± 0.1)
Air Content, % (reference concrete)	.....	5.5 ± 0.5
Air Content, % (retarded concrete)	.....	6.0 ± 1.0
Slump, inches (millimeters)	.....	2 1/2 ± 1/2 (66 ± 12)
Fine aggregate, by soil volume of total aggregate, %	.....	36 to 41

An approved air-entraining admixture shall be used, if necessary, to obtain the required air content.

A sufficient amount of retarding admixture shall be used to cause an increase of 50% to 60% in setting time over the setting time of the reference mix. The setting time for both mixes shall be determined by ASTM C 403 using a pressure of 500 psi (3.45 megapascals) at a temperature of 73.4°±3°F (23 °± 2°C) for the concretes and ambient air.

Required Properties of Retarder: When added to concrete in powder or liquid form, in the manner prescribed by it's manufacturer or marketer and in sufficient amount to retard the setting time 50% to 60%, the retarding admixture shall cause the concrete to have the following properties in comparison with those of the reference concrete.

When the test and reference concrete have equal cement content and equal slump, the water content shall be decreased at least 5%; the air content of the retarded concrete with or without an air-entraining admixture, shall not exceed 7%; and the compressive strength at ages of 3, 7 and 28 days shall be increased at least 10%.

Performance Requirements: When a Contractor proposes to use a previously approved retarding admixture, he shall submit a certificate stating that the admixture is identical in composition with the sample that was used for the acceptance tests. If the admixture varies in concentration from the acceptance sample, a certificate will be required stating that the product is essentially the same for chemical constituents as the approved admixture and that no other admixture or chemical has been added. Either prior to or at any time during construction, the Engineer may require the selected admixture to be re-tested. When re-tested, the 3- and 7-day compressive strengths or 7-day flexural strength of the concrete shall meet the requirements stated above.

(c) **All Other Admixtures,** when specified, shall meet the requirements set forth in the special provisions or on the plans.

10. Curing Materials:

(a) **Cotton Mats:** Cotton mats for curing concrete shall consist of a filling material of cotton "bat" or "bats" covered with un-sized cloth and tufted or stitched to maintain the shape and stability of the unit under job conditions of handling.

The covering of the mats shall be one of the following:

- (1) Cotton cloth covering shall have a mass of not less than 6.3 ounces per square yard (215 grams/square meter) and shall have an average of not less than 32 threads in warp and not less than 28 threads in filling, having a minimum average breaking strength (grab method) of 60 pounds (270 newtons) in the warp and 60 pounds (270 newtons) in the filling. The weight (mass) of the cotton cloth covering shall not fall below the specified weight (mass) by more than 5%. The raw material used in the manufacture of the cotton cloth shall be raw cotton, cotton comber waste, cotton card strip waste, or combination thereof. The other physical characteristics of the cloth shall be equal to those in such material for industrial purposes.
- (2) Burlap or jute covering shall weigh (have a mass) of not less than 6.7 ounces per square yard (230 grams/square meter) and shall have not less than 8 threads per 1 inch (25 millimeters) of warp and not less than 8 threads per 1 inch (25 millimeters) of filling. It shall be the grade known commercially as "firsts" and shall be free from avoidable imperfections in manufacture and from defects or blemishes affecting the serviceability. A tolerance in weight (mass) of minus 5% will be permitted.

The filling material for the mats shall be a cotton bat, or bats, made of raw cotton, cotton waste, cotton

linters, or combinations thereof, and shall weigh (have a mass) of not less than 12 ounces per square yard (410 grams/square meter). The mats shall not contain any materials such as dyes, sugar, etc., that may be injurious to the concrete. The batting used shall not be lower in quality than a batting made of U.S. Standard Grade No. 3 Linters.

The cotton thread for tufting shall be not less than 4-cord number 12's. The thread used for all sewing or stitching shall be at least equivalent in size and strength to standard 3-cord, number 30 cotton thread.

The mats shall have a filler 5 feet 9 inches (1.8 meters) in width and shall have a flap 6 inches (150 millimeters) or more in width, consisting of an extension of two thicknesses of the covering material, extending along one longitudinal edge of the mat. The length of the mats shall be 2 feet 6 inches (765 millimeters) greater than the width of pavement slab to be cured. The length or width of the mats shall be not less than that specified by more than 2%.

The covering material for each surface of the mat shall consist of two widths of cloth joined by a lapped seam or by a seam formed by superimposing the two widths and uniting them by one row of stitches. If the seam is of the latter type, the edges shall be on the inside of the finished mat. The cotton filling material in the form of a bat or bats shall be held in place between the coverings by sewing or tufting all around the periphery of the mat within 1 inch (25 millimeters) of each of the four edges of the filler, and by sewing or quilting longitudinally at intervals not greater than 4 inches (100 millimeters), or by tufting at intervals, both longitudinally and transversely, not greater than 3 inches (75 millimeters). The sewing or tufting shall be sufficiently loose to permit substantially all of the surface of the mat to come in contact with a flat surface when in use, but not so loose as to permit the filling material to shift. The flap shall be constructed by sewing the upper and lower covering together longitudinally within 1 inch (25 millimeters) of the outer edge of the flap. Along the edge of the mat opposite the flap, the filling material shall be within 1 inch (25 millimeters) of the edges of the covering material, and the covering material shall be sewn together so as to enclose the filling material. The ends of the mats shall be finished by running an additional seam (i.e., a seam in addition to the seam holding the filling material in place) across the mats. This seam shall not be closer to the seam holding the filling material in place than 1/4 inch (6.4 millimeters) and not closer to the end of either covering than 1/2 inch (12.5 millimeters), unless the ends of the mat are finished with an overlying or whip stitch or in a manner which will not leave a raw edge. All longitudinal sewing or quilting shall average at least three stitches per 1 inch (25 millimeters) and shall have not less than five stitches in any 2 inches (50 millimeters). All other sewing shall average six stitches per 1 inch (25 millimeters) and shall have not less than nine stitches in any 2 inches (50 millimeters).

(b) Waterproof Paper: Waterproof paper shall conform to the requirements of AASHTO M 171 and in addition shall not be less than 20 feet (6.1 meters) in length and shall be of sufficient width to cover completely the surface of the pavement.

(c) Liquid Membrane-Forming Compound: Liquid membrane-forming compound shall conform to the requirements of AASHTO M 148 Type 2, Class B, or shall be a water-soluble linseed oil-based compound conforming to the requirements of AASHTO M 148, Type 2.

(d) White Polyethylene Sheeting (Film): White polyethylene sheeting (film) shall conform to the requirements of AASHTO M 171.

11. Protective Compound Material: This material shall be listed on the approved list of the ConnDOT for the specified use.

12. Non-shrink, Non-staining Grout:

(a) Bagged, pre-mixed formulations of non-shrink grout shall meet the requirements of ASTM C 1107, Grade B. The grout must be mixed with potable water for use. The grout shall be mixed to a flowable consistency as determined by ASTM C 230. All bagged material shall be clearly marked with the manufacturer's name, date of production, batch number, and written instructions for proper mixing, placement and curing of the product.

(b) The Contractor may formulate and design a grout mix for use on the project in lieu of using a pre-bagged product. The Contractor must obtain prior written approval of the Engineer for any such proposed mix design. Any such mix design shall include the proportions of hydraulic cement, potable water, fine aggregates, expansive agent, and any other necessary additive or admixture. This material shall meet all of the same chemical and physical requirements as must the pre-bagged grout, in accordance with ASTM C 1107, Grade B.

13. Other Cementitious Material:

(a) Fly Ash

1. Fly ash may be used to replace up to a maximum of 15% of the required Portland cement. The fly ash

shall be substituted on a weight (mass) basis, with a minimum of 1 pound (0.45 kilogram) of fly ash for 1 pound (0.45 kilograms) of Portland cement.

2. Fly ash to be used as a replacement for Portland cement in Portland cement concrete shall meet the requirements of AASHTO M 295, either Class C or Class F, including the uniformity requirements of Table 2A. Loss on Ignition for either class of fly ash shall not exceed 4.0%.

3. Ordering: Before starting work, the Contractor shall notify the Engineer, in writing, of the class, the name and location of the producing plant and the name and location of the bulk storage facilities, if different from the producing plant, for the fly ash he proposes to use in the work. Different classes of fly ash or the same class from different producing plants, shall not be used on any project without the written express approval of the Engineer.

Fly ash shall be obtained from an approved source and shall be supplied from silos or bulk storage facilities, whose contents have been approved by the Department.

4. Testing: Fly ash shall be sampled and tested in accordance with the procedures and methods prescribed in ASTM C 311.

The producer or supplier of the fly ash shall provide the Division of Materials Testing with three copies of certified test reports from an approved laboratory for all fly ash supplied to the Department. The certified test reports shall conform to Article 1.06.07. An approved laboratory shall be defined as a laboratory whose cement and concrete testing equipment and methods are regularly inspected by the CCRL.

Approval of the laboratory will be contingent on review by the Department of the last two inspection reports by the CCRL, which are to be submitted by the laboratory.

5. Storage: The fly ash shall be stored at the producing plant or at the supplier's terminal in approved weather-tight silos or bulk storage facilities. All silos or storage facilities shall be completely empty and clear before the fly ash is deposited therein.

Fly ash remaining in bulk storage for a period greater than one year after approval shall be re-sampled and tested prior to shipment or use. Fly ash, which has been in bulk storage for a period exceeding two years from the time of original manufacture, shall not be used on Department work.

14. Anchoring Cement: The premixed anchoring cement shall be non-metallic, concrete gray in color and packaged in bags. The mix shall consist of hydraulic cement, fine aggregate, expansive admixtures and water conforming to the following requirements:

1. The anchoring cement shall have a minimum 24 hour compressive strength of 2,600 psi (18 megapascals), when tested in accordance with ASTM C 109.
2. The water content of the anchoring cement shall be as recommended by the manufacturer. Water shall conform to the requirements of Article M.03.01-4. The potable water shall not contain chlorides or nitrates.

Portland cement shall be Type I, II, or III cement conforming to the requirements of Article M.03.01-3.

Fine aggregate shall conform to the requirements of Article M.03.01-2.

The Contractor shall provide a Certified Test Report and Materials Certificate for the premixed anchoring cement in conformance with Article 1.06.07. The Contractor shall also provide, when requested by the Engineer, samples of the premixed anchoring cement for testing and approval.

15. Chemical Anchors: The chemical anchor material shall be epoxy or polyester polymer resin. It shall contain no metals or products that promote corrosion of steel. The Contractor shall supply the Engineer with a Certified Test Report and Materials Certificate for the chemical anchor material in conformance with Article 1.06.07. The Contractor shall also provide, when requested by the Engineer, samples of the chemical anchors for testing and approval. Chemical anchor material shall be listed on the Approved Products List of the ConnDOT and approved by the Engineer for the specified use.

SECTION M.04
BITUMINOUS CONCRETE MATERIALS

M.04.01—Hot Mix Asphalt Materials

M.04.02—Mix Design and Job Mix Formula (JMF)

M.04.03—Testing and Control of Mixture

M.04.01—Bituminous Concrete Materials: All facilities producing and testing bituminous concrete materials must be approved on an annual basis by the Director of Research and Materials (DRM). The basis of approval for plant machinery, materials processing & controls, and field laboratory requirements is set forth in the “Materials Testing Manual” published by the Department’s Division of Materials Testing. Asphalt test modifications are also included in the Materials Testing Manual.

Materials: All sources of materials used for the production of bituminous concrete materials must be approved by the DRM prior to their use. Such materials shall include coarse aggregate, fine aggregate, mineral filler and designated bitumen combined to meet the composition limits by weight (mass) and other requirements stated in Table M.04.01. The Contractor shall submit to the Engineer a request for approval of all material sources of supply on a project-by-project basis. The Contractor shall also submit a Material Safety Data Sheet (MSDS) for each grade of binder to be used on the Project.

An adequate quantity of each size aggregate, mineral filler and bitumen shall be maintained at the bituminous concrete plant site at all times while the plant is in operation to ensure that the plant can consistently produce bituminous concrete materials that meet the job mix formula (JMF) as specified in M.04.02. The quantity of such material shall be approved by the Engineer on an individual plant basis and is dependent upon the plant's daily production capacity, but shall never be less than one day’s production capacity.

1. Coarse Aggregate:

a. **Requirements:** The coarse aggregate shall consist of clean, hard, tough, durable fragments of crushed stone or crushed gravel of uniform quality. Aggregates from multiple sources of supply shall not be mixed or stored in the same stockpile.

b. **Basis of Acceptance:** The request for approval of the source of supply shall include a washed sieve analysis in accordance with AASHTO T-27. The apparent specific gravity (G_{sa}), bulk specific gravity (G_{sb}) and percent absorption (P_{a_w}) shall be determined in accordance with AASHTO T-85. The aggregate shall not contain more than 1% crusher dust, sand, soft disintegrated pieces, mud, dirt, organic and other injurious materials. When tested for abrasion using AASHTO T-96, the aggregate loss shall not exceed 40.0%. When tested for soundness using AASHTO T-104 with a magnesium sulfate solution, the coarse aggregate shall not have a loss exceeding 10.0% at the end of 5 cycles.

2. Fine Aggregate:

a. **Requirements:** The fine aggregate shall consist of clean, hard, tough, rough-surfaced and angular grains, of natural sand; manufactured sand prepared from washed stone screenings; stone screenings, slag or gravel; or combinations thereof. Fine aggregates from multiple sources of supply shall not be mixed or stored in the same stockpile.

b. **Basis of Acceptance:** The request for approval of the source of supply must include the location, manufacturing and processing methods. The request for approval shall also include a washed sieve analysis in accordance with AASHTO T-27. Any fine aggregate component or final combined product shall have 100% passing the 3/8 inch (9.5 millimeter) sieve. The apparent specific gravity (G_{sa}), bulk specific gravity (G_{sb}) and percent absorption (P_{a_w}) shall be determined in accordance with AASHTO T-84. The fine aggregates shall be free from injurious amounts of clay, loam, and other deleterious substances.

3. Mineral Filler:

a. **Requirements:** Mineral filler shall consist of finely divided mineral matter such as rock dust, including limestone dust, slag dust, hydrated lime, hydraulic cement, or other approved mineral matter. At the time of use it shall be freely flowing and devoid of agglomerations.

b. **Basis of Acceptance:** The request for approval of the source of supply shall include the location, manufacturing process, handling and storage methods for the material. Mineral filler shall conform to the requirements of AASHTO M-17.

4. Liquid Bituminous Materials:

a. **Performance grade (PG) binder**

i. **Requirements:** Materials for this item shall have uniformly mixed and blended liquid

bituminous materials that are free of contaminants such as fuel oils and other solvents. Such materials shall be properly heated and stored to prevent damage or separation. PG binders used in the production of bituminous materials shall be approved by the DRM. PG binders that are modified with fillers, extenders, reinforcing agents, adhesion promoters, additives, and thermoplastic polymers shall be approved for use only with the prior written approval from the DRM.

- ii. **Basis of Acceptance:** The request for approval of the source of supply shall list the location where the materials will be produced, and manufacturing, processing, handling and storage methods along with necessary certification in accordance with AASHTO R-26. The PG binder utilized for the production of bituminous materials shall consist of the grade specified in the Contract when tested in accordance with AASHTO M-320 and AASHTO R-29.

b. Cut-backs (medium cure type)

- i. **Requirements:** The liquid petroleum materials for this item shall be produced by fluxing an asphalt base with appropriate petroleum distillates to produce the grade specified.
- ii. **Basis of Acceptance:** The request for approval of the source of supply shall be submitted at least seven days prior to its use listing the location where the materials will be produced, and manufacturing, processing, handling and storage methods. The liquid asphalt shall be MC-250 conforming to AASHTO M-82.

c. Emulsions

- i. **Requirements:** The emulsified asphalt shall be homogeneous and not be used if exposed to freezing temperatures.
- ii. **Basis of Acceptance:** The request for approval of the source of supply must include the location where the materials will be produced, and manufacturing, processing, handling and storage methods.
 - 1. Emulsified asphalts shall conform to the requirements of AASHTO M-140. Materials used for tack coat shall be grade RS-1. When ambient temperatures are 80 F (27 C) and rising, grade SS-1 or SS-1h may be substituted if approved by the Engineer.
 - 2. Cationic emulsified asphalt shall conform to the requirements of AASHTO M-208. Materials used for tack coat shall be grade CRS-1. The settlement and demulsibility test will not be performed unless deemed necessary by the DRM. When ambient temperatures are 80 F (27 C) and rising, grade CSS-1 or CSS-1h may be substituted if approved by the Engineer.

5. **Reclaimed Asphalt Pavement (RAP):**

- a. Requirements: RAP shall consist of asphalt pavement constructed with sand and aggregate reclaimed by cold milling or other removal techniques approved by the DRM. For bituminous mixtures containing RAP, the Contractor shall submit a JMF in accordance with M.04.02 to the Engineer for advance approval.
- b. Basis of Acceptance: The RAP material will be accepted on the basis of one of the following criteria:
 - i. When the source of all RAP material is from pavements previously constructed in accordance with Department specifications, the Contractor shall provide certification that the RAP is only from such pavements and that the binder is substantially free of solvents, tars and other contaminants. Stockpiles of such materials shall be continuously labeled with a sign reading "ConnDOT RAP" and remain separate from all other materials. A request for approval for the RAP material shall include the stockpile location and estimated quantities to be used.
 - ii. When the RAP material source or quality is not known, the Contractor shall test the material and provide the following information along with a request for approval to the DRM at least 30 calendar days prior to the start of the paving operation. The request shall include a material certificate stating that the RAP consists of aggregates that meet the specification requirements of M.04.01-1a through c and that the binder in the RAP is substantially free of solvents, tars and other contaminants. Stockpiles of such material shall remain separate from all other RAP materials at all times. The request for approval shall include the following:
 - 1. A 5-pound (2.5-kilogram) sample of the RAP to be incorporated into the recycled mixture.
 - 2. A 5-pound (2.5-kilogram) sample of the extracted aggregate from the RAP.

3. After recovery of from the RAP by AASHTO T-170, the viscosity test results shall be reported when tested at 140°F (60° C) by AASHTO T-202.
4. Statement that RAP material has been crushed to 100% passing the ½ inch (12.5 millimeter) sieve and remains free from contaminants such as joint compound, wood, plastic, and metals.

6. Crushed Recycled Container Glass (CRCG):

- a. Requirements: The Contractor use clean and environmentally-acceptable CRCG in an amount not greater than 5% by weight (mass) of total aggregate.
- b. Basis of Acceptance: The Contractor shall submit to the Engineer a request for approval to use CRCG. The request shall state that the CRCG contains no more than 1% by weight (mass) of contaminants such as paper, plastic and metal and conform to the following gradation:

CRCG Grading Requirements

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8-inch (9.5 mm)	100
No. 4 (4.75mm)	35-100
No. 200 (75µm)	0-10

7. Joint Seal Material:

- a. Requirements: Joint seal material shall be a hot-poured rubber compound.
- b. Basis of Acceptance: Joint seal material will be tested in accordance with the requirements of AASHTO M-301.

M.04.02—Mix design and Job Mix Formula (JMF)

1. Marshall Method - Class 1, 2, 3, 4 and 12:

- a. Requirements: The Marshall method shall be employed to develop a bituminous concrete mix design that includes a JMF consisting of target values for gradation and bitumen content for each class of bituminous concrete designated for the project in accordance with the AI’s MS-2 manual. Each class of bituminous concrete must meet the requirements as shown in Table M.04.01.
- b. Basis of Acceptance: The Contractor shall submit to the Engineer a request for approval of the JMF in accordance with one of the methods described in c, d, and e below. Prior to the start of any paving operations the JMF and production percentage of bitumen must be approved by the Engineer, and the Contractor must demonstrate the ability to meet the approved JMF and production percentage of bitumen for each class of material. Additionally, the fraction of material retained between any two consecutive sieves shall not be less than 4%.

The Engineer will test each class of material for compliance with the submitted JMF and Table M.04.01. The maximum theoretical density (Gmm) will be determined by AASHTO T-209 (modified). If the material does not meet the requirements, the JMF shall be adjusted within the ranges shown in Table M.04.01 until an acceptable material is produced. All equipment, tests and computations shall conform to the Marshall method in accordance with AASHTO T-245 (modified).

An approved JMF from the previous operating season may be acceptable to the Engineer provided that there are no changes in the sources of supply for the coarse aggregate, fine aggregate, recycled material (if applicable) and the plant operation had been consistently producing acceptable material.

The Contractor shall not change sources of supply after a JMF has been approved. Before a new source of supply for materials is used, a new JMF shall be submitted to the Engineer for approval.

- c. Marshall mixture (virgin): For Bituminous concrete materials that contain no recycled material, the limits prescribed in Table M.04.01 govern. The Contractor shall submit to the Engineer for approval, a JMF with the individual fractions of the aggregate expressed as percentages of the total weight (mass) of the mix and the source(s) of all materials. The JMF shall indicate two bitumen contents; the JMF target percentage and a production percentage (actual amount added to mix) of bitumen for each mix class by total weight (mass). For surface course Class 1, a 0.45 power gradation chart shall also be submitted on which is plotted the percentage passing each sieve. The JMF shall also indicate the target temperature of completed mixture as it is dumped from the mixer and tested in accordance with M.04.03-3.

- d. Marshall mixtures with RAP: Bituminous concrete that contains RAP shall comply with requirements stated in M.04.01-1(a through e). Upon approval by the Engineer, a maximum of 10% RAP may be used with no binder grade modification. RAP material shall not be used with any other

recycling option.

The Contractor may increase the RAP percentage in 5% increments up to a maximum of 30% provided a new JMF is approved by the Engineer. The following information shall be included in the JMF submittal:

- i. Gradation and asphalt content of the RAP.
 - ii. Percentage of RAP to be used.
 - iii. Virgin aggregate source(s).
 - iv. Total JMF content based on total mixture weight (mass).
 - v. Production pull percentage of bitumen (added virgin) based on total mixture weight (mass).
 - vi. Gradation of combined bituminous concrete mixture (including RAP).
 - vii. Grade of virgin added, if greater than 10% of total mix weight (mass).
- e. Marshall mixture with CRCG: For Bituminous concrete that contains CRCG, the Contractor shall submit a materials certificate to the Engineer stating that the mixture and its components comply with requirements stated in M.04.0-1 (f). Additionally, 1% hydrated lime, or other approved non-stripping agent, shall be added to all mixtures containing CRCG. CRCG material shall not be used with any other recycling option.
- 2. Cold Patch Method - Class 5, 5A, 5B:**
- a. Requirements: This material must be capable of being stockpiled and workable at all times. A non-stripping agent approved by the Engineer shall be used in accordance with manufacturer's recommendations.
 - i. Class 5A material shall have 3/8 to 1/2 inch (9.5 to 12.5 millimeters) polypropylene fibers added at a minimum rate of 6 pounds per ton (3 kilograms per metric ton) of mixture.
 - ii. Class 5B mixture shall have 1/4 inch (6.3 millimeters) polyester fibers added at the minimum rate of 2 1/2 pounds per ton (1.25 kilograms per metric ton) of mixture.
 - b. Basis of Acceptance: The Contractor shall submit to the Engineer a materials certificate for this material. The aggregates, fibers and binder (MC-250) shall meet the requirements as specified in M.04.01-1 (a through d) and in Table M.04.01. The use of recycled material is not permitted with this class of Bituminous concrete.

Table M.04.01 Master Range

Ranges for Bituminous Concrete Hot Mix Asphalt Mixtures										JMF Tolerance ± Percent	
CLASS	1	2	3	4	12	5A (f)	5B (f)				
Grade of PG binder content %	PG 64-28 5.0 - 6.5	PG 64-28 5.0 - 8.0	PG 64-28 6.5 - 9.0	PG 64-28 4.0 - 6.0	PG 64-28 7.5 - 10.0	MC-250 (e) 6.0 - 7.5	MC-250 (e) 6.0 - 7.5	MC-250 (e) 6.0 - 7.5	MC-250 (e) 6.0 - 7.5	0.4	
Sieve Size	Percent Passing (%)										
#200	3 - 8 (h)	3 - 8 (h)	3 - 8 (h)	0 - 5 (h)	3 - 10 (h)	0 - 2.5	0 - 2.5	0 - 2.5	0 - 2.5	2	
#50	6 - 26	8 - 26	10 - 30	5 - 18	10 - 40	10 - 40	10 - 40	10 - 40	10 - 40	4	
#30	10 - 32	16 - 36	20 - 40	20 - 40	20 - 60	2 - 15	2 - 15	2 - 15	2 - 15	5	
#8	28 - 50	40 - 64	40 - 70	20 - 40	60 - 95	10 - 45	10 - 45	10 - 45	10 - 45	6	
#4	40 - 65	55 - 80	65 - 87	30 - 55	80 - 95	40 - 100	40 - 100	40 - 100	40 - 100	7	
1/4"	6.3 mm										
3/8	9.5 mm	90 - 100	95 - 100	42 - 66	98 - 100	100	100	100	100	8	
1/2	12.5 mm	100	100	60 - 80	100					8	
3/4"	19.0 mm										
1"	25.0 mm										
2"	50.0 mm			100							
Additionally, the fraction of material retained between any two consecutive sieves shall not be less than 4%.											
Material Temperature											
Aggregate	325 max (163 max)										140 - 185 (60 - 85)
Mixtures	280 - 350 (138 - 177)										100 - 175 (38 - 79)
	265 - 325 (129 - 163)										120 - 175 (49 - 79)
Mixture Properties											
VOIDS - %	3.0 - 6.0 (b)	2.0 - 5.0 (c)	0 - 4			0 - 5.0 (b)					
Stability [g]	1200 (d)	1000	1000			1000					
Newton's - min.	5300 (d)	4500	4500			4500					
FLOW [g]	08 - 15	08 - 15	08 - 18			08 - 15					
	(2 - 4)	(2 - 4)	(2 - 5)			(2 - 4)					
VMA (m)	15(k) - 16 (L)										

Notes:

- (a) 300° F (149 °C) minimum after October 1.
- (b) 75 blow (Marshall Criteria)
- (c) 3-6% when used for a roadway wearing surface
- (d) For divided highways with 4 or more lanes, a stability of 1500 lbs. (6600 N) is required.
- (e) Contains an approved non-stripping compound
- (f) To help prevent stripping, the mixed material will be stockpiled on a paved surface, and at a height not greater than 4 feet (1.2 m) during the first 48 hours.
- (g) As determined by AASHTO T-245 (modified)
- (h) The percentage of material passing the #200 (75 µm) sieve shall not exceed
- (i) The percentage of bituminous asphalt binder determined by AASHTO T-164 (modified), minimum rate of 6 pounds per ton (3 kilograms per metric ton). Fibers shall be pre-approved by the DPM.
- (j) Polyester Fibers - 1/4 inch (6.3 mm) added to the mix at a minimum rate of 2 1/2 lb. per ton (1.25 kg per metric ton). Fibers shall be pre-approved by the DPM.
- (k) Mixture with 5% or more aggregate retained on 3/4" (19 mm) sieve
- (L) Mixtures finer than condition (K) above
- (m) Voids in Mineral Aggregate (VMA)

M.04.03—Control of mixture: The requirements of the plant during production, the sampling & testing methods used by Engineer during production, and the cessation of supply during paving operations are as follows:

1. Plant production requirements

a. **Storage silos:**

- i. For mixtures sampled from hauling vehicles at the plant after storage in silos (for all classes except 5, 5A, and 5B), the viscosity of the recovered asphalt shall be no greater than 5,500 poises at 140° F (550 Pa·s at 60° C).
- ii. A storage silo's usage shall cease and that bin placed "off test" when the results from one production test from a storage silo are not within the tolerances in Table M.04.01 or the results from two production tests from a silo are not within JMF tolerances. The silo shall remain "off test" until an acceptable trial test result is obtained. The trial test will be performed by the Engineer, and if the test results are within the JMF and Table M.04.01 criteria, the silo use may resume. If the trial test fails, the remaining materials stored in the silo will be rejected.

b. **Aggregates:** The Contractor shall ensure that aggregate stockpiles are managed to provide uniform gradation and particle shape, prevent segregation and cross contamination in a manner acceptable to the Engineer.

c. **Mixture:** The Contractor shall provide to the Engineer upon request, the dry and wet mix times for each class of materials. The dry and wet mix times shall be sufficient to provide proper coating of all particles with bitumen and produce a uniform mixture. The Contractor shall make necessary adjustments to ensure bituminous concrete materials are free from moisture throughout.

d. **RAP:** The Contractor shall indicate on the ticket the percent of RAP, the moisture content, and the net weight of RAP added to the mixture. The Contractor shall make necessary adjustments to ensure bituminous concrete materials are free from moisture throughout. For each day of production, the Contractor shall not change from the JMF and RAP percentage without prior approval of the Engineer.

2. Sampling & testing methods: The Contractor shall furnish the Engineer a field laboratory approved by the Department to test bituminous materials during production. Material samples will be obtained from the hauling vehicles by the Engineer at the plant during each day's production, as indicated in the Department's "**Schedule of Minimum Requirements for Sampling Materials for Test**". The following test procedures will be used:

AASHTO T-30 (modified)	Mechanical Analysis of Extracted Aggregate
AASHTO T-40 (modified)	Sampling Bituminous Materials
AASHTO T-164 (modified)	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
AASHTO T-245 (modified)	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
AASHTO T-209 (modified)	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
AASHTO T-269 (modified)	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

In addition, the DRM may sample any load in transit or at the Project site in accordance with Section 1.06. The results of AASHTO T-164 (modified) and T-30 (modified) will be used to determine if the material is within the tolerances shown in Table M.04.01.

- a. The Contractor will be notified that a plant is "Off Test" for a class of material when the test results indicate that any single value for bitumen content or gradation are not within the tolerances shown in Table M.04.01 for that class of material.
- b. If a subsequent test indicates that the bitumen content or gradation are outside the tolerances, the Contractor may make a single JMF change on classes 1, 2, 3, 4 and 12 as approved by the DRM prior to any additional testing. Consecutive test results outside the JMF tolerances may result in rejection of the mixture.
- c. Any adjustment to the JMF shall not exceed 50% of the JMF tolerances indicated in Table M.04.01 for any given component of the mixture without approval of the DRM. When such an adjustment is made to the bitumen, the corresponding production percentage of bitumen shall be

revised accordingly.

3. Cessation of Supply: The Engineer will cease the supply of material for the Project from any plant that consistently fails to produce material that meets the JMF. The criteria for ceasing the supply of a class of material from any plant are as follows:

- a. When the test results from three consecutive samples are not within the JMF tolerances or the test results from two consecutive samples are not within the ranges indicated in Table M.04.01.
- b. When the percent of material passing the minus #200 (75 μ m) sieve material exceeds the percent of extracted bitumen content for three consecutive samples during any production period.

In addition, when the test results from three non-consecutive samples of a class of material not within the JMF tolerances or the test results from two non-consecutive samples not within the range indicated in Table M.04.01 during any one production period, the Engineer may cease supply of material from the plant.

Following cessation, a trial production period will be required at the plant for that class of material. Use of that class of material from that plant will be prohibited on the Project until the plant has demonstrated the ability to consistently produce acceptable material. When the DRM has approved the materials from the trial production period, the use of that material on the Project may resume.

**SECTION M.05
PROCESSED AGGREGATE BASE AND
PAVEMENT SURFACE TREATMENT**

M.05.01—Processed Aggregate Base and Pavement

M.05.02—Surface Treatment

M.05.01—Processed Aggregate Base and Pavement: The materials for this work shall conform to the following requirements:

1. Gradation: Coarse and fine aggregates shall be combined and mixed by approved methods so that the resulting material shall conform to the following gradation requirements:

Square Mesh Sieves	Percent Passing by Mass
Pass 2 1/2 inches (63 mm)	100
Pass 2 inches (50 mm)	95-100
Pass 3/4 inch (19 mm)	50-75
Pass 1/4 inch (6.3 mm)	25-45
Pass #40 (425 μm)	5-20
Pass #100 (150 μm)	2-12

2. Coarse Aggregate: Coarse aggregate shall be either gravel, broken stone or reclaimed miscellaneous aggregate containing no more than 2% by weight (mass) of asphalt cement, at the option of the Contractor. When tested by means of the Los Angeles Machine, using AASHTO Method T 96, the coarse aggregate shall not have a loss of more than 50%.

(a) If gravel is used for the coarse aggregate, it shall consist of sound, tough, durable particles of crushed or uncrushed gravel or a mixture thereof, free from soft, thin, elongated or laminated pieces, lumps of clay, loam and vegetable or other deleterious substances.

(b) If broken stone is used for the coarse aggregate, it shall consist of sound, tough, durable fragments of rock of uniform quality throughout. It shall be free from soft disintegrated pieces, mud, dirt, organic or other injurious material.

(c) If the reclaimed miscellaneous aggregate is used for the coarse aggregate, it shall consist of sound, tough, durable fragments of uniform quality throughout. It shall be free from soft disintegrated pieces, mud, dirt, glass, organic or other injurious material.

(d) Soundness for Gravel, Broken Stone and Reclaimed Miscellaneous Aggregate: When tested by magnesium sulfate solution for soundness using AASHTO Method T 104, the coarse aggregate shall show a loss of not more than 15% at the end of 5 cycles.

3. Fine Aggregate: The fine aggregate shall be natural sand, stone sand, screenings or any combination thereof. The fine aggregate shall be limited to material 95% of which passes a No. 4 (4.75-mm) sieve having square openings and not more than 8% of which passes a No. 200 (75-μm) sieve. The material shall be free from clay, loam and deleterious materials.

(a) Plasticity: When natural sand is used, the fine aggregate shall conform to the requirements of Article M.02.06-2.

(b) Plasticity: When screenings or any combination of screenings and natural sand or any combination of stone sand and natural sand are used, the following requirements shall apply:

(1) When the fraction of the dry sample passing the No. 100 (150-μm) mesh sieve is 6% or less by weight (mass), no plastic limit test will be made.

(2) When the fraction of the dry sample passing the No. 100 (150-μm) mesh sieve is greater than 6% and not greater than 10% by mass, that fraction shall not have sufficient plasticity to permit the performing of the plastic limit test, using AASHTO Method T 90.

(3) When the fraction of the dry sample passing the No. 100 (150-μm) mesh sieve is greater than 10% by weight (mass), the sample shall be washed; and additional material passing the No. 100 (150-μm) mesh sieve shall be determined by AASHTO Method T 146, except that the No. 100 (150-μm) mesh sieve shall be substituted for the No. 40 (425-μm) mesh sieve where the latter is specified in AASHTO Method T 146. The combined materials that have passed the No. 100 (150-μm) mesh sieve shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO Method T 90.

M.05.02—Surface Treatment: Materials for this work shall conform to the following requirements:

1. Bituminous Material: The Bituminous materials shall be selected from the following grades and shall

meet the requirements shown in Section M.04.

Asphaltic Cutback	MC-70 or MC-800
Tar	RT-2, RT-4 or RT-6
Asphalt Emulsion	As directed by the Engineer

The type of bituminous material to be used, as well as its viscosity or grade, will depend upon the character and condition of the surface to be treated, the season of the year at which the work is to be done, and will be determined by the Engineer. The Contractor shall not order any material for this work until he has obtained definite instructions from the Engineer as to whether tar, asphalt or asphalt emulsion is required and as to the type of the bituminous material selected.

2. Sand Cover: Sand shall contain not more than 3% inorganic silt and clay by actual dry weight (mass), using AASHTO Method T 11 and shall conform to the following gradation requirements:

Square Mesh Sieves	Percent Passing by Weight (Mass)
Pass 1/2 inch (12.5 mm)	100
Pass 3/8 inch (9.5 mm)	95-100
Pass #4 (4.75 mm)	80-100
Pass #50 (300 μ m)	10-30
Pass #100 (150 μ m)	0-10

**SECTION M.06
METALS**

M.06.01--Reinforcing Steel

M.06.02--Structural Steel and Other Structural Materials

M.06.03--Galvanizing

M.06.04--Filler Metal for Welding

M.06.01--Reinforcing Steel: The materials for this work shall conform to the following requirements:

1. Bar Reinforcement:

Bar reinforcement shall be deformed and conform to the following:

Uncoated bar reinforcement shall conform to the requirements of ASTM A 615/A 615M, Grade 60(420).

Epoxy coated bar reinforcement shall conform to the requirements of ASTM A 615M, Grade 420 and shall be epoxy coated to the requirements of ASTM D 3963/D 3963M.

Galvanized bar reinforcement shall conform to the requirements of ASTM A 615/A 615M, Grade 60 (420) and be galvanized, after fabrication, to the requirements of ASTM 767/A 767M, Class 1, including supplemental requirements. Dowels and tie bars for masonry facing and for granite curbing shall be galvanized, after fabrication, in accordance with ASTM A 767/A 767M, Class 1.

Weldable bar reinforcement shall conform to the requirements of ASTM A 706/A 706M.

Prior to incorporation into the work, samples of the uncoated, epoxy coated, galvanized and weldable bar reinforcement shall be submitted to the Engineer for destructive testing in accordance with the latest edition of the "Schedule of Minimum Requirements for Sampling Materials for Test". One sample, at least 60 inches (1550 millimeters) long, shall be submitted for each size, source of supply, and type of bar reinforcement.

2. Unit Weights (Mass): Listed below are the bar sizes with approximate diameters, areas and weights (mass).

Bar Designation No.**	Nominal Weight lb./ft. (Nominal Mass) (kg/m)	<u>A 615/A 615M</u>		
		Nominal Dimensions*		
		Diameter, in. (mm)	Cross Sectional Area sq. inch (mm ²)	Perimeter inch (mm)
3 (10)	0.376 (0.560)	0.375 (9.5)	0.11 (71)	1.178 (29.9)
4 (13)	0.668 (0.994)	0.500 (12.7)	0.20 (129)	1.571 (39.0)
5 (16)	1.043 (1.552)	0.625 (15.9)	0.31 (199)	1.963 (49.9)
6 (19)	1.502 (2.235)	0.750 (19.1)	0.44 (284)	2.356 (59.8)
7 (22)	2.044 (3.042)	0.875 (22.2)	0.60 (387)	2.749 (69.8)
8 (25)	2.670 (3.973)	1.000 (25.4)	0.79 (510)	3.142 (79.8)
9 (29)	3.400 (5.060)	1.128 (28.7)	1.00 (645)	3.544 (90.0)
10 (32)	4.303 (6.404)	1.270 (32.3)	1.27 (819)	3.990 (101.3)
11 (36)	5.313 (7.907)	1.410 (35.8)	1.56 (1006)	4.430 (112.5)
14 (43)	7.65 (11.38)	1.693 (43.0)	2.25 (1452)	5.32 (135.1)
18 (57)	13.60 (20.24)	2.257 (57.3)	4.00 (2581)	7.09 (180.1)

* The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same weight (mass) pound per foot (kilogram per meter) as the deformed bar.

**Bar numbers are based on the number of eighths of an inch included in the nominal diameter of the bars (bar numbers approximate the number of millimeters of the nominal diameter of the bar).

3. Wire and Welded Steel Wire Fabric: Wire shall be cold-drawn steel wire conforming to the requirements of ASTM A 82 (AASHTO M 32).

Welded steel wire fabric, when used as reinforcement in concrete, shall conform to the requirements of ASTM A 185 (AASHTO M 55). The type of welded steel wire fabric shall be approved by the Engineer.

4. Bar Mat Reinforcement: Bar mat reinforcement shall conform to the requirements of ASTM A 184/A 184M (AASHTO M 54)

5. Dowel Bar Mechanical Connections: Dowel bar mechanical connections shall develop in tension and compression at least 125 percent of the specified yield strength of the bar reinforcement being spliced.

Epoxy coated mechanical connectors shall be epoxy coated in accordance with the requirements of ASTM D 3963/D 3963M.

Galvanized mechanical connectors shall be galvanized, after fabrication, in accordance with the requirements of ASTM A 767/A 767M, Class 1, including supplemental requirements.

Prior to incorporation into the work, samples of the uncoated, epoxy coated and galvanized dowel bar mechanical connections shall be submitted to the Engineer for destructive testing. One sample, complete with all the components, shall be submitted for each size, type and manufacturer of the dowel bar mechanical connections.

6. Deformed Steel Wire and Welded Deformed Steel Wire Fabric: Deformed steel wire shall be cold-worked, deformed steel wire conforming to the requirements of AASHTO M 225 (ASTM A 496). Welded deformed steel wire fabric, when used as reinforcement in concrete, shall conform to the requirements of AASHTO M 221 (ASTM A 497). The type of welded deformed steel wire fabric shall be approved by the Engineer.

7. Reinforcing Steel for Pavement: Reinforcing steel for pavement shall be in accordance with the applicable standard plans.

8. Reports and Certification: Mill test reports and materials certification shall be submitted for all types of reinforcing steel and dowel bar mechanical connections confirming they meet the requirements of the applicable specifications.

Materials Certificates shall be submitted in accordance with Article 1.06.07 for all types of reinforcing steel and dowel bar mechanical connections.

M.06.02--Structural Steel and Other Structural Materials: The materials for this work shall conform to the following requirements:

1. Structural Steel: All structural steel shall conform to ASTM A 709/A 709 M, Grade 36(250), Grade 250 unless otherwise specified.

(a) **Charpy V-notch Impact Testing:** Unless otherwise shown on the plans or indicated in the Special Provisions, all structural steel used for main load carrying components shall meet the Charpy V-notch impact value requirements specified herein. Main load carrying components shall include but not necessarily be limited to the following:

Flange and web plates of welded plate and box girders; rolled beams; welded cover plates; and longitudinal stiffener plates.

Flange and web splice plates.

Cross frames and their connection plates on horizontally curved girders.

Portions of trusses, arches, and rigid frames.

Charpy V-notch sampling and testing procedures shall be in accordance with ASTM A 673/A 673M (AASHTO T 243). The H (Heat) frequency of testing shall be used for structural steels conforming to ASTM Designations A 36/A 36M, A 572/A 572M, and A 588/A 588M; the P (Piece) frequency of testing shall be used for structural steel conforming to ASTM Designation A 514/A 514M/A 517/A 517M.

Charpy V-notch (CVN) impact values shall meet the following minimum values:

ASTM Designation	Thickness—Inches (Millimeters) Foot Pounds (Joules)	Charpy V-notch	
		Foot Pounds @ Temp. (Joules (J) @ Temp. (°C))	
A 36/A 36M		15 @ 40° F	(20 @ 4)° C
A 572*/A 572M		15 @ 40° F	(20 @ 4)° C
A 588*/A 588M	2 inches (50 millimeters) and under – welded	15 @ 40° F	(20 @ 4)° C
	Over 2 inches (50 millimeters) – welded	20 @ 40° F	(27 @ 4)° C
	4 inches (100 millimeters) and under - mech. fastened	15 @ 40° F	(20 @ 4)° C
A 514/517	2 ½ inches (64 millimeters) and under – welded	25 @ 0° F	(34 @ -18)° C
	Over 2 ½ inches (64 millimeters) welded	35 @ 0° F	(48 @ -18)° C
	4 inches (100 millimeters) and under - mech. fastened	25 @ 0° F	(34 @ -18)° C

*If the yield point of the material exceeds 65 kips per square inch (450 megapascals), the temperature for acceptability shall be reduced by 15°F (10°C) for each increment of 10 kips per square inch (70 megapascals) above 65 kips per square inch (450 megapascals).

Except as otherwise noted in the Special Provisions or on the plans, Charpy V-notch tests will be required for structural repairs but will not be required for temporary structures.

(b) **Ordering Weathering Steel:** When placing an order for ASTM A 588/A 588M steel which is to be used as "Weathering Steel", the fabricator shall notify the manufacturer that it is "weathering steel" (structural steel for use in bare, unpainted applications) and that the steel shall not be marked with paint or steel die stamped, but identification shall be stenciled with permanent ink.

2. **Anchor Bolts:** Unheaded anchor bolts shall be swaged and shall conform to the requirements of ASTM A 36/A 36M. Anchor bolts, nuts and washers shall be galvanized in conformance with ASTM A 153/A 153M

3. **Eyebars:** Steel for eyebars shall conform to the requirements specified on the plans or in the contract documents.

4. **Structural Rivets:**

(a) **Structural Rivet Steel:** Unless otherwise specified, all rivets shall be made of structural rivet steel conforming to the requirements of ASTM A 502/A 502M, Grade 1.

(b) **High Strength Structural Rivet Steel:** Where high strength structural rivets are called for on the plans or in the special provisions, rivets shall be made of high-strength structural rivet steel conforming to the requirements of ASTM A 502, Grade 2.

The steel for rivets used in fastening weathering steel, conforming to ASTM A 588/A 588M, shall be modified by the addition of such alloying elements as to have, while in a fully stressed condition, weathering and corrosion characteristics equal to or exceeding the requirements for weathering steel conforming to ASTM A 588/A 588M. The final weathered appearance of the rivets shall be compatible with that of the structural steel.

5. **High Strength Bolts:** Bolts, nuts and circular washers shall conform to the requirements of the specification for High-Strength Bolts for Structural Steel Joints, including suitable Nuts and Plain Hardened Washers. Bolt and nut dimensions shall conform to the Manufacturer's dimensions and tolerances.

Subject to the approval of the Engineer, other fasteners which meet the chemical composition requirements of ASTM A 325 or ASTM A 490 and which meet the mechanical requirements of the same specifications in full size tests, and which have body diameter and bearing areas under the head and nut or their equivalent, not less than those provided by a bolt and nut of these same nominal dimensions shown in the table below, may be used. Such alternate fasteners may differ in other dimensions from those specified for ASTM 325 or ASTM A 490 bolts and nuts.

When high-strength, low-alloy steel conforming to the requirements of ASTM A 588/A 588M is specified, high strength bolts, if specified, shall conform to the requirements of ASTM A 325, Type 3.

Circular washers shall be flat and smooth, and their nominal dimensions shall conform to the dimensions given in the table below.

Beveled washers for American Standard beams and channels shall be square or rectangular, shall taper in thickness, and shall conform to the dimensions given in the table below.

Where necessary, washers may be clipped on one side to a point not closer than 7/8 of the bolt diameter from the center of the washers.

WASHER DIMENSIONS ^a							
Bolt Size D	Circular Washers				Square or Rectangle Beveled Washers for American Standard Beams and Channels		
	Nominal Outside Diameter ^b	Nominal Diameter of Hole	<u>Thickness</u> Min. Max.		Minimum side dimension	Mean thickness	Slope or taper in thickness
1/2	1-1/16	17/32	.097	.177	1-3/4	5/16	1:6
5/8	1-5/16	21/32	.122	.177	1-3/4	5/16	1:6
3/4	1-15/32	13/16	.122	.177	1-3/4	5/16	1:6
7/8	1-3/4	15/16	.136	.177	1-3/4	5/16	1:6
1	2	1-1/16	.136	.177	1-3/4	5/16	1:6
1-1/8	2-1/4	1-1/4	.136	.177	2-1/4	5/16	1:6
1-1/4	2-1/2	1-3/8	.136	.177	2-1/4	5/16	1:6
1-3/8	2-3/4	1-1/2	.136	.177	2-1/4	5/16	1:6
1-1/2	3	1-5/8	.136	.177	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	.178 ^c	.28 ^c	—	—	—
2	3-3/4	2-1/8	.178	.28	—	—	—
over 2 to 4 incl.	2D-1/2	D+1/8	.24 ^d	.34 ^d	—	—	—

a Dimensions in inches

b May be exceeded by 1/4 inch

c 3/16 inch nominal

d 1/4 inch nominal

Washer Dimensions (millimeters)									
	Circular Washers						Square or Rectangle Beveled Washers for American Standard Beams and Channels		
Nominal Washer Size	Inside Diameter max min		Outside Diameter max min		Thickness max min		Minimum side dimension	Mean thickness	<u>Slope or taper in thickness</u>
12	14.4	14.0	27.0	25.7	4.6	3.1	42	7	1:6
14	16.4	16.0	30.0	28.7	4.6	3.1	42	7	1:6
16	18.4	18.0	34.0	32.4	4.6	3.1	42	7	1:6
20	22.5	22.0	42.0	40.4	4.6	3.1	42	7	1:6
22	24.5	24.0	44.0	42.4	4.6	3.4	42	7	1:6
24	26.5	26.0	50.0	48.4	4.6	3.4	56	7	1:6
27	30.5	30.0	56.0	54.1	4.6	3.4	56	7	1:6
30	33.6	33.0	60.0	58.1	4.6	3.4	56	7	1:6
36	39.6	39.0	72.0	70.1	4.6	3.4	56	7	1:6
42	45.6	45.0	84.0	81.8	7.2	4.6	56	7	1:6
48	52.7	52.0	95.0	92.8	7.2	4.6	—	—	—
56	62.7	62.0	107.0	104.8	8.7	6.1	—	—	—
64	70.7	70.0	118.0	115.8	8.7	6.1	—	—	—
72	78.7	78.0	130.0	127.5	8.7	6.1	—	—	—
80	86.9	86.0	142.0	139.5	8.7	6.1	—	—	—
90	96.9	96.0	159.0	156.5	8.7	6.1	—	—	—
100	107.9	107.0	176.0	173.5	8.7	6.1	—	—	—

6. Supplementary Requirements: The specification requirements stated above for the various types of steel are modified and supplemented by the following requirements:

- (a) **Stock Material:** Stock material of a quality substantially equal to that called for by the above specifications, and free from surface imperfections, may be used to such an extent as the Engineer may permit. Mill test reports shall constitute a sufficient record as to the quality of material carried in stock.
- (b) **Full Size Tests:** When full size tests of fabricated structural members of eyebars are required by the contract, the plans or specifications shall state the number and nature of the tests, the results to be attained, and the measurements of strength, deformation or other performance requirements that are to be made. The Contractor shall provide suitable facilities, material, supervision and labor necessary for making and recording the tests. The members tested in accordance with the contract will be paid for in accordance with paragraph (c) below.
- (c) **Payment for Full Size Tests:** Any full sized member tested to destruction will be paid for by the Department at the same rate as for comparable members for the structure if the test proves satisfactory. If the test proves the member to be unsatisfactory, the members represented by it will be rejected; and all material so rejected will not be paid for by the Department. The expense of conducting the tests shall be borne by the Contractor unless otherwise specified. The scrap from the tests shall be the property of the Contractor.
- (d) **Anchor Bolts/High Strength Bolts--Certified Test Report:** The Contractor shall submit a Certified Test Report and Materials Certificate in conformance with Article 1.06.07 and a sample of all anchor bolts and nuts and high strength bolts and nuts for testing prior to their installation. The Contractor shall not install any anchor bolts or high strength bolts prior to receipt of the approved test results and approval by the Engineer.

7. Steel Shaftings and Forgings: Pins and rollers, unless otherwise specified on the plans or elsewhere within the contract documents, shall conform to the following:

Rollers 20 inches (508 millimeters) or less in diameter shall conform to the requirements of ASTM A 668, Class C. Pins 4 inches (102 millimeters) or less in diameter shall conform to the requirements of ASTM A 108, Grade 1016 to 1030 inclusive. Pins having a diameter greater than 4 inches (102 millimeters) shall conform to the requirements of ASTM A 668, Class C.

Steel forgings for hangers shall conform to the requirements of ASTM A 668 Class G, annealed, modified by such alloying elements as will produce a steel suitable for the thickness of the hangers shown on the plans, and shall have a minimum comparative resistance to atmospheric corrosion of four times that of structural carbon steel.

Pins and rollers incorporated in structural steel components for weathering steel applications shall be corrosion-resisting (stainless) steel conforming to ASTM A 276, Types 410 or 414, which shall develop a minimum yield strength of 40,000 psi (275 megapascals).

8. Welded and Seamless Steel Pipe: Welded and Seamless Steel Pipe shall conform to the requirements of ASTM A 53, Type E or S, Grade A, Schedule 40 Black Finish.

9. Metal Castings: Castings shall be boldly filleted at angles, and the arrises shall be sharp and perfect.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and other defects in positions affecting their strength and value for the service intended.

Castings shall be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

- (a) **Carbon steel castings** shall conform to the requirements of ASTM A 27/A 27M. Grade 60-30[415-205 megapascals], 65-35 [450-240] or 70-36 [485-250] castings shall be furnished unless otherwise specified.
- (b) **Chromium alloy-steel castings** shall conform to the requirements of ASTM A 743 or A 744, Grade 10 shall be furnished unless otherwise specified.
- (c) **Gray iron castings** shall conform to the requirements of the specifications for gray iron castings, ASTM A 48. Unless otherwise specified, Class 30 (207) castings shall be furnished.
- (d) **Malleable castings** shall conform to the requirements of the specifications for malleable iron castings, ASTM A 47, Grade No. 32510 (22010). Ductile iron castings shall conform to the Specifications for Ductile Iron Castings, ASTM A 536, Grade 60-40-18 (414-276-18) unless otherwise specified. In addition to the specified test coupons, test specimens from parts integral with the castings, such as risers, shall be tested for castings having a weight (mass) of more than 1000 pounds (455 kilograms) to determine that the required quality is obtained in the castings in the finished condition.

10. Bronze or Copper Alloy Bearing and Expansion Plates: Bronze bearing and expansion plates shall conform to the requirements of ASTM B 22. Alloy B shall be furnished unless otherwise specified.

Rolled copper alloy bearing expansion plates shall conform to the requirements of ASTM B 100, Alloy No. 1.

Bearing surfaces of self-lubricating bronze bearings and bearing plates shall be provided with trepanned or drilled-in recesses (not grooves) filled with a lubricating compound capable of withstanding atmospheric elements. The

compound shall consist of graphite and metallic substances with a lubricating binder. The compound shall be forced into the recesses under pressure to form or retain the form of dense, non-plastic lubricating inserts. The lubricating area shall comprise not less than 25% of the total area. The self-lubricating bearings and bearing plates shall have a finish of 125 micro-inch (3.2 microns) root mean square, and all surfaces in contact with them shall have the same degree of finish.

The lubricant to be used for the self-lubricating plates shall provide a coefficient of friction not to exceed 0.10, as determined by the following test procedure:

A self-lubricating bronze test plate measuring not less than 5 inches (127 millimeters) long by 5 inches (127 millimeters) wide shall be prepared and shall conform to all requirements of this specification.

An assembly consisting of the fixed self-lubricating test plate and a movable steel plate shall be subjected to a vertical unit loading 1000 psi (7 megapascals). The steel plate shall then be subjected to not less than 100 cycles of horizontal movement at a speed not to exceed 30 cycles per minute. Each cycle shall consist of a forward and return movement of not more than 1/2 inch (12.5 millimeters) in each direction. The recorded horizontal force, divided by the recorded vertical force, shall be established as the coefficient of friction between the sliding surfaces.

The coefficient determined by the foregoing method shall not exceed 0.10, and tests indicating a coefficient of friction greater than 0.10 shall be cause for rejection of the lubricating compound.

Before such materials are incorporated into the work, the supplier, at his own expense, shall furnish a Certified Test Report Certificate that the lubricant, when tested as herein before described, shall not have coefficient of friction greater than 0.10.

Batches of the lubricating compound shall be clearly tagged or marked by the supplier for identification with the certification.

11. Aluminum Castings, Tubing and Fittings:

- (a) The castings for ornamental posts shall be permanent mold aluminum alloy castings conforming to the requirements of ASTM B 108, Aluminum Alloy A 356.0-T6.

The castings for traffic rail posts shall be permanent mold aluminum alloy castings conforming to the requirements of ASTM B 108 Aluminum Alloy A 444.0-T4.

The finish of all castings shall be commercial with all gates, risers and seams finished flush. Casting tolerances will be plus or minus (\pm) 1/32 inch (\pm) 0.8 millimeter).

- (b) The extruded aluminum for posts, bases, post connection splice bars and rails shall conform to ASTM B 221 Aluminum Alloy 6061--T6, unless 6063--T6 is indicated on the plans or in the special provisions.
- (c) Aluminum for bolts and screws shall be aluminum alloy made from rod or wire conforming to ASTM B 211 Aluminum Alloy 2024--T4.

Aluminum for nuts 1/4-inch (6.4-millimeter) tap and under shall be aluminum alloy made from rod or wire conforming to ASTM B 211 Aluminum Alloy 2024--T4.

Aluminum for nuts 5/16-inch (8-millimeter) tap and over shall be aluminum alloy made from rod or wire conforming to ASTM B 211 Aluminum Alloy 6061--T6, or 6262--T9, or extruded rods conforming to ASTM B 221 Aluminum Alloy 6061--T6.

Unless otherwise noted, all nuts shall conform to American Standard Heavy Hexagon, ASA Specification B 18.2. Threads shall conform to American Standard Coarse Series, Class 2 fit, ASA Specification B-1.1. The finished bolts and nuts shall be heat-treated to the required temper and given an anodic coating at least 0.0002 inches (5 microns) in thickness with dichromate or boiling water seal.

- (d) Washers shall be made from aluminum alloy sheet or plate conforming to ASTM B 209 Aluminum Alloy Alclad 2024--T4. Shims shall be of aluminum alloy shim material made from sheet or plate conforming to ASTM B 209, Aluminum Alloy 1100-0.
- (e) End caps shall be sand mold castings conforming to ASTM B 26 Alloy SG-70A Commercial Alloy 356--F or ASTM B 26 Alloy S-5A, Commercial Alloy 443-F or sheet and plate conforming to ASTM B 209 Aluminum Alloy 6061--T6.
- (f) Rivets shall conform to ASTM B 316 Aluminum Alloy 6061-T6 or ASTM B 221 Aluminum Alloy 6061-T6.

12. Welded Stud Shear Connectors and Welded Studs: Stud shear connectors shall be of a design suitable for electrically end-welding to steel with automatically timed stud welding equipment. The studs shall be of the sizes and dimensions noted on the plans. Flux for welding shall be furnished with each stud, either attached to the end of the stud or combined with the arc shield for automatic application in the welding operation. Each stud shall be furnished with a disposable ferrule of sufficient strength to remain intact during the welding operation and not crumble or break; it shall not be detrimental to the weld or create excessive slag.

Stud shear connectors shall conform to the requirements of ASTM A 108, cold-drawn bar, Grades 1015, 1018 or 1020, either semi- or fully-killed. If flux-retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall comply with ASTM A 109.

Tensile properties as determined by tests of bar stock after drawing or of finished studs shall conform to the following requirements:

Tensile strength (min.)	60,000 psi (415 megapascals)
Yield strength (min.) *	50,000 psi (345 megapascals)
Elongation (min.)	20% in 2 inches (50 millimeters)
Reduction of area (min.)	50%

* as determined by the 0.2% offset method

Tensile properties shall be determined in accordance with the applicable sections of ASTM A 370.

Finished studs shall be of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends or other injurious defects. Finish shall be as produced by cold-drawing, cold-rolling or machining.

Studs shall be tested for weldability in accordance with the requirements of the ANSI/AASHTO/AWS D1.5 Bridge Welding Code. Certified copies of in-plant control test reports shall be furnished to the Engineer upon request.

13. Mill and Shop Inspection of Structural Steel:

- (a) **Notice of Beginning of Work:** The Contractor shall give ample notice to the Engineer of the beginning of work at the mill and shop so that inspection may be provided. The term "mill" means any rolling mill, foundry or fabricating plant where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the Engineer has been so notified.
- (b) **Facilities for Inspection:** The Contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and inspectors shall be allowed free access to the necessary parts of the premises.
- (c) **Inspector's Authority:** The inspector shall have the authority to reject the materials or work which do not meet the requirements of these specifications. In case of dispute, the Contractor may appeal to the Engineer whose decision shall be final.
- (d) **Mill Orders:** The Contractor shall furnish the Engineer with as many copies of mill orders as the Engineer may direct.
- (e) **Facilities for Testing:** The contractor shall furnish without charge test specimens as specified herein, and all labor, testing machines and tools necessary to prepare the specimens and to make the full sized tests.
- (f) **Rejections:** The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection if found defective. Rejected material and workmanship shall be replaced promptly or satisfactorily corrected by the Contractor.
- (g) **Marking and Shipping:** Each member shall be painted or marked with an erection mark for identification, and an erection diagram shall be furnished with erection marks shown thereon.

The Contractor shall furnish to the Engineer as many copies of material orders, shipping statements and erection diagrams as the Engineer may direct. The mass of the individual members shall be shown on the statements. Members having a weight (mass) of more than 3 tons (2700 kilograms) shall have the weight (mass) marked thereon. Structural members shall be loaded on trucks or cars in such manner that they may be transported and unloaded at their destination without being deformed, excessively stressed or otherwise damaged.

Bolts and rivets of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts and small packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels; but the gross weight (mass) of any package shall not exceed 300 pounds (135 kilograms). A list and description of the contained material shall be plainly marked on the outside of each shipping container.

M.06.03--Galvanizing: Unless otherwise specified on the plans or in the special provisions, the zinc coating on all iron and steel materials, other than wire, shall meet the requirements of ASTM A 123/A 123M, or A 153/A 153M, whichever shall apply.

When mechanical galvanizing is used it shall meet the requirements of ASTM B 695 Class 50.

M.06.04--Filler Metal for Welding: Unless otherwise shown on the plans or as indicated in the special provisions, fill metal for welding shall conform to the requirements of AWS.

The fabricator shall note on the shop plans the electrode classification number and other identification references for the electrodes and flux he proposes to use.

**SECTION M.07
PAINT**

- M.07.01—General for All Paints and Enamels**
- M.07.02—Coating Systems for Structural Steel**
- M.07.03—Vacant**
- M.07.04—Vacant**
- M.07.05—Vacant**
- M.07.06—Vacant**
- M.07.07—Black Paint**
- M.07.08—White Undercoat for Semigloss White Enamels**
- M.07.09—Semigloss White Enamel**
- M.07.10—Vacant**
- M.07.11—Vacant**
- M.07.12—Aluminum Finish Coat - Bridge Color Number 17178**
- M.07.13—Vacant**
- M.07.14—Vacant**
- M.07.15—Vinyl Wash Pretreatment**
- M.07.16—Vacant**
- M.07.17—Zinc Silicate Primer**
- M.07.18—Vacant**
- M.07.19—Vacant**
- M.07.20—Waterborne Pavement Marking Paint**
- M.07.21—Hot-Applied Waterborne Pavement Marking Paint**
- M.07.22—Epoxy Resin Pavement Markings**
- M.07.23—Vacant**
- M.07.24—Preformed Black Line Mask Pavement Marking Tape**
- M.07.25—Black Epoxy Resin Pavement Markings**
- M.07.30—Glass Beads**

M.07.01—General for All Paints and Enamels:

1. **Paints and enamels** shall consist of pigments of the required fineness and composition, ground in the required vehicle by a suitable grinding machine to the required fineness. All pigments, resins, oils, thinners and driers used shall be of the best quality, free from adulterants of any kind and shall comply with the specific requirements of the specifications. Materials not definitely covered by specifications shall be of the best quality used for the purpose in good commercial practice.

2. **Proportions:** All proportions as specified in formulas are by mass unless otherwise specified.

3. **Fineness:** All pigments, except aluminum, unless otherwise specified, shall be so finely ground that 100% shall pass through a No. 200 (75- μ m) sieve; and not less than 97 % shall pass through a No. 325 (45- μ m) sieve.

4. **Curdling, Livering, Leveling:** No paint or enamel shall liver or curdle, and the pigment shall remain in suspension in a satisfactory manner. The enamel type paints shall level properly and not show brush marks.

5. **Colors:** All paints and enamels shall be matched to the Department's standard shades. Color chips may be obtained at the Laboratory.

6. **Time of Drying:** All paints or enamels, unless otherwise specified, shall dry to the full gloss in not more than 18 hours.

7. **Weight (Mass) per Gallon (Liter):** The weight (mass) per gallon (liter) of all paints and enamels shall be determined at 77°F (25°C).

8. **Shipping:** All paints and enamels shall be shipped in strong metal containers, plainly marked with the name, net weight (mass) and volume of paint or enamel content. The manufacturer's name, address, date and lot number shall be stenciled on every package.

9. **Samples, Sampling, and Testing:** When so requested, samples and certified analysis of all pigments, oils, resins, thinners, driers or paint furnished shall be supplied by the manufacturer within 10 days after request is made therefor.

Sampling and testing will be in accordance with ASTM, Federal Supply Service, or by methods on file in the Laboratory of the Department.

The following tests on the paints will follow the procedures outlined in Federal Test Method Standard No. 141: Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing.:

Tests	Methods
Percentage of pigment	4021
Isolation of vehicle	4032
Nonvolatile in vehicle	4041
Phthalic anhydride	7021
Weight per Gallon (Mass per liter)	4184
Uncombined water	4081
Coarse particles and skins	4092
Viscosity: Krebs-Stormer	4281
Drying time	4061
Condition in container	3011
Fineness of Grind	4411
Skinning (48 hours)	4141
Brushing properties	2141,4321
Spraying properties	2131,4331

M.07.02—Coating Systems for Structural Steel: The coating system to be used shall be selected from the Product Reference List of the latest Product Use Status Lists for ConnDOT Projects. Coating materials on this list are pre-qualified by meeting the NEPCOAT Specification Criteria for Protective Coatings.

Color: The color of the topcoat shall be as noted on the plans (FS 595 Color Number).

Packaging and Labeling of Coating Material: The container shall be designed to store the specific coating material. Each container of coating materials shall bear a label that clearly shows the name of the coating manufacturer, the name of the product, the lot and batch numbers, the date of manufacture and the shelf life expiration date. The label shall also include complete specific instructions for opening the container and for mixing, thinning, and applying the coating material contained therein. If the coating material cannot be positively identified from the label on the container, it shall not be used.

Delivery: Coating material shall be furnished in the manufacturer's original sealed and undamaged container.

Control of Materials: For each coating material, a Certified Test Report and a Materials Certificate shall be submitted in conformance with Article 1.06.07. The Certified Test Report shall contain the data required in NEPCOAT Specification Criteria for Protective Coatings, Section VII, Groups I and II.

M.07.03—Vacant

M.07.04—Vacant

M.07.05—Vacant

M.07.06—Vacant

M.07.07—Black Paint: Black paint shall be a refined tar product. It shall be homogeneous and shall dry hard in 5 hours, under normal weather conditions, with a jet black color.

It shall conform to the following requirements:

	Min.	Max.
Water Content, %	—	0.5
Engler Viscosity at 40°C.	5	8
	Min.	Max.
Free Carbon Insoluble in CS ₂ % Distillation:	—	12
0—170°C, %	8	20
0—235°C, %	15	35
0—270°C, %	—	41
0—300°C, %	—	46
Softening Point of Distillation Residue (R&B), °C	55	70

M.07.08—White Undercoat for Semigloss White Enamels: This white undercoat for semi-gloss white enamel shall meet the requirements of FS TT-P-659 for primer-surfacer, synthetic tints, and white for metal

and wood surface.

M.07.09—Semigloss White Enamel:

1—Enamel Composition:

	Min.	Max.
Pigment, %	37	—
Vehicle, %	—	63
Volatile matter in vehicle, %	—	55
Coarse particles retained on No. 325 (45 µm) screen based on pigment, %	—	0.5
Viscosity, Krebs Units at 77°F (25°C).	65	75
Weight per Gallon, pound	1.2	—
Mass per Liter, kilogram	10	
Fineness of grind (North Standard)	5	—

2—Pigment Composition:

	Min.	Max.
Titanium Dioxide, %	60	—
Zinc Oxide (lead free), %	—	7
Extender Pigments, %	—	33

The titanium-dioxide shall meet FS TT-P-442, Type 3.

The lead-free zinc oxide shall meet FS TT-P-00463 French process.

The extender pigments shall consist of any one of the following or combination thereof: magnesium silicate, barium sulfate or diatomaceous silica. A ratio of 50% magnesium silicate and 50% diatomaceous silica has been found to be satisfactory in order to produce the desired semi-gloss appearance.

3. Vehicle: The vehicle shall contain not less than 45% solids by weight (mass) and shall be composed of a long oil soya-modified alkyd resin solution or solutions, petroleum solvent thinners and driers. Rosin or rosin derivatives shall not be present. The alkyd resin solution or solutions shall conform to the FS TT-R-266, Type 1, Class A.

4. Specular Gloss: The enamel shall be flowed on a tin panel and allowed to dry for 24 hours before measuring. The specular gloss at 60 degree angle of incident, ASTM D 523 shall be between 35 and 45.

5. Setting and Drying Time: This enamel shall set to touch in less than 5 hours. It shall dry hard and tough in not more than 24 hours.

6. Flash Point: The flash point shall not be below 86°F (30°C) when determined by the Pensky-Martin closed flash tester.

7. Water Resistance: The enamel shall be flowed on a tin panel and allowed to dry for 48 hours. After being immersed for 18 hours in distilled water, it shall show no blistering or wrinkles upon removal and shall show no dulling or change in color after two hours' recovery.

8. Skinning: This enamel shall not skin over within 48 hours in a three-quarters filled closed container. Small amounts of anti-skinning agents, wetting agents, suspension agents and anti-drier absorption agents may be added at the discretion of the manufacturer.

9. Working Properties: The enamel shall be well ground, shall not settle in the container, shall be capable of being broken up with a paddle to a smooth, uniform enamel of good brushing consistency and shall have good flowing, covering and leveling properties.

M.07.10—Vacant

M.07.11—Vacant

M.07.12—Aluminum Finish Coat—Bridge Color Number 17178: This ready-mixed aluminum paint

shall be applied over the second field coat and shall conform to the following requirements:

Pigment: The leafing aluminum pigment shall consist entirely of finely divided, polished aluminum flakes in paste form, and shall meet the minimum requirements for coarse particles and leafing of FS TT-P-320, Type II, Class B, latest revisions. The leafing aluminum paste shall be mixed with the vehicle on the basis of 2 pounds (0.24 kilograms) of paste to 1 gallon (1 liter) of vehicle.

Vehicle: The vehicle shall consist of a long oil alkyd resin varnish suitable for making a ready-mixed aluminum paint. The resin shall conform to the type described in FS TT-R-226, Type I, Class A. The vehicle shall be formulated as follows:

Long oil alkyd resin solution
conforming to FS TT-R-266,

Type I, Class A	100 pounds (12.5 gallons)	(45 kilograms (47 Liters))
Mineral Spirits	40 pounds (6.0 gallons)	(18 kilograms (22.5 Liters))

After accurately determining the acid number of the vehicle, and before adding driers, 113 grams of Alcoa Stabilizer No. 5 per acid number per 100 pounds (45 kilograms) of vehicle solids shall be added. Example: For a vehicle with an acid number of 7 on nonvolatile basis, add 28 ounces (790 grams) of Stabilizer for every 100 pounds (45 kilograms) of vehicle solids.

The vehicle, with Stabilizer added, shall stand for at least 18 hours before mixing with the aluminum paste pigment.

Driers shall not be added until after mixing the stabilized vehicle with the aluminum paste pigment. At that time cobalt naphthenate, manganese naphthenate and zirconium octoate shall be added using 0.5% cobalt, 0.03% manganese and 0.3% zirconium, based on vehicle solids.

The finished vehicle shall meet the following requirements:

- (1) It shall be clear and transparent. (4261)*
- (2) The viscosity shall be between 0.85 and 1.25 poises (5 0.085 and 0.125 pascal-seconds) corresponding to tubes C to E of the Gardner Bubble Viscometer. (4271)
- (3) It shall contain not less than 48% by weight (mass) of nonvolatile matter. (4041)
- (4) It shall contain not less than 23% phthalic anhydride (quantitative) based on nonvolatile content. (7021)
- (5) The moisture content shall not exceed 0.1% (4081)
- (6) There shall be no skinning after 48 hours in a half-filled, tightly closed container. (4141)
- (7) A flow-out film of the vehicle (with drier added for test purposes) on a 28-gage tin plate panel, air-dried for 48 hours, shall withstand immersion in water at 75°F ± 5° (24°C ± 3°C) for 24 hours without showing whitening, dulling, checking, or other serious defect 2 hours after removal. (Paragraph 4.47 of TT-R-266).

Mixed Paint:

(1) **Composition**—The paint shall show the following composition by mass:

	Min. %	Max. %
Paint nonvolatile (4041)	53.0	—
Pigment (aluminum pigment, non-volatile)	13.0	—
Total impurities (mica, filler, or other adulterants)	None	
Coarse pigment particles on No. 325 (45-µm) mesh screen (paint basis)	—	0.2
Vehicle		84.0
Nonvolatile matter	44.0	—
Volatile thinner	—	56.0

(2) **Weight (Mass) per Gallon (Liter)**—8 pounds min. (1.0 kilograms min.) (4184)

(3) **Working properties**—The paint, as received, shall show only slight settling, and the pigment shall be readily dispersed by moderate stirring. The resulting paint shall be smooth and uniform in appearance,

free from skins or coarse particles and suitable for application by brush or spray.

(4) **Leafing**—The paint, when flowed on a clean glass panel, supported at an angle of 45, and then allowed to dry, protected from all drafts, for 24 hours at 75°F ± 5°F (24°C ± 3°C), shall produce a film comparable in smoothness, color, luster and opacity to that of a similar film applied at the same time and in the same manner, using a standard comparison paint. The comparison standard shall be prepared by freshly mixing 5 ounces (142 grams) of aluminum paste meeting FS TT-P-320, Type II, Class B, with 0.5 liter of long oil alkyd varnish, conforming to the vehicle described in M.07.12.

(5) **Stability**—Sample of the paint under test, set aside in full, tightly closed container for 30 days at 75°F ± 5° (24°C ± 3° C), shall also pass the test for leafing, given in Paragraph (4).

(6) **Moisture Content**—The paint shall contain not more than 0.1% water as received. (4081). The paint container described in paragraph (5) shall show no gas pressure after 30 days storage at 75°F ± 5° (24°C ± 3°C).

(7) **Drying Time:**

Set-to-touch	1 hour max.
Handling	12 hours max.

(8) **Viscosity**—The viscosity of the paint as received shall be between 40 and 55 seconds as determined by a No. 4 Ford Cup. (4282).

*Unless otherwise noted, all numbers in parenthesis refer to sections in Federal Test Method Standard No. 141.

M.07.13—Vacant

M.07.14—Vacant

M.07.15—Vinyl Wash Pretreatment: This pretreatment shall be a two-component paint mixture conforming to the requirements of DOD-P-15328 PRIMER (WASH) PRETREATMENT prepared in accordance with the manufacturer's printed instruction.

The addition of a suspending agent to the wash pretreatment may be permitted subject to the approval by the Engineer as to the type and quantity of agent requested.

M.07.16—Vacant

M.07.17—Zinc Silicate Primer: The zinc silicate primer shall be a self-cure, two-component, ethyl silicate vehicle type, zinc silicate paint, which, when properly mixed and applied, cures without use of a separate curing solution.

It shall conform to the following requirements:

1. Properties of Pigment Component: The zinc portion of the pigment component shall be a finely divided zinc powder containing, by mass, a minimum of 94% metallic zinc and a minimum of 98% total zinc using Federal Test Standard No. 141, Method 7221. All other materials contained in the pigment component shall be inert. The pigment component shall also conform to the following requirements:

	Min.	Max.
Specific gravity of zinc powder (ASTM D 153)	7.0	7.15
Average particle size in micrometers (as determined by the Fisher Sub-Sieve Sizer)	—	9.5

2. Properties of Vehicle Components: The vehicle shall consist primarily of a partially hydrolyzed ethyl silicate in an appropriate alcohol solvent and shall have the following properties:

	Min.	Max.
Matter non-volatile at 105°C, percent by weight (mass)	39	43
Silicon Dioxide, percent by weight (mass) of vehicle (without pigments)	9.0	12
Weight (Mass) per gallon, pounds at 77°F (liter, kilogram at 25°C)	1.0	—
Storage life of vehicle at 77°F (25°C), months	12	—

3. Properties of Mixed Paint:

	Min.	Max.
Weight per gallon at 77°F, pounds	17.0	-
(Mass per liter at (25°C, kilograms))	(2.0)	-

The total zinc portion shall be at least 79% by weight (mass) of the total solids of the dried coating.

The total solids, when heated at 105°C for one-half hour shall be not less than 72% by weight (mass).

The total solids by volume shall be not less than 65%.

The paint shall tolerate up to 1% water contamination by weight (mass) without gelation.

The usable pot life of the mixed paint shall be not less than 8 hours at 77°F (25°C) There shall be no hard settling which cannot be easily re-dispersed during this period.

Working properties shall be satisfactory at all temperatures and conditions under which the paint is applied to produce a satisfactory sprayable coating.

The mixing paint shall be so formulated as to produce a distinct contrast in color with the blast cleaned metal surfaces and any top coat.

4. Resistance Tests: Test panels of steel meeting the requirements of ASTM D 609 having dimensions of 2 x 5 inches x 1/8 inch (50 millimeter x 127 millimeters x 3.2 millimeters), shall be blast cleaned in accordance with SSPC-SP 10 "Near-White Blast Cleaning." A 3-mil (75-micron) coating (dry thickness) shall then be applied to the test panels in accordance with the manufacturer's current printed instructions. The coating shall be cured as recommended by the manufacturer. Each of the following tests shall be performed on one or more test panels. The materials will not be accepted if any individual test panel fails any of the following tests:

- Fresh Water Resistance. Panels shall be scribed down to base metal with an X of at least 2-inch (50-millimeter) legs and shall be immersed in fresh tap water at 75°F ± 5°F (24°C ± 3°C). The panels shall show no rusting, blistering, or softening when examined after 30 days.
- Salt Water Resistance. Panels shall be scribed down to base metal with an X of at least 2-inch (50-millimeter) legs and immersed in 5% sodium chloride at 75°F ± 5°F (24°C ± 3°C). The panels shall show no rusting, blistering, or softening upon examination after 7, 14 and 30 days. The sodium chloride solution shall be replaced with fresh solution after each examination.
- Weathering Resistance. Panels shall be tested in accordance with ASTM G 23, Type D. The panels shall be placed on test at the beginning of the wet cycle. After 1,000 hours continuous exposure, the coating shall show no rusting, loss of adhesion to the steel test panel, or blistering.
- Salt Fog Resistance. The test panels will be scribed in an X pattern of at least 2-inch (50-millimeter) legs, to the steel substrate and shall be tested in accordance with ASTM B117. After 3,000 hours of continuous exposure, the coating shall exhibit no loss of bond, rust creepage or blistering at the scribe beyond 1/16 inch (1.6 mm) and no more than 2% rust at the edges.
- Resistance to Elevated Temperature and Thermal Shock. Panels shall be exposed to a temperature of 500°F (260° C) for one hour, then quenched immediately in 65°F ± 5° (18°C ± 3°C) water. Panels subjected to this test shall show no blistering or flaking of the coating.

5. Application: 3-mil (75-micron) (dry thickness). The coating shall be capable of being applied in accordance with Specification requirements. All application shall be done in accordance with the manufacturer's latest printed instructions. Procedures shall also conform to the following requirements:

After initial mixing, the paint shall be strained through a metal 30 to 60 (600-µm to 300-µm) mesh screen.

Up to 1 pint (0.5 liter) of thinner per gallon (4 liters) may be added to the paint. The type of thinner shall be that approved by the manufacturer of the paint.

Stirring paddles on mechanical mixers shall reach to within 1 inch (25 millimeters) of the bottom of the stirring container during mechanical mixing.

Airless spray equipment for application of inorganic zinc silicate paint shall provide pressure of about 2200 psi (15 megapascals) at the nozzle. Fluid hose between pot and nozzle shall not be less than 3/8 inch (9.5 millimeters) inside diameter. Pressure may vary depending on tip size and pump.

Conventional spray equipment for application of inorganic zinc silicate paint shall provide pressure of not less than 10 psi (70 kilopascals) at the pot and 30 psi (210 kilopascals) at the nozzle. Fluid hose between pot and nozzle shall not be less than 1/2-inch (12.5-millimeter) inside diameter. The inorganic zinc primer coat shall not be applied when the surrounding air temperature is below 40°F (4°C).

6. Packaging and Labeling: The two components shall be packaged, in two separate containers, so

that one unit of the pigment shall be mixed with one unit of the vehicle in making the paint. The lining of the vehicle container shall be of a type that will prevent attack of the container.

Each container shall bear a label clearly showing the name of manufacturer, brand name of paint, lot number, date of manufacture, net weight (mass) of contents and complete instructions and precautions for use. The instructions and precautions need only appear on the vehicle component container. The labels shall also state that containers of unused material must be kept tightly sealed, and the paint must be used within 12 hours from the time it was mixed when the temperature does not exceed 90°F (32°C). All mixed paint not used within this time shall be wasted.

7. Control of Materials: A Certified Test Report and a Materials Certificate will be required in accordance with Article 1.06.07. The Certified Test Report shall specifically include the pigment composition, the vehicle composition, the pigment properties previously stated, the vehicle properties previously stated, including the initial viscosity at 77°F (25°C) and the viscosity after 72 hours at 140°F (60°C), and the PH of the vehicle. The test viscosities listed shall be Brookfield viscosity, Model RVT, No. 1 spindle at 50 rpm pascal-seconds

The mixed paint properties shall include: (a) the exact ratio, by mass, of the pigment component, (b) weight per gallon at 77°F, pounds (mass per liter at 25°C, kilograms,) (c) viscosity, KU @ 77°F (25°C), (d) Viscosity, KU @ 77°F (25°C), after 24 hours, (e) Non-Volatile @ 105°C, percent by mass, (f) Dry Time @ 77°F (25°C), and 50% relative humidity, 6-mil (150-micron) doctor blade clearance: (1) Set to touch, hours and (2) Dry Hard, hours, (g) Pencil Hardness when applied to plate glass panel with a 6-mil (150-micron) gap doctor blade and cured for 15 days at a relative humidity of 90-100%, (greater than H, 2H, etc.)

M.07.18—Vacant

M.07.19—Vacant

M.07.20—Waterborne Pavement Marking Paint: This is for white and yellow waterborne pavement marking paint that is to be applied to bituminous concrete and Portland cement concrete pavements. This paint shall be capable of being applied with paint striping equipment that does not require heating above ambient temperatures. All requirements shall be as specified in Article M.07.21, except as follows:

1. Total nonvolatile shall not be less than 70% by weight (mass);
2. Pigment shall be 45-55% by weight (mass);
3. Weight per gallon (Mass per liter) shall not be less than 12.5 pounds/gallon (1.50 kilograms/liter) when tested in accordance with ASTM D 1475;
4. Drying time to no pick up shall be 15 minutes or less when tested in accordance with ASTM D 711.

M.07.21—Hot-Applied Waterborne Pavement Marking Paint: This is for white and yellow fast-drying waterborne pavement marking paint to be applied to bituminous concrete and Portland cement concrete pavements. This paint shall be capable of being applied with paint striping equipment at an application temperature of 130°F to 145°F (54°C to 63°C).

General: Specifications and publications that apply are as follows:

FS: TT-P-1952D Paint, Traffic and
Air Field Marking, Water Emulsion Base; Federal Test-
Method Standard #141 Paint, Varnish, Lacquer and Related
Materials, Methods of Inspection, Sampling and Testing;
FS No. 595 Colors; and HH-R-590 Roofing
Felt (Asbestos, Asphalt-saturated).

ASTM Standards: D 211-Specifications for Chrome Yellow and Chrome Orange; D 476-Specifications for Titanium Dioxide Pigments; D 562 Test for Consistency of Paints Using the Stormer Viscometer; D 869-Test for 45-deg, 0-deg Directional Reflectance Factor of Opaque Specimens by Broad Band Filter Reflectometry.

Detailed Requirements, Formulation and Manufacture: The paint shall be formulated and manufactured from first-grade raw materials and shall be free from defects and imperfections that might adversely affect the serviceability of the finished product. The materials shall not exhibit settling or jelling after storage in the sealed containers as received that will affect the performance of the products. The paint shall provide the proper anchorage, refraction and reflection for the finished glass spheres when applied as specified.

Composition: The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of any applicable Federal, State or Local regulations for

products of this type and the requirements as follows:

1. Paint shall not contain more than 0.06% lead;
2. Total nonvolatile shall not be less than 76% by weight (mass);
3. Pigment shall be 58-63% by weight (mass);
4. Resin solids shall be composed of 100% acrylic emulsion polymer;
5. Volatile organic compounds shall not exceed 150 grams/liter, excluding water;
6. Closed-cup flash point shall not be less than 100°F (38°C), and weight per gallon (mass per liter) shall not be less than 12.5 pounds/gallon(1.50 kilograms/liter) when tested in accordance with ASTM D 1475.

Viscosity: The consistency of the paint shall not be less than 80, nor more than 90 Krieb units when tested in accordance with ASTM D562. The paint shall have good spraying characteristics when the material is heated to application temperature of 130°F to 145°F (54-63°C).

Flexibility: The paint shall not show cracking or flaking when subjected to the TT-P-1952D flexibility test in which the panels used shall be tin plates that are 3 inches x 5 inches (76 millimeters x 127 millimeters) in area and 35 - 31 U.S. Gauge in thickness. The tin panels shall be lightly buffed with steel wool and thoroughly cleaned with solvent before being used for tests.

Dry Opacity: Both white and yellow paints shall have a minimum contrast ratio of 0.96. Contrast ratio shall be determined by applying a wet film thickness of 0.005 inches (127 microns) to a standard hiding power chart. After drying, the black and white reflectance values shall be determined using a suitable reflectometer and the contrast ratio determined.

Bleeding: The paints shall have a minimum bleeding ratio of 0.97 when tested in accordance with FS TT-P-1952D. The asphalt-saturated felt shall conform to FS HH-R-590.

Abrasion Resistance: No less than 210 liters of sand shall be required to remove paint film when tested in accordance with TT-P-1952D.

Color: The paint shall not discolor in sunlight and shall maintain colorfastness throughout its life, approximately two years. Color determination shall be made without beads, after a minimum of 24 hours. Color for yellow paint shall be a visual match for 595-13538. If not a visual match, the diffuse day color of the paint shall conform to the CIE Chromaticity coordinate limits as follows:

	$\frac{x}{y}$	$\frac{y}{y}$	$\frac{x}{y}$	$\frac{y}{y}$	$\frac{x}{y}$	$\frac{y}{y}$	$\frac{x}{y}$	$\frac{y}{y}$	Brightness
White	0.305	0.295	0.360	0.360	0.388	0.377	0.280	0.310	84.0 min
Yellow	0.485	0.455	0.506	0.452	0.484	0.428	0.477	0.438	50.0 min

Glass Bead Adhesion: The paint with glass beads conforming to M.07.30, applied at the rate of 6.0 pounds/gallon (0.72 kilograms/liter) of paint, shall require not less than 150 liters of sand to remove paint film and glass beads.

Scrub Resistance: The paint shall pass 300 cycles minimum when tested in accordance with ASTM D2486.

Drying Time: The reflectorized line shall dry to no pick up in 120 seconds or less when applied at the ratio provided for specified glass spheres to paint (the paint at 15+ 1 mil (381 millimeters ± 25 millimeters) wet film thickness equivalent to 100-115 square foot/gallon (2.45-2.82 square meters/liter) and the glass spheres at the equivalent rate of 6.0 pounds/gallon (0.72 kilograms/liter). The paint shall be applied with equipment so as to have the paint at a temperature of 130°F to 145°F (54°C to 63°C) at the spray gun.

M.07.22—Epoxy Resin Pavement Markings:

General Requirements:

Standards: All standards herein are minimum standards.

Identification: Each container must bear a label with the following information thereon: Name and address of manufacturer, production batch number, date of manufacture, shipping point, grade name and/or identification number, type of material, number of gallons, contract number, use intended, directions for application and formula. Improperly labeled samples and deliveries shall be rejected.

Certification: The manufacturer shall furnish a certified test report by an independent testing laboratory prior to the start of work indicating that the material as specified has been tested in accordance with ASTM or ACI testing procedures noted in this specification. The certified test report shall indicate the results of testing for the criteria contained herein.

Additionally, infrared spectrophotometer plots for both components of the test material shall be included by the independent laboratory in the certified test report. The unused material submitted for testing by the independent laboratory (minimum 1 gallon (4 liters) unmixed components) shall be forwarded to the

ConnDOT, Materials Testing Laboratory, 280 West Street, Post Office Box 207, Rocky Hill, Connecticut 06067. This sample shall be labeled as required under Section 1.06.07.

The manufacturer shall furnish certified test reports, in accordance with Section 1.06.07 for each batch delivered for application at the project site.

Detailed Requirements:

- (a) **Epoxy Resin Material:** The material shall be composed of epoxy resins and pigments only.
- (b) **Composition:**

WHITE (percent by weight (mass))	YELLOW (percent by weight (mass))
20% ± 2% Titanium Dioxide (ASTM D 476 Type III)	25% ± 2% Chrome Yellow (ASTM D 211 Type III)
80% ± 2% Epoxy Resins	75% ± 2% Epoxy Resins
- (c) **Color:** The color of the white material shall be no darker or yellower than color chip 17778 of FS No. 595a of the latest issue, when the material is placed in a type EH weatherometer for a period of 500 hours and weathered according to ASTM G 23. Any noticeable discoloration of the epoxy markings, either during or after application to the pavement surface, as determined by the Engineer, will be considered unacceptable. Any discolored areas shall be removed and the markings shall be reapplied in accordance with this specification. The color of the yellow shall be reasonably close to color chip 13538 of the Federal Standard No. 595a of the latest issue.
- (d) **Adhesion Capabilities:** When the adhesion of the material to Portland cement concrete (the concrete shall have a minimum of 300 psi (2070 kilopascals) tensile strength) is tested according to ACI 503R testing procedure, the failure of the system must take place in the concrete. The concrete shall be 90°F (32°C) when the material is applied, after which the material shall be allowed to cure for 72 hours at 73°F ± 3.5°F (23°C ± 2°C).
- (e) **Abrasion Resistance:** When the abrasion resistance of the material is tested according to ASTM C 501 with a CS-17 wheel under a load of 1000 grams for 1000 cycles, the wear index shall be no greater than 82. (The wear index is the weight (mass) in milligrams that is abraded from the sample under the test conditions).
- (f) **Hardness:** The Type D Durometer hardness of the material shall be not less than 75 nor more than 90 when tested according to ASTM D2240 after the material has cured for 72 hours at 73°F ± 3.5°F (23°C ± 2°C).
- (g) **Tensile Strength:** The tensile strength of the material, when tested according to ASTM D 638, shall not be less than 6,000 psi (41 370 kilopascals) after 72 hours cure at 73°F ± 3.5°F (23°C ± 2°C).
- (h) **Compressive Strength:** The compressive strength of the material, when tested according to ASTM D 695, shall not be less than 12,000 psi (82 740 kilopascals) after 72 hours cure at 73°F ± 3.5°F (23°C ± 2°C).
- (i) **Shelf Life:** The individual components shall not require mixing prior to use when stored for a period of 12 months.
- (j) **Glass Beads:** General Requirements – The beads shall be transparent, clean, colorless glass, smooth and spherically shaped, free of milkiness, pits, or excessive air bubbles and conform to the following specific requirements:
 - **Quality Assurance Control** – The beads shall be segregated into maximum lots of 2,500 pounds (1125 kilograms) and lot numbers shall be stamped onto each lot. Each lot shall be tested for gradation, rounds and embedment coating.
 - **Gradation** – The glass spheres shall meet the following gradation requirements:

<u>Grading "A"</u>		<u>Grading "B"</u>	
<u>Sieve Size</u>	<u>% Passing</u>	<u>Sieve Size</u>	<u>% Retained</u>
#20 (850 µm)	100	#10 (2.0 mm)	0
#30 (600 µm)	80 – 95	#12 (1.7 mm)	0 – 5
#50 (300 µm)	9 – 42	#14 (1.4 mm)	5 – 20
#80 (180 µm)	0 – 10	#16 (1.18 mm)	40 – 80
		#18 (1.0 mm)	10 – 40
		#20 (850 µm)	0 – 5
		Pan	0 – 2

- **Roundness** – The glass beads shall have a minimum of 80% rounds per screen for two highest sieve quantities and no more than 3% angular particles per screen for Grading “B”. The remaining sieve fractions shall typically be no less than 75% rounds.
- **Refractive Index** – The glass beads shall have a refractive index of 1.50 to 1.52.

M.07.23—Vacant

M.07.24—Preformed Black Line Mask Pavement Marking Tape:

General Requirements: The preformed, patterned black line mask pavement marking tape shall consist of a matte black, non-reflective tape in widths or sizes sufficiently large to mask the existing markings which are to be temporarily covered.

The patterned masking tape shall be pre-coated with a pressure sensitive adhesive and shall be capable of being adhered to existing markings, on bituminous concrete pavement or Portland cement concrete in accordance with the manufacturer's instructions without the use of heat, solvents or other additional adhesives, and shall be immediately ready for traffic use after application. The Contractor shall identify equipment necessary for proper application and removal, and make recommendations for application that will assure effective product performance.

The preformed, patterned black line masking pavement marking tape shall be suitable for use for one year after the date of receipt when stored in accordance with the manufacturer's recommendations.

Detailed Requirements:

- (a) **Composition:** The non-reflective, patterned black line mask pavement marking tape shall not contain metallic foil and shall consist of a mixture of high quality polymeric materials, pigments and inorganic fillers distributed throughout its base cross-sectional area, with a matte black non-reflective top layer. The patterned surface shall have a minimum of 20% of the surface area raised and coated with non-skid particles. The channels between the raised areas shall be substantially free of particles. The film shall be pre-coated with a pressure sensitive adhesive. A non-metallic medium shall be incorporated to facilitate removal.
- (b) **Skid Resistance:** The surface of the patterned, non-reflective black line mask pavement marking tape shall provide an initial average skid resistance value of 60 BPN when tested in accordance with ASTM E 303.
- (c) **Thickness:** The patterned material, without adhesive, shall have a minimum thickness of 0.065 inch (1.65 millimeters) at the thickest portion of the patterned cross-section and a minimum thickness of 0.02 inch (0.5 millimeters) at the thinnest portion of the cross-section.
- (d) **Adhesion:** The black line mask pavement marking tape shall adhere to the pavement and existing pavement markings under climatic and traffic conditions normally encountered in the construction work zone.
- (e) **Removability:** The black line mask pavement marking tape shall be removable after its intended use, intact or in large pieces, manually, at temperatures above 40°F (4°C) without the use of heat, solvents, grinding or sand or water blasting. The black line mask pavement marking tape shall be totally removed from existing markings that are adequately adhered to the pavement surface, without damage to the underlying markings.

M.07.25—Black Epoxy Resin Pavement Markings:

Identification: Each container shall have a label affixed to it with the following information thereon: name and address of manufacturer, shipping point, grade production batch number, date of manufacture, grade name and/or identification number, type of material, number of liters, contract number, use intended, directions for application, and formula. Improperly labeled samples and deliveries shall be rejected.

Certification: For each batch of black epoxy resin, Certified Test Reports conforming to Article 1.06.07 shall be submitted from an independent testing laboratory and approved by the Engineer, prior to installation on the project.

Detailed Requirements:

- (a) **Epoxy Resin Material:** The material shall be composed of epoxy resins and pigments only.

(b) **Composition:**

<u>Component</u>	<u>Percent by Weight (Mass)</u>
Carbon Black (ASTM D 476 Type III)	7 ± 2
Talc	14 ± 2
Epoxy Resins	79 ± 4

- (c) **Black Aggregate:** The moisture resistant aggregate shall meet the gradation requirements as follows:

<u>Sieve Size</u>	<u>Percent Retained</u>
#20 (850 μm)	23 - 38
#50 (300 μm)	58 - 74
#270 (53 μm)	1 - 6
Pan	0 - 0.5

The moisture resistant aggregate shall have a urethane coating. The aggregate shall be angular with no dry dispensement pigment allowed.

- (d) **Adhesion:** The black epoxy resin pavement marking material shall be formulated so as to adhere to the pavement and existing pavement markings under climatic and traffic conditions normally encountered in the construction work zone.
- (e) **Abrasion Resistance:** When the abrasion resistance of the material is tested according to ASTM D 4060 with a CS-17 wheel under a load of 1000 grams for 1000 cycles, the wear index shall be no greater than 82.
- (f) **Hardness:** The Type D Durometer hardness of the material shall not be less than 75 nor more than 90 when tested according to ASTM D 2240 after the material has cured for 72 hours at $73.5^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 2^{\circ}\text{C}$).
- (g) **Compressive Strength:** The compressive strength of the material, when tested according to ASTM D 695, shall not be less than 12,000 psi (82 740 kilopascals) after 72 hours cured at $73.5^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 2^{\circ}\text{C}$).
- M.07.30—Glass Beads:** The glass beads shall conform to the requirements of AASHTO M 247, Type 1.

**SECTION M.08
DRAINAGE**

M.08.01—Pipe

M.08.02—Catch Basins, Manholes and Drop Inlets

M.08.03—Aggregates for Underdrains

M.08.01—Pipe: The pipe for this work shall conform to the following requirements:

1. Cast Iron Pipe: This pipe shall conform to the requirements of AASHTO M 64 for Extra-Heavy Cast Iron Culvert Pipe.

2. Coated Corrugated Metal Pipe and Coated Corrugated Metal Pipe Elbows: This pipe shall conform to the requirements of AASHTO M 36, Type 1, Type IR or AASHTO M245, Type 1. For either specification, the Contractor shall submit manufacturer's and/or fabricator's certified test reports and material certifications, in accordance with Section 1.06.07. AASHTO M 36, Type 1 & IR includes pipe fabricated from zinc-coated steel sheet coated with bituminous material and aluminum-coated (Type 2) steel sheet. AASHTO M 245, Type 1 is for pipe fabricated from metallic-coated and polymer-pre-coated steel sheet.

The corrugation size and sheet thickness shall conform to the following:

<u>Nominal Inside Diameter (inches)</u>		<u>Specified Sheet Thickness (inches)</u>
6	1 1/2" X 1/4"	.052
8	Corrugations	.064
10		.064, .079
12		.064, .079
15		.064, .079, .109
18		.064, .079, .109
21	2 2/3" X 1/2"	.064, .079, .109
24	Corrugations	.079, .109, .138
30		.079, .109, .138, .168
36		.079, .109, .138, .168
42		.109, .138, .168
48		.109, .138, .168
54		.064, .079, .109
60		.064, .079, .109
66	3" X 1"	.079, .109, .138
72	or	.079, .109, .138
78	5" X 1"	.109, .138, .168
84	Corrugations	.109, .138, .168
90		.109, .138, .168
96		.109, .138, .168

		<u>Steel</u>	<u>Aluminum</u>
18		.064, .079	.060, .075
24		.064, .079	.060, .075
30		.064, .079	.060, .075
36		.064, .079	.075, .105
42		.079, .109	.105, .135
48	Helical Rib	.079, .109	.105, .135
54	3/4" X 3/4" X 7 1/2"	.079, .109	.105, .135
60		.109	.135
66		.109	.135
72		.109	.135
78		.109	.135
84		.109	.135

Nominal Inside Diameter (mm)		Specified Sheet	
		Thickness (mm)	
150	38 X 6.5 mm Corrugations	1.32	
200		1.63	
250		1.63, 2.01	
300	68 X 13 mm Corrugations	1.63, 2.01	
375		1.63, 2.01, 2.77	
450		1.63, 2.01, 2.77	
525		1.63, 2.01, 2.77	
600		2.01, 2.77, 3.51	
750		2.01, 2.77, 3.51, 4.27	
900		2.01, 2.77, 3.51, 4.27	
1050		2.77, 3.51, 4.27	
1200		2.77, 3.51, 4.27	
1350		75 X 25 mm or 125 X 25 mm Corrugations	1.63, 2.01, 2.77
1500	2.01, 2.77, 3.51		
1800	2.01, 2.77, 3.51		
2100	2.77, 3.51, 4.27		
2250	2.77, 3.51, 4.27		
2400	2.77, 3.51, 4.27		
		<u>Steel</u>	<u>Aluminum</u>
450	9 X 19 X 190 mm Helical Rib	1.63, 2.01	1.52, 1.91
600		1.63, 2.01	1.52, 1.91
750		1.63, 2.01	1.52, 1.91
900		1.63, 2.01	1.91, 2.67
1050		2.01, 2.77	2.67, 3.43
1200		2.01, 2.77	2.67, 3.43
1350		2.01, 2.77	2.67, 3.43
1500		2.77	3.43
1650		2.77	3.43
1800		2.77	3.43
1950		2.77	3.43
2100	2.77	3.43	

Aluminum pipe sheet thickness shall be .004 inch (100 microns) less than specified above for 1 1/2-inch x 1/4-inch, 2 2/3-inch x 1/2-inch and 3-inch x 1-inch (38-millimeter x 6.5-millimeter, 68-millimeter x 13-millimeter, and 75-millimeter x 25-millimeter) corrugations. Helical Rib shall be as specified above.

Unless otherwise specified, the lightest sheet thickness listed for a specified diameter may be furnished.

The pipe and pipe elbows conforming to the requirements of AASHTO M 36 shall be coated with bituminous material as specified in AASHTO M 190 Type C. Steel Sheet, Aluminum-Coated (Type 2) does not require a coating of bituminous material or paved invert.

The pipe and pipe elbows conforming to the requirements of AASHTO M 245 shall be coated as specified in AASHTO M 246, Type B.

The thicker polymeric coating shall be on the inside of the pipe.

Coupling bands shall conform to the requirements of AASHTO M 36 or M 245, whichever is applicable. All coupling bands shall be coated with material conforming with AASHTO M190 or in conformance with M 246, Type B. Coupling bands for Steel Sheet, Aluminum-Coated (Type 2) pipe do not require a coating of bituminous material.

Only one type of coating will be allowed for any continuously connected run of pipe.

If elongation of the pipe is required, it shall be done by one of the following methods:

- (a) **Shop Strutting:** The pipe shall be elongated by the manufacturer, after fabrication, by reducing the horizontal diameter three percent and increasing the vertical diameter three percent, and held in the elongated shape by means of rod, all in accordance with this specification.

The rods shall be 5/8-inch (16-millimeter) diameter, threaded 7 inches (180 millimeters) at both ends with washers and nuts. The length of the rods shall be the diameter of the pipe plus 8 inches (203 millimeters). The rods shall be placed on the horizontal axis of the pipe on 2-foot (610-millimeter) spacing and located at the halfway point between the circumferential riveting.

A soft wood block 2 inches x 4 inches and 12 inches (50 millimeters X 100 millimeters and 300 millimeters) long shall be placed over the rods at each end to provide contact against the outside of the pipe. The long dimension of the blocks shall be parallel with the horizontal axis of the pipe in order to prevent distortion of the pipe when the nuts are tightened.

The 3% elongation shall be obtained by tightening on rods uniformly from end-to-end of the pipe, obtaining approximately one-quarter of the required elongation each time through the length of the pipe.

The strutting rods shall be left in the pipe until the fill is completed and well compacted, unless for some unusual condition their removal is ordered by the Engineer.

The rods shall be removed by the Contractor by cutting them from the inside of the pipe flush with the sidewalls, and a coating of bituminous material shall be applied to protect the metal of the pipe where it has been exposed.

A tolerance of 1% of the pipe diameter in the elongation will be permitted.

- (b) **Mechanical Elongation:** The manufacturer shall elongate the pipe by increasing the diameter along the vertical axis by approximately 5% with a corresponding decrease along the horizontal axis by mechanical means in which sufficient pressure is applied to the sides of the pipe after fabrication to produce the specified distortion. The elongation shall be maintained by drilling holes in the ends of sections and placing horizontal wires. The wires shall be removed after the pipe sections have been placed, coupling bands installed and backfill placed.

3. Perforated or Plain Coated Metal Pipe for Underdrains or Outlets: This pipe shall conform to the requirements of AASHTO M 36, Type III or AASHTO M 245, Type III. The specifications are further supplemented by the following: For either specification, the Contractor shall submit manufacturer's and/or fabricator's certified test reports and Materials Certificates, in accordance with Section 1.06.07.

- (a) **Perforations:** The minimum diameter of 1/4 inch (6.5 millimeters) for the perforations shall apply after asphalt coating. Pipe to be used for outlets shall not be perforated.
- (b) **Coating:** The pipe conforming to the requirements of AASHTO M 36 shall be coated to the requirements of AASHTO M 190, Type A, except the thickness shall be 0.03 inches (0.75 millimeters) instead of 0.05 inches (1.25 millimeters). Steel Sheet, Aluminum-Coated (Type 2) does not require a coating of bituminous material.

The pipe conforming to the requirements of AASHTO M 245 shall be coated as specified in AASHTO M 246, Type B.

The thicker polymeric coating shall be on the inside of the pipe.

Coupling bands shall conform to the requirements of AASHTO M 36 or M 245, whichever is applicable.

All steel coupling bands shall be coated with material conforming with AASHTO M 190 or in conformance with M 246, Type B. Coupling bands for Steel Sheet, Aluminum-Coated (Type 2) do not require a coating of bituminous material.

Only one type of coating will be allowed for any continuously connected run of pipe.

Sheet thickness shall conform to Subarticle M.08.01-2

4. Coated Corrugated Metal Pipe-Arches: These pipe-arches shall conform to the requirements of AASHTO M 36, Type II, Type IIR or AASHTO M 245, Type II. The corrugation size and sheet thickness shall conform to the following: For either specification, the Contractor shall submit manufacturer's and/or fabricator's certified test reports and materials certificates, in accordance with Section 1.06.07.

<u>Pipe-Arch Size (Inches)</u>	<u>Equivalent Diameter (Inches)</u>	<u>Specified Sheet Thickness (Inches)</u>
17 X 13	15	.064
21 X 15	18	.064
24 X 18	21	.064
28 X 20	24	.079
35 X 24	30	.079
42 X 29	36	.109
49 X 33	42	.109
	2 2/3" X 1/2" Corrugations	

57 X 38	48		.109
64 X 43	54		.138
71 X 47	60		.138
71 X 47	60		.168
66 X 51	60		.079
73 X 55	66	3" X 1"	.079
81 X 59	72	or	.079
87 X 63	78	5" X 1"	.109
95 X 67	84	Corrugations	.109
103 X 71	90		.109
112 X 75	96		.109
20 X 16	18		.064
23 X 19	21		.064
27 X 21	24		.064
33 X 26	30	3/4" X 3/4" X 7 1/2"	.079
40 X 31	36	Helical Rib	.079
46 X 36	42		.109
53 X 41	48		.109
60 X 46	54		.109
66 X 51	60		.109

<u>Pipe-Arch Size (mm)</u>	<u>Equivalent Diameter (mm)</u>		<u>Pipe-Arch Specified Sheet Thickness (mm)</u>
430 X 330	375		1.63
530 X 380	450		1.63
610 X 460	525		1.63
710 X 510	600		2.01
885 X 610	750		2.01
1060 X 740	900	68 X 13 mm	2.77
1240 X 840	1050	Corrugations	2.77
1440 X 970	1200		2.77
1620 X 1100	1350		3.51
1800 X 1200	1500		3.51
1800 X 1200	1500		4.27

1670 X 1300	1500	75 X 25 mm	2.01
1850 X 1400	1650	or	2.01
2050 X 1500	1800	125 X 25 mm	2.77
2200 X 1620	1950	Corrugations	2.77
2400 X 1720	2100		2.77
2600 X 1820	2250		2.77
2840 X 1920	2400		2.77
500 X 410	450		1.63
580 X 490	525		1.63
680 X 540	600		1.63
830 X 670	750	19 X 19 X 190 mm	2.01
1010 X 790	900	Helical Rib	2.01
1160 X 920	1050		2.77
1340 X 1050	1200		2.77
1520 X 1170	1350		2.77
1670 X 1300	1500		2.77

Unless otherwise specified, the lightest sheet thickness listed for a specified diameter may be furnished.

Pipe-arches conforming to the requirements of AASHTO M 36 shall be coated with bituminous material as specified in AASHTO M190, Type C. Steel Sheet, Aluminum-Coated (Type 2) does not require a coating of bituminous material or paved invert.

Pipe-arches conforming to the requirements of AASHTO M 245 shall be coated as specified in AASHTO

M 246, Type B.

The thicker polymeric coating shall be on the inside of the pipe.

Only one type of coating will be allowed for any continuously connected run of pipe-arch.

Coupling bands shall conform to the requirements of AASHTO M 36 or M 245, whichever is applicable. All coupling bands shall be coated with material conforming with AASHTO M190 or in conformance with M 246, Type B. Coupling bands for Steel Sheet, Aluminum-Coated (Type 2) pipe arches do not require a coating of bituminous material.

5. Corrugated Structural Plates and Bolts: These plates and bolts are for use in the construction of metal pipe of the large diameter and for metal plate arches or pipe arches to be assembled in the field, and they shall conform to the requirements of AASHTO M 167 for corrugated metal pipe. For this specification, the Contractor shall submit manufacturer's and/or fabricator's certified test reports and Materials Certificates, in accordance with Section 1.06.07. The plates shall have not less than the minimum gage shown on plans, which shall provide with the corrugations a section modulus not less than that specified.

The dimensions of plates and details of fabrication shall conform to the requirements of the manufacturer. Where the plans call for a heavier gage for the bottom of the pipe than for the remainder of the pipe circumference, the lower fourth of the circumference shall be the minimum width of the heavier gage material.

The coating shall conform to the requirements of AASHTO M 243.

6. Reinforced Concrete Pipe: Unless otherwise specified, this pipe shall conform to the requirements of AASHTO M 170, Class IV, as supplemented and modified by the following:

- (a) **Reinforcement:** In circular pipe, only circular reinforcement will be allowed.
- (b) **Laps and Welds:** The reinforcement shall be lapped not less than 2 inches (51 millimeters) and welded with an electric welding machine.
- (c) **Quality Assurance Testing:** Circular and elliptical reinforced concrete pipe shall be tested by the three-edge bearing method prescribed in AASHTO T 280, except as follows:
 - 1) Modified or special design pipe shall be tested to the 0.01-inch (0.3-millimeter) load and the ultimate load requirements as per AASHTO M 170 and M 207.
 - 2) At the discretion of the Engineer, pipe of standard design, as specified in AASHTO M 170 and M 207, may be tested to the 0.01-inch (0.3-millimeter) requirement plus 10% additional load in lieu of ultimate load testing. Test pipe attaining a 0.01-inch (0.3-millimeter) crack will not be acceptable for use on ConnDOT projects.
 - 3) Cores for absorption and determination of steel reinforcement shall be taken on a random basis as determined by the Engineer. The cores shall be at least 6 inches (150 millimeters) in diameter.
- (d) **Inspection:** The pipe plant, materials, processes of manufacture and the finished pipe shall be subject to inspection and approval by the Department. The pipe manufacturer's records related to component materials, production and shipment of pipe for Department use shall be made available to the Department on request. The equipment and labor necessary for inspection, sampling and testing as required by the Department shall be furnished by the pipe manufacturer. Test equipment shall be calibrated at least once each 12 months, or as directed by the Engineer. The plant cement and aggregate scales shall be inspected and sealed by the approved agency at least once every twelve months.
- (e) **Preliminary Tests and Tests for Extended Deliveries:** As directed by the Engineer, the Department shall select for test from the stock of any manufacturer proposing to supply pipe to the Department, 2 of each size pipe up through 30-inch (750-millimeter) diameter and 1 of each size greater than 30-inch (750-millimeter) diameter. These sample pipes shall be tested under Department supervision by the three-edge bearing method. Absorption tests shall be made on each size, wall thickness, and class of pipe meeting the three-edge bearing load requirements. Frequency for extended deliveries shall be one three-edge bearing test for each 500 pipes shipped to Department projects.

For pipe that fails, it shall be necessary for the manufacturer to either physically isolate the rejected pipe at his plant or to provide some means to clearly indicate the unacceptability of the pipe. Either method shall be performed to the satisfaction of the Engineer. When production is resumed on any size, wall thickness or class previously rejected, preliminary tests shall be required. Moreover, the frequency of tests for extended deliveries shall be one three-edge bearing test for each 200 pipes

shipped to Department projects.

If 95% of all pipe tested at a particular plant from the first of the calendar year to September 30 meet specifications, including both preliminary and extended tests, it will not be necessary to perform the Fall three-edge bearing tests at this plant.

Use of compression tests on representative cylinders or cores to determine the compressive strength of the concrete incorporated into the pipe products will be at the discretion of the Engineer.

- (f) **Shipping:** Pipe shall not be shipped until it is at least 7 days old unless earlier shipment is authorized by the Engineer on the basis of tests.
- (g) **Certification:** Pipe will be accepted by the Department on the basis of manufacturer's certification. The manufacturer shall certify each shipment of pipe on Department Form MAT-073(PC-1), "Certification of Precast Concrete Products." Two (2) copies of this certification shall be furnished with the shipment to the Engineer at the project site.

7. Plain and Perforated Concrete Drain Pipe: The materials entering into the construction of this pipe shall be the same as described hereinbefore under Reinforced Concrete Pipe, except that the pipe shall not be reinforced.

Workmanship, variations in dimensions, marking, curing, shipping, test specimens, and inspection shall be the same as that specified for reinforced concrete pipe described above.

- (a) **Wall Thickness:** The wall thickness of concrete drain pipe shall not be less than 3/4 inch (19 millimeters).
- (b) **Perforations:** The perforations shall be 1/4 inch (6.5 millimeters) clear opening. The number and location of longitudinal rows of perforations shall be as shown on the plans. Unless otherwise specified, the pipe shall be 6 inches (152 millimeters) minimum inside diameter.
- (c) **Absorption Tests:** Absorption testing shall be performed in accordance with the requirements of AASHTO T 280 and M 170.

8. Plain and Perforated Vitrified Clay Pipe: This pipe shall conform to the requirements of AASHTO M 65 for pipe of full circular cross-section as supplemented by the following requirements:

Pipe for use under pavements and shoulders shall be extra-strength pipe. Outside of these areas, standard-strength pipe may be used.

Unless otherwise specified, the pipe shall be 6 inches (152 millimeters) minimum in diameter.

9. Reinforced Concrete Elliptical Pipe: This pipe shall conform to the requirements of AASHTO M 207, Class HE IV and supplemented as follows:

- (a) Manufacturing and testing shall conform to Articles M.08.01-6.

10. Slotted Reinforced Concrete Pipe for Underdrain and Outlets: This pipe shall conform to the requirements of Article M.08.01-6 and shall be slotted in accordance with AASHTO M 175, Type 2 or as shown on the plans.

The pipe for outlets shall not be slotted.

11. Slotted Drain Pipe: The pipe shall be asphalt coated and conform to Subarticle M.08.01-2. Concrete shall conform to Article M.03.01, Class "A" or pavement type. Concrete shall be cured in conformance with M.03.01. The inlet aperture shall be longitudinal on top of the pipe and may be continuous or intermittent. The opening in the pipe wall may be fabricated in the form of continuous bar risers and spacers or of intermittent cut-out segments with structural members supporting a continuous grating as indicated in the plans. End caps shall be as provided by the manufacturer.

Elastomeric polymer sealer shall meet the physical requirements of either FS SS-S-195B or ASTM D 3406 and be accepted on manufacturer's certification.

The pipe shall be helically corrugated with a continuous welded or lock seam. Pipe ends shall have 2 rolled annular corrugations on each end for jointing.

Bar Riser and Spacer Type: Riser assemblies shall be fabricated from structural steel, in accordance with the dimensions on the plans. The riser assemblies shall be hot dipped galvanized according to ASTM A123. The assemblies shall be welded to the corrugated pipe on each side of the riser at the location of the solid web spacers. The riser shall terminate 1 inch (25 millimeters) from the ends of each pipe length to allow clearance for single bolt coupling bands. The ends of the riser shall be closed with a suitable welded plate where solid web spacers do not come to the ends of the riser.

The maximum deviation from straight in both the vertical and horizontal plane of the riser assembly shall not exceed 3/4 inch (19 millimeters) in a 20-foot (6-meter) length.

Continuous Grating Type: The cut-out pipe segments shall provide a 2-inch (50-millimeter) wide slot of maximum length between the lock seams. The slot shall be left intact 1 inch (25 millimeters) on each side

of the lock seam and this material shall be utilized to fasten the reinforcing bar in place.

A bent epoxy coated reinforcing bar shall cross the slotted opening on 6-inch (150-millimeter) centers. The reinforcing bar shall be an ASTM A 615, No. 13 deformed bar epoxy coated with 7 mils of fusion bonded epoxy powder conforming to AASHTO M 284.

Grating shall be furnished unless noted in the contract documents. Grating and all bearing bars, cross bars, and bent connecting bars shall be welding quality, mild carbon steel conforming to ASTM A 569 and to the dimensions shown on the plans.

Tie down bolts shall be J-Type bolts, plated, ASTM A 307 steel supplied with self-locking nuts.

Concrete forms shall be of cellular foam plastic base, fabricated as an integral part of the pipe and reinforcing bar assembly. The form shall be capped with a thick wood or plastic cap resting on top of the foam plastic and reinforcing bar.

The maximum deviation from straight in both the vertical and horizontal plane of the completed assembly shall not exceed 3/4 inch in a 20-foot (19 millimeters in a 6-meter) length. All grating and hardware shall be galvanized in conformance with Article M.06.03. Expansion joint filler shall conform to M.03.01-5(B).

12. Vacant

13. Porous Concrete Pipe for Underdrains and Outlets: This pipe shall conform to the requirements of AASHTO M 176, except that the minimum laying length shall be 2 feet (610 millimeters).

14. Corrugated Aluminum Pipe: This pipe shall conform to the requirements of AASHTO M 196 Type I or Type IR. Sheet thickness shall conform to the requirements of M.08.01-2. For this specification, the Contractor shall submit manufacturer's and/or fabricator's certified test reports and materials certificates, in accordance with Section 1.06.07.

15. Corrugated Aluminum Pipe for Underdrains and Outlets: This pipe shall conform to the requirements of AASHTO M 196 Type III or Type IIIR. Sheet thickness shall conform to the requirements of M.08.01-2.

Pipe for outlets shall not be perforated.

16. Corrugated Aluminum Pipe Arches: These pipe arches shall conform to the requirements of AASHTO M 196 Type II or Type IIR. For this specification, the Contractor shall submit manufacturer's and/or fabricator's certified test reports and materials certificates, in accordance with Section 1.06.07.

Sheet thickness shall conform to the requirements of M.08.01-4.

17. Vacant

18. Cold-Applied Bituminous Sealer: This material, for use in sealing of joints in concrete and vitrified clay pipes, shall be free of asbestos and shall meet the following requirements:

	Min.	Max.
Penetration, 25°C, 150 grams., 5 seconds., with cone, dmn (FS SS-R-406, Method 223.12)	175	300
Loss on Heating, 325°F (163°C), 5 hours., 50 grams. (AASHTO T 47)	—	10
Total Bitumen, Benzene (AASHTO T 44), %	40	—
Inorganic Content (Ash) (AASHTO T111), %	15	50

It shall be of such consistency that it may be spread on the joints with a trowel when the temperature of the air is between -20°F and 100°F (7°C and 38°C). The bituminous material shall adhere to the concrete or clay pipe so as to make a watertight seal, and shall not flow, crack or become brittle when exposed to the atmosphere.

Unless otherwise specified, sampling shall be done in accordance with AASHTO T 40.

The bituminous sealer shall be delivered to the project in suitable containers for handling, and shall be sealed or otherwise protected from contamination. The container shall show the brand name, net mass or volume, and the requirements for application.

19. Preformed Plastic Gaskets: This material for use in sealing of joints in concrete and vitrified clay pipe shall conform to the requirements of FS SSSS00210 (G.S.A.—F.S.S.)

20. Flexible, Watertight, Rubber-Type Gaskets: This material for use in sealing concrete pipe joints shall conform to the requirements of AASHTO M 198.

21. Bedding Material: This material shall be sand or sandy soil, all of which passes a 3/8-inch (9.5-millimeter) sieve, and not more than 10% passes a No. 200 (75-micron) sieve.

When ground water is encountered, the Engineer may allow No. 6 stone conforming to Article M.01.01 to be used instead of sand or sandy soil.

22. Reinforced Concrete Culvert End: The barrel shall conform to the requirements of AASHTO M 170, Class II, except that the three-edge bearing tests will not be required. The flare shall be of the same thickness and materials as the barrel, and shall have steel reinforcement equaling or exceeding the amount shown on the table for the pertinent size.

Tongues and grooves shall be compatible with tongues and grooves of pipe meeting AASHTO M 170, Class IV.

Air entrainment shall be added to these units so as to maintain 5 to 8% entrained air.

23. Metal Culvert End: The materials used in this work shall meet the pertinent requirements of Articles M.08.01-2 and M.08.01-4.

Bolts and fittings shall conform to the requirements of ASTM A 307 and shall be galvanized to conform to the requirements of ASTM A 153.

The units shall be coated as specified in Articles M.08.012, M.08.01-4 or M.08.01-5.

Fabrication: These units shall be formed from a rectangular sheet of metal by cutting and bending to form the desired shape. Two or more sheets may be fastened together by riveting or bolting so as to form a rectangular sheet of the required width. Skirt extensions and a top plate, as needed to complete the unit, shall be separately formed. Skirt extensions shall be riveted or bolted to the skirt.

All edges which will be exposed above the surface of the ground shall be reinforced before forming the unit by either of the following means:

- (1) The edge shall be bent to form a semicircular roll with an exterior diameter of 1 inch (25 millimeters), as shown in the detail drawing on the plans.
- (2) A split tube of 1 inch (25 millimeters) outside diameter and not lighter than 14 gage, shall be slipped over a row of rivets spaced not more than 6 inches (152 millimeters) apart, as shown in the detail drawing on the plans.

One corrugation, matching the corrugations of the pipe or pipe-arch to which the unit is to be attached, shall be formed in the unit to insure secure and accurate alignment.

Attachment: The unit may be shop-riveted to a length of the appropriate pipe or pipe-arch, or may be field attached to the pipe or pipe arch by either of the other attachment systems shown on the plans, or by other means acceptable to the Engineer. If the unit is shop-riveted to a length of pipe or pipe-arch, this length shall be sufficient to permit proper use of standard coupling bands.

24. Vacant

25. Corrugated Polyethylene Pipe: Corrugated Polyethylene Pipe, either corrugated interior surface (Type C) or smooth interior surface (Type S) without perforations or with perforations (Type CP or SP), shall conform to AASHTO M 252 or M 294. Type D pipe shall have a smooth interior surface braced circumferentially or spirally with projections or ribs joined to a smooth outer wall. Both surfaces shall be fused to, or be continuous with, the internal supports. Type D shall conform to AASHTO M 294.

26. Geotextile: The geotextile shall be non-rotting, acid and alkali resistant and have sufficient strength and permeability for the purpose intended, including handling and backfilling operations. Fibers shall be low water absorbent. The fiber network must be dimensionally stable and resistant to delamination. The geotextile shall be free of any chemical treatment or coating that will reduce its permeability. The geotextile shall also be free of any flaws or defects which will alter its physical properties. Torn or punctured geotextiles shall not be used. For each specific use, only geotextiles which are already on the Connecticut Department of Transportation's Approved Products List for the geotextile type will be used. The Engineer reserves the right to reject any geotextile which he deems unsatisfactory for a specific use. The brand name shall be labeled on the geotextile or the geotextile container. Geotextiles which are susceptible to damage from sunlight or heat shall be so identified by suitable warning information on the packaging material.

Geotextiles susceptible to sunlight damage shall not be used in any installations where exposure to light will exceed 30 days, unless specifically authorized in writing by the Engineer.

27. Polyvinyl Chloride Plastic Pipe: The pipe shall conform to the requirements of ASTM D 1785. Couplings and elbows shall conform to the requirements of ASTM D 2466 or D 2467.

28. Polyvinyl Chloride Gravity Pipe: This pipe shall conform to one of the following specifications: ASTM F789, ASTM F 679 or ASTM F 794.

This pipe shall require a certificate of compliance and a materials certificate in conformance with Article 1.06.07.

M.08.02—Catch Basins, Manholes and Drop Inlets: The materials to be used in the construction shall be those indicated on the plans or ordered by the Engineer, and they shall conform to the requirements of these specifications.

1. Brick for Catch Basins, Manholes or Drop Inlets: Brick for catch basins, manholes or drop inlets shall conform to the requirements of AASHTO M 91, Grade SM, except that the depth shall be 2 1/4 inches (57 millimeters), the width 3 5/8 inches (92 millimeters) and the length 8 inches (203 millimeters), and except that the maximum water-absorption by 5-hour boiling shall not exceed the following limits:

Average of 5 bricks	15%
Individual brick	18%

2. Concrete Building Brick for Catch Basins, Manholes or Drop Inlets: Concrete building brick for catch basins, manholes or drop inlets shall conform to the requirements of ASTM C 55, Grade S II.

3. Masonry Concrete Units for Catch Basins, Manholes or Drop Inlets: Masonry concrete units for catch basins, manholes or drop inlets shall conform to the requirements of ASTM C 139.

4. Precast Units for Drainage Structures: Precast units for drainage structures may be used except where particular conditions require building or casting in place.

Fabrication plants shall have a quality control plan approved by the Director of Research and Materials Testing that is demonstrated to the satisfaction of the Engineer. The fabrication plant, the quality of materials, the process of fabrication and the finished precast unit shall be subject to inspection and approval by the Engineer.

Precast manholes shall conform to the requirements of AASHTO M 199 (ASTM C 478).

Circular precast catch basins and drop inlets shall conform to AASHTO M 199 (ASTM C 478) as supplemented below. Rectangular precast catch basins and drop inlets shall conform to ASTM C 913 as supplemented below:

All materials used for concrete shall conform to the requirements of Section M.03.

The provisions of Subarticle 4.01.03 (A) shall apply except that the concrete shall contain 4% - 7% entrained air. Water-absorption of individual cores taken from precast units shall be not more than 7%.

Reinforcement shall conform to the requirements of Article M.06.01.

The units shall be cast in substantial permanent steel forms so constructed that no overall dimension of a casting shall vary more than 1/4 inch (6.4 millimeters) over and under the specified dimension, and so that the frame for the inlet grate is in the desired position in the completed unit.

Suitable provision shall be made in casting the units for convenient handling of the completed casting, and additional reinforcement steel shall be provided to allow for such handling in the casting yard and during transportation and placement. Each completed unit shall be identified with the name of manufacturer and date of the concrete pour from which it was cast, either by casting this information into an exposed face of the unit or by suitable stencil. The precast units shall be cured in accordance with AASHTO M 170, except that liquid membrane-forming compounds for curing concrete shall not be used in curing the precast tops of catch basins or drop inlets.

For each day's production of precast units, the fabricator shall mold, cure and test 1 set of 4 standard cylinders, or cylinders compacted in a similar manner to the parent precast units, for the purpose of determining the compressive strength of the concrete incorporated into the precast units. Concrete used in molding the cylinders shall be representative of the concrete incorporated into the precast units during the production period. Cylinders shall be molded in accordance with AASHTO T 23, cured by the same method as the units they represent, and tested as prescribed in AASHTO T 22. A compression test will be performed on 2 cylinders 7 days after casting. If the average compressive strength is not less than that required and no individual cylinder is less than 90% of the required compressive strength, the precast units represented by these cylinders will be acceptable for use at 7 days of age.

If the strength requirement is not met in the first test, a second test will be performed on one cylinder at 14 days; and provided the minimum strength is achieved, the units will be acceptable for use as of that date. Should the second test fail, a third compression test will be performed on the 4th cylinder at 28 days after casting; and the units will be acceptable for use at that time if the minimum strength requirement is met. If the strength requirements are not met in the 28-day test, all precast units of the production period will be rejected.

In lieu of cylinders, the fabricator may, with the permission of the Department, perform compression tests on 4-inch (100-millimeter) cores drilled from the walls of appropriate precast units to determine the

compressive strength of the concrete. Cores shall be obtained and tested in accordance with AASHTO T 24.

The fabricator shall determine the air content of the concrete used in the day's production of precast units by performing tests as prescribed in AASHTO T 152.

The equipment and personnel necessary to perform the required testing shall be furnished by the fabricator and approved by the Engineer. All testing equipment shall be calibrated at least once each 12 months or as directed by the Engineer. The fabricator shall maintain records relative to the production, testing and shipment of precast units supplied to the Department. Said records shall be available to a representative of the Department upon his request.

The Department will accept precast concrete units on the basis of fabricator's certification. The fabricator shall certify each shipment of precast concrete units on Department Form MAT PC-1, "Certification of Precast Concrete Products." Two (2) copies of this certification shall be furnished with the shipment to the Engineer at the Project site.

Precast units that are cracked, show evidence of honeycomb, or have over 10% of their surface area patched, shall be subject to rejection, even though meeting other requirements.

Upon requested, the fabricator shall furnish and deliver to the Laboratory, at no cost to the Department, a complete unit for coring and absorption test purposes. A maximum of 2 such units per year will be requested except that for each failure in the test, an additional unit shall be furnished.

5. Metal for Drainage Structures: Metal for catch basin, 13ns. Covers and gratings shall bear uniformly on their supports.

Extensions shall be designed so that the existing manhole cover or catch basin grate, when set in place, will have substantially the same bearing, fit and load carrying capacity as in the existing frame. The extension shall be designed to fit into the original frame, resting specifically on the flange and rim area. The extension shall accept the existing cover or grate so that the cover or grate is seated firmly without movement.

Ladder rungs for manholes shall conform to AASHTO M 199 (ASTM C 478). Those portions of aluminum ladder rungs embedded in concrete shall be given one coat of zinc chromate paint conforming to FS TT-P645 or equivalent.

Cast iron shall conform to the requirements of AASHTO M 105, Class 25 for the frames and Class 30 for grates.

Cast steel shall conform to the requirements of ASTM A 27, Grade optional, and shall be thoroughly annealed.

Structural Steel shall conform to the requirements of ASTM A 36, or A 283, Grade B or better, as to quality and details of fabrication, except that in the chemical composition of the steel, the 2/10 of 1% of copper may be omitted.

Malleable iron shall conform to the requirements of the specifications of ASTM A 47, Grade 22010.

The materials and method of manufacture for drop inlets shall conform to the requirements as stated on the plans or as ordered.

M.08.03—Aggregates for Underdrains: Materials for filling the trench shall consist of well-graded, clean, non-plastic sands or well-graded, clean, durable broken stone or screened gravel. The type of material to be used shall be sand, unless otherwise called for by the contract documents or ordered by the Engineer.

1. Broken Stone or Screened Gravel: This material shall conform to the gradation requirements for Size No. 8 under Article M.01.01.

1. Sand: This material shall be a commercial product and shall meet the requirements of Article M.03.01.2.

**SECTION M.09
SHEET PILING AND PILES**

M.09.01—Sheet Piling

M.09.02—Piles

M.09.01—Sheet Piling: The materials for this work shall conform to the following requirements:

1. Timber Sheet Piling: The timber, unless otherwise definitely noted on the plans or in the special provisions, may consist of any species which will satisfactorily stand driving. It shall be sawn or hewn with square corners and shall be free from worm holes, loose knots, wind shakes, decayed or unsound portions, or other defects which might impair its strength or tightness.

The piles shall be of the dimensions shown on the plans or as directed, either cut from the solid material or made by building up the piles of three planks securely fastened together. The piles shall be drift sharpened at their lower ends so as to wedge the adjacent piles tightly together.

2. Steel Sheet Piling: Steel sheet piles shall conform to the requirements of ASTM A 328/A 328M.

M.09.02—Piles: The materials for this work shall conform to the following requirements:

1. Untreated Timber Piles: Timber piles shall conform to the requirements of AASHTO M 168, as supplemented by the following requirements:

All timber piles shall be cut from sound, live trees preferably during the winter season. Piles shall contain no unsound knots or other defects which may impair their strength and durability. All knots shall be trimmed close to the body of the piles. All measurements for piles shall be taken under the bark.

Piles shall have the following minimum dimensions:

Pile Length	Tip Dia. Inches (Millimeters)	Butt Dia. Inches (Millimeters)
20 feet (6 meters) and under	8 (200)	11 (280)
21 to 40 feet (6.5 to 12 meters)	8 (200)	12 (305)
41 to 60 feet (12.5 to 18 meters)	7 (175)	13 (330)
Over 60 feet (18 meters)	6 (150)	15 (380)

2. Treated Timber Piles: The timber piles shall be pressure-treated with wood preservatives of creosote oil or creosote solution types. Piles shall comply with the requirements of Article M.09.02(1) except that piles for treatment shall be Douglas fir, larch, Southern yellow pine, Norway pine or red oak. They shall be peeled of outer bark and inner skin soon after cutting so that the piles are smooth and clean. Piles shall contain as much sapwood as possible, and care shall be taken to minimize damage to the sapwood when peeling and cleaning the piles. After preparation, the minimum thickness of the sapwood ring at the butt end shall be 1 inch (25 millimeters), except for Southern yellow pine which shall have 1 1/2 inches (38 millimeters).

Conditioning, treatment and wood preservative shall conform to the requirements of AASHTO M 133, except that creosote petroleum solution shall not be used for treatment of piles to be utilized in coastal waters.

The minimum net final retention of preservative per cubic foot (cubic meter) of wood shall be as follows:

For piles to be used on land or in fresh water: 12 pounds (192 kilograms)

For piles to be used in brackish or salt water:

Douglas fir and larch 14 pounds (224 kilograms)

Southern yellow pine 20 pounds (320 kilograms)

Red oak (Full cell process) refusal

Prior to furnishing the treated piles, the Contractor shall submit certification of the species, grade or class of pile material, the grade of wood preservative used, and the final net retention of the preservative in pounds (kilograms) per cubic foot (meter) of wood.

Treated piles shall be subject to inspection by the Engineer at the site. No previous certifications or approval at the treatment plant shall bar rejection in the field for injury, breakage or defects in the piles prior to their installation. The use of "S" irons for repairing or preventing checks, splits or other defects will not be permitted. All treated timber piles shall be carefully handled and properly stored. Any surface breaks which do not warrant rejection shall be given three coats of hot creosote oil.

The heads of piles shall be treated as follows: The sawed surface shall be thoroughly brush-coated with three successive applications of hot creosote, followed by a thick application of a mixture of 30% creosote and 70% pitch. The application of the pitch coat will not be required to pile heads encased in concrete. All bolt holes made in the pile subsequent to treatment shall be treated with creosoted oil by means of an approved pressure bolt hole treater. After being so treated, all unfilled holes shall be plugged with creosoted plugs.

3. Steel Piles: Piles shall be rolled steel sections of the mass and shape called for on the plans or specified by the Engineer. Piles, splice plates and points shall be new material meeting the requirements of ASTM A 36/A 36M. Stock Steel conforming to these requirements and free from surface imperfections will be accepted upon presentation of certified mill test reports as to the quality of the stock material and receipt of affidavit that the stock material furnished is a product of the open-hearth method manufacture. Immediately prior to driving, steel piles when placed in leads shall not exceed the camber and sweep permitted by allowable mill tolerance. Piles bent or otherwise injured shall be rejected.

4. Precast Concrete Piles: Precast concrete piles shall be in strict accordance with the details shown on the plans or in the special provisions. The materials shall conform to the following requirements:

- (a) **Concrete:** The concrete for the piles shall be air-entrained concrete composed of Portland cement, fine and coarse aggregates, admixtures and water. The air-entraining feature may be obtained by the use of either air-entraining Portland cement or an approved air-entraining admixture. The entrained air content shall be not less than 4% or more than 6%.

The Contractor shall design and submit for the approval of the Engineer a concrete mix which shall attain a minimum 28-day compressive strength of 5000 psi (35 megapascals), or as shown on the plans. The Contractor shall further provide a certified statement that the mix submitted shall meet the requirements.

Prior to any handling or pickup, after casting of piles the compressive strength shall be 3500 psi (25 megapascals) minimum.

- (b) **Coarse Aggregate** shall consist of broken stone, having a maximum size of 3/4 inch (19 millimeters), conforming to the requirements of Article M.03.01.
- (c) **Fine Aggregate**, water, air-entraining admixture and retarder admixture shall conform to the requirements of Article M.03.01.
- (d) **Portland Cement** for the units shall conform to the requirements of Article M.03.01, except that Type III or Type IIIA Portland cement may be used at no additional cost to the State.
- (e) **Water Reducing Admixture:** The Contractor may submit, for approval of the Engineer, a water-reducing admixture for the purpose of increasing the workability and reducing the water requirement for the concrete.
- (f) **Calcium Chloride:** The addition to the mix of calcium chloride, or admixtures containing calcium chloride, will not be permitted.
- (g) **Steel Reinforcement:** Steel Reinforcement shall conform to the requirements of Article M.06.01.

5. Cast-in-Place Concrete Piles: Cast-in-place concrete piles shall be in strict accordance with the details shown on the plans or in the special provisions. Unless otherwise indicated, the concrete shall conform to Class "C" as shown in Article M.03.01, and no air-entraining shall be provided. The steel reinforcement shall conform to the requirements of Article M.06.01

Shells shall be manufactured specifically for use as piles. The use of other type metal products such as piping, tubing or circular forms shall not be permitted without prior written approval of the Engineer. Any such approval will be contingent upon the actual driving performance of the shell in place.

6. Prestressed Concrete Piles (Pretensioned): Materials for pretensioned piles shall conform to the requirements of Article M.14.01, except as follows:

Concrete: The concrete for the piles shall be air-entrained concrete composed of Portland cement, fine and coarse aggregates, admixtures and water. The air-entraining feature may be obtained by the use of

either air-entraining Portland cement or, if permitted by the Engineer, an approved air-entraining admixture. The entrained air content shall be not less than 4 percent or more than 6%.

The Contractor shall design and submit for the approval of the Engineer a concrete mix, which shall attain a minimum strength of 5000 psi (35 megapascals). The mix shall have a minimum cement content of 6.0 bags per cubic yard (8.0 bags per cubic meter). The compressive cylinder strength at the time of transfer of prestressing load shall be a minimum of 3500 psi (25 megapascals). No piles shall be removed from the casting plant, nor be transported to the work site, nor be driven until the compressive strength is 5000 psi (35 megapascals) minimum.

The Contractor shall further provide a certified statement that the mix submitted shall meet the requirements. Its ultimate strength at 28 days shall have a minimum value of 5000 psi (35 megapascals).

Fine Aggregate: The fine aggregate shall conform to the requirements of Article M.03.01-2 except as amended by the addition of the following:

Fine aggregate for use in prestressed piles shall not contain any materials that are deleteriously reactive with the alkalis in the cement in an amount sufficient to cause excessive expansion of mortar, grout or concrete; except that if such materials are present in injurious amounts, the Portland cement shall be modified in accordance with the provisions listed under the requirements for Portland cement.

Portland Cement: Portland cement for the piles shall conform to the requirements of Article M.03.01, except as supplemented and amended hereinafter.

Type III or Type IIIA Portland cement may be used at the Contractor's option. The tricalcium aluminate ($3\text{Ca Al}_2\text{O}_3$) content of the Portland cement shall be limited to a maximum of 8%. Where high sulfate resistance is required, as specified on the plans or as directed, the tricalcium aluminate content shall be limited to a maximum of 5%. This criteria is attained when the water-soluble sulfate (as SO_4) in soil exceeds 0.20% or the sulfate (as SO_4) in ground or surface water exceeds 1,000 parts per million.

Where the fine aggregate contains materials that are deleteriously reactive with the alkalis in the cement, as noted in the requirements of fine aggregate, the Portland cement shall contain less than 0.6% alkalis calculated as sodium oxide or shall have a material added that has been shown to prevent harmful expansion due to the alkali-aggregate reaction.

Splicing cement shall conform to the requirements of the special provisions.

Pile Tip: Steel for the pile tip shall conform to the requirements of Article M.06.02. Anchorages for the pile tip shall conform to the requirements of Article M.06.01 or M.06.02, whichever shall apply.

Jet Pipe: The jet pipe and fittings shall be a 2-inch (50-millimeter) galvanized steel pipe provided with a top connection and bottom jetting outlets as shown on the plans or as directed. With the approval of the Engineer, other material may be substituted for the galvanized pipe, connections, fittings and outlets.

Pile Extension: Materials for pile extensions shall conform to the requirements listed above or as noted on the plans.

SECTION M.10
RAILING AND FENCE

M.10.01--Cable Guide Railing and Anchorages: The materials for this work shall meet the following requirements:

1. Wire Rope: Wire rope shall be Class A, 3/4-inch (19 millimeter) in diameter, conforming to the requirements of AASHTO M 30.

2. Fittings: All fittings shall meet the details as shown on the plans. Fittings subject to the direct action of the wire rope shall be sufficiently strong to develop the full-specified tensile strength of the rope. Fittings used in the attachment of two ropes shall be sufficiently strong to develop the full-specified tensile strength of both ropes. Other fittings shall be in accordance with standard commercial specifications, and shall be free from flaws or defects that would tend to impair their use or durability.

All metal fittings shall be galvanized, after fabrication, to meet the requirements of ASTM A 153.

3. Steel Posts: All steel posts shall meet the requirements of ASTM A 36.

Steel posts shall meet the details shown on the plans as to size, shape and weight; and they shall be punched or drilled as indicated on the plans. After fabrication, all posts shall be galvanized to meet the requirements of ASTM A 123.

4. Anchorages: Anchorages shall be as shown on the plans.

5. Wood Posts: Wood posts shall meet the requirements of Subarticle M.10.04-2 except that the diameter shall be as shown on the plans

6. Steel Eyebolt and Standard Turnbuckle: The steel eyebolt and standard turnbuckle shall meet the requirements of ASTM A 237 and shall be galvanized to meet the requirements of ASTM A 153.

7. Connector Plate Bolts: The connector plate bolts shall meet the requirements of ASTM A 325 and shall be galvanized to meet the requirements of ASTM A 153.

8. Cast Steel Connector Plate: The cast steel connector plate shall meet the requirements of ASTM A 27, Grade 65-35 and shall be galvanized to meet the requirements of ASTM A 123.

9. Malleable Iron Connector Plate: The malleable iron connector plate shall meet the requirements of ASTM A 47, Grade No. 32510 and shall be galvanized to meet the requirements of ASTM A 123.

M.10.02--Metal Beam-Type Rail and Anchorages: The materials for this work shall comply with the plans as to size, shape and weight.

1. Steel Posts, Welded-Soil Plates, Brackets, Back-Up Rails and Channel Rubrails:

(a) Steel posts, welded-soil plates, brackets, back-up rails and channel rubrails shall meet the requirements of ASTM A 36. After fabrication, all steel posts, welded-soil plates, brackets, back-up rails and channel rubrails shall be galvanized to meet the requirements of ASTM A 123.

(b) All welding shall meet ANSI/AASHTO/AWS D1.5.

(c) Weathering steel for posts shall meet Subarticle M.06.02-1 (b). The dimensions of each post shall meet the plans and ASTM A 6. All weathering steel posts shall be galvanized after fabrication to meet the requirements of ASTM A 123 and the plans. A single 3/4 inch (19 millimeters) diameter hole may be punched or drilled 2 inches (50 millimeters) from the top of each post, in the center of the web, to facilitate the galvanizing process.

2. Wood Posts: Wood posts shall be commercial lumber Grade No. 1 or better and meet AASHTO M 168. It shall have a minimum stress rating of 1,350 psi (9.3 megapascals) and be either rough sawn (non-planed) or S4S (surface four sides) Southern Yellow Pine or Douglas Fir-Larch with nominal dimensions as indicated on the plans. Variation in the size of any dimension shown on the plans shall not be more than ± 1/4 inch (6 millimeters).

After all end cuts are made and all holes are drilled the wood shall be pressure treated with Ammoniacal Copper Zinc Arsenate (ACZA) conforming to AWPAs Standard P5 to a minimum net retention of 0.60 lb./cubic foot (9.61 kilograms/cubic meter) in the assay zone in accordance with AWPAs Standard C14. All wood shall be free of excess preservatives and solvent at the conclusion of the treatment process. Post treatment cleaning shall be by expansion bath or steaming in accordance with AWPAs Standard C2. Wood shall be Kiln or air-dried to a maximum moisture content of 25% after treatment (KDAT – 25) and grade marked after treatment by an agency certified by the ALSC.

3. Rail Elements (W-Beam, Thrie-Beam) and Terminal Sections: Rail elements and terminal sections shall meet the requirements of AASHTO M 180 and the following:

(a) **Class A (12 gauge):** Base metal nominal thickness, 0.105 inches (2.7 millimeters).

(b) **Class B (10 gauge):** Base metal nominal thickness, 0.135 inches (3.5 millimeters).

(c) Galvanizing shall be Type II.

(d) Acceptance shall be based on Article 5.3 "Acceptance by Brand Registration and Guarantee" of AASHTO M 180.

(e) Weathering steel for rail elements and terminal sections shall meet the requirements of AASHTO M 180 Class A Type IV.

(f) Rail elements with radii less than or equal to 150 feet (45.72 meters), as shown on the plans, shall be shop fabricated and then permanently stamped or embossed with the designated radius ($R = \text{_____}$) on the element near the brand registration stamp.

4. Box Beam Rail Elements: Elements shall be either structural tubing 8 x 6 x 1/4 (203 x 152 x 6.4) or structural tubing 6 x 6 x 3/16 (152 x 152 x 4.8) manufactured from either ASTM A 500 Grade B cold-rolled tubing, ASTM A 501 hot-rolled tubing or Automatic Rollover Protective Steel. When ASTM A 500 Grade B steel is used, the DROP-Weight-Tear Test in conformance with ASTM E 436 shall be performed. All plates shall meet ASTM A 36. All material for box beam rail elements and splices shall be galvanized after fabrication in accordance with ASTM A 123.

5. Steel Plates, Steel Washer Plates and Square Steel Washers: These shall meet the requirements of ASTM A 36 and shall be galvanized to meet the requirements of ASTM A 153 unless otherwise noted on the plans.

6. Bolts, Rods, Washers, and Nuts: Anchor bolts and rods for attachment to barriers and parapets shall meet ASTM A449. The nuts for anchor bolts and rods shall meet ASTM A 563, Grade B. The washers for anchor bolts or rods shall meet the requirements of ASTM F 436. All other bolts and nuts, unless otherwise noted on the plans, shall meet the requirements of ASTM A 307.

Bolts, nuts and washers, unless otherwise noted on the plans, shall be galvanized after fabrication to meet the requirements of ASTM A153.

7. End Anchorages: The bar reinforcement shall meet the requirements of Subarticle M.06.01-1. The Class "A" concrete shall meet the requirements of Article M.03.01. Anchor bolts and rods for end anchorages shall meet the requirements of AASHTO M 314.

8. Galvanized Coating Touch-up: The zinc dust-zinc oxide paint for galvanized coating touchup shall meet the requirements of AASHTO M 180.9.6.1.

9. Plastic Blockouts: **Plastic blockouts shall be made with a minimum of 50% recyclable polyethylene plastic comprised of low-density and high-density polyethylene with a specific gravity less than or equal to 1.0 in accordance with ASTM D 792 and be recyclable. They shall also have a minimum compressive stress of 450 psi (3.1 megapascals) in accordance with ASTM D 695, meet the dimensions indicated on the plans, and be a shade of gray or black. Blockouts must have been crash-tested and have approval in writing by the FHWA in compliance with NCHRP Report 350, Test Level 3 requirements. Each blockout shall be stamped at the factory with the manufacturer's identification and lot number. The Contractor shall furnish to the Engineer prior to construction a Certified Test Report and a Material Certificate for the blockouts in conformance with Article 1.06.07.**

M.10.03--Barways:

1. Wood Posts: Wood posts shall meet the requirements of Subarticle M.10.04-2, except the minimum diameter shall be as shown on the plans.

2. Wood Rails: Wood rails shall be made of Number 1 Common Fir or other lumbers of equal quality, approved by the Engineer, and S4S.

3. Fittings: Fittings shall be of the type and dimensions shown on the plans and must be approved by the Engineer.

M.10.04--Wire Fence:

1. Wire Fencing: The wire fencing shall be composed of woven wire fencing of an approved type. It shall be 45 inches (1.14 meters) in height, plus or minus 1/2 inch (12.5 millimeters), and shall be constructed of not smaller than No. 9 gage (American Steel & Wire) wire. There shall be not less than 8 horizontal wires spaced at various distances apart with the smaller spaces at the bottom to the fence.

Vertical stays, securely welded or fastened to the horizontal wires, shall be provided at intervals of 12 inches (305 millimeters), plus or minus 1/8 inch (3 millimeters), and shall run from top to bottom of the fence.

Each wire shall be galvanized by the hot-dip method conforming to the requirements of ASTM A 116, Class 2 or protected with other protective coating approved by the Engineer.

2. Wood Posts: Wood posts for wire fence shall meet any one of the following specifications, provided that all posts on any one project shall meet the same specification:

(a) **Untreated Posts:** These posts shall be cut from either of the species locust or red cedar.

All posts shall be round, straight and of the length shown on the plans. Red cedar posts shall have a minimum diameter of 5 inches (125 millimeters) at the small end; for locust posts the same minimum diameter shall apply after removal of the bark. The bottom shall be sawed off square and all knots hewn flush with the surface. On locust posts, the inner and outer bark shall be removed and the surface shaved smooth.

(b) Treated Posts: These posts shall be cut from one of the following species: Norway (red) pine, southern yellow pine, scotch pine, pitch pine, oak, red maple, black birch or yellow birch.

All posts shall be round, straight, of the length shown on the plans, and after removal of the bark, shall have the minimum diameter at the small end as shown hereinbelow. Top and bottom of the posts shall be cut off square, with a maximum permissible deviation of 10 degrees at the butt end. Reduction of the total diameter of the butt end by felling undercuts of up to 25% is permissible, but not more than one such undercut will be permitted on a post. The posts shall be peeled as soon after cutting as possible and shall be conditioned for treatment by air seasoning to moisture content of 20 to 35% (dry basis). The outer bark must be removed completely. No single patch of inner bark on any post may be neither more than 3/4 inch (19 millimeters) wide nor more than 12 inches (305 millimeters) long, and adjacent patches must be separated from each other by a strip of bark-free wood at least 1 inch (25 millimeters) wide. Branch stubs and overgrown knots shall be trimmed close to the face of the post. All posts shall be treated for their full length.

Timber preservatives used and method of treatment shall be the following:

Pentachlorophenol Cold-Soaking Treatment: Posts to be treated with pentachlorophenol shall have at the small end a minimum diameter of 5 inches (125 millimeters), as determined by a circumference tape. The pentachlorophenol shall meet the requirements of AASHTO M 133. Pentachlorophenol may be obtained as liquid concentrates containing up to 40% pentachlorophenol. The concentrate shall be reduced to 5% strength by the addition of Stoddard solvent, kerosene or No. 2 fuel oil. Treatment shall be by immersing the posts in cold preservative for a sufficient length of time to provide for the retention specified below. Retention of 5% pentachlorophenol solution immediately after treatment shall be not less than 5 pounds/cubic foot (80-kilograms/cubic meter) of wood. Radial penetration at a point midway between the ends of the post shall be 1 inch (25 millimeters) or more.

3. Metal Post: Metal posts shall be of the length shown on the plans, straight and true to section, and shall be of a standard commercial type.

All posts, braces, anchors, plates and other devices shall be galvanized on all inner and outer surfaces by an approved method.

The zinc coating shall weigh not less than 2.0 ounces/square foot (610-grams/square meter) when tested in accordance with AASHTO T 65.

All end posts shall have one brace; all corner and intermediate braces or pull posts shall have two braces.

(a) Intermediate or Line Posts: Intermediate or line posts shall meet one of the following types and to the minimum requirements stated for each:

Quadruple Ribbed Tee Post: Quadruple ribbed tee post minimum weight = 1.32 pounds/linear foot (2 kilograms/meter).

Channel or U Post: Channel or U Post, minimum weight = 1.12 pounds/linear foot (1.7 kilograms/meter).

Standard Tee Post: Standard tee post, minimum weight = 1.22 pounds/linear foot (1.8 kilograms/meter).

Tubular Post: Tubular post, minimum outside diameter 1 3/4 inches (45 millimeters) minimum gage No. 15. (U.S. Standard).

Angle Post: Angle posts minimum section 2 inch x 2-inch x 1/4 inch (50 x 50 x 6.4 millimeters).

(b) End posts, corner posts, pull posts and braces shall meet one of the following types and do the minimum requirements stated for each:

Tubular Section Post and Brace: Tubular section post and brace, minimum outside diameter 2 1/2 inches (64 millimeters), minimum gage No. 8 (U.S. Standard).

Standard Pipe Section Post and Brace: Standard pipe section post and brace, minimum weight per linear foot, 3.65 pounds (1.66 kilograms).

Angle Post and Brace: Angle post and brace, minimum section of post 2 1/2 inch x 2 1/2 inch x 1/4 inch (64 millimeters x 64 millimeters x 6.4 millimeters), minimum section of brace 2 inches x 2 inch x 1/4 inch (50 millimeters x 50 millimeters x 6.4 millimeters).

The minimum weights stated for the several types of posts do not include anchors, plates or other devices. Intermediate or line posts shall be provided with a plate or anchor or other satisfactory means to hold the posts in proper alignment and plumb. Plates or anchors shall be securely fastened to the post by welding or by a minimum of 2 rivets per plate.

All posts having a tubular or pipe section shall be provided with a suitable cap at the top.

M.10.05--Chain Link Fence: All gage measurements of finished wire shall be United States Steel Wire Gage or equivalent. Tolerance for wire sizes shall be as specified in AASHTO M-181. Materials for this work shall meet the following requirements:

1. Fabric: Wire Fencing shall be composed of woven wire of the chain link type. It shall be not less than the height specified on the plans or in the special provisions and shall be constructed of not smaller than No. 9 gage wire. The wire shall be woven to form a continuous fabric having 2-inch (50-millimeters) mesh. The chain link fabric shall have a knuckled finish on both edges.

(a) Aluminum-Coated Steel Fabric: The base metal of the fabric shall be of steel wire having a minimum tensile strength of 80,000 psi (550 megapascals), coated with aluminum alloy applied at the rate of not less than 0.40 ounces/square foot (122 grams/square meter) of uncoated wire surface.

(b) Polyvinyl chloride-coated steel fabric shall meet the requirements of FS RR-F-00191, Type IV, and shall be the color green.

(c) Aluminum Alloy Fabric shall meet the requirements of ASTM B211, Alloy 6061 wire having a minimum tensile strength of 50,000 psi (345 megapascals).

2. Metal Posts and Rails: Metal posts shall be straight, true to section and of sufficient length to enable the post to be encased for a depth of 2 feet 8 inches (815 millimeters) in a concrete footing which shall have a depth 3 feet (1 meters) below ground.

All posts, rails, braces, anchors, plates and other devices shall meet one on the following specification.

Galvanized material shall be made of steel of a standard commercial type, hot-dip galvanized with a zinc coating weighing not less than 2.0 ounces/square foot (610 grams/square meter) when tested in accordance with AASHTO T65 or shall be in accordance with AASHTO M181, Class 2.

The Contractor shall provide a Materials Certificate in accordance with Article 1.06.07 for materials conforming to AASHTO M181, Class 2.

All aluminum coated steel posts and rails shall meet ASTM F669, minimum yield strength 50,000 psi (345 megapascals), for industrial chain link fence. The posts and rails shall be manufactured by roll forming aluminum coated steel strip and electric resistance welding into tubular form. The outside of the weld area shall be metallized with commercially pure aluminum to a thickness sufficient to provide resistance to corrosion equal to that of the remainder of the outside of the tube. The aluminum coating weight on the outer and inner surfaces shall be a minimum of 0.75 ounces/square foot (230grams/square meter), Triple spot test 0.70 ounces/square foot (215 grams/square meter), single spot test, as measured in accordance with ASTM A428.

Polyvinyl chloride-coated material shall be made of steel of a standard commercial type coated inside and outside with the same polyvinyl chloride coating as the chain link mesh or shall have all surfaces galvanized with the outside galvanized surface coated with the same polyvinyl chloride coating as the chain link mesh.

Aluminum Alloy shall meet the requirements of FS RR-F-00191.

3. Fittings: These shall be malleable irons, pressed steel, or aluminum alloy. The fittings shall be either hot-dip galvanized, polyvinyl chloride-coated, or aluminum alloy.

(a) Hot-dip galvanizing shall meet the requirements of ASTM A 153.

(b) Polyvinyl chloride-coated material shall have the same polyvinyl chloride coating as the chain link mesh.

(c) Aluminum alloy shall meet the requirements of FS RR-F-00191.

4. Tension and Tie Wire:

(a) Tension wire for steel fence shall be coil spring steel not less than 7 gage. The base material shall have a minimum tensile strength of 80,000 psi (550 megapascals) with an aluminum coating applied at a rate of 0.40 ounces/square foot (122grams/square meter) of surface area.

Aluminum tension wire shall not be less than 6 gage 6061-T6 or 5052-H38 Aluminum Alloy.

(b) Wire clamps for fastening fabric to line posts shall not be less than 6 gage. Tie wires or hog rings used to fasten the fabric to the top rail or tension wire shall be not less than 9 gage aluminum for aluminized or aluminum fabric fence and not less than 9 gage polyvinyl chloride coated steel wire for polyvinyl chloride fence.

Aluminized steel hog rings for aluminized fabric shall not be less than 11 gage.

5. Gates: Gates shall be of the same type of materials used for the chain link fence.

M.10.06--Vacant

M.10.07--Vacant

M.10.08--Three-Cable Guide Railing (I-Beam Posts) and Anchorages:

1. Wire Rope: Wire rope shall be Class A coating, 3/4-inch (19 millimeters) in diameter, Type 1 construction conforming to AASHTO M 30.

2. Fittings:

(a) Material indicated on the plan as "Cast Steel" shall meet the requirements of ASTM A 27 Grade 70-40 Class 1.

(b) Material indicated on the plan as "Malleable Iron" shall meet the requirements of ASTM A 47, Grade 32510.

(c) The cable wedge for splices and cable fittings shall be malleable iron casting conforming to ASTM A 47 Grade 32510. The cable wedge shall be uncoated (black).

(d) The cable splice shall meet the requirements of ASTM A 536 Ductile Iron Grade 65-45-12. All cable ends and splices shall meet the details on the plans and have the properties necessary to develop the full tensile strength (25,000 lbs.)(112 kilonewtons) of ¾" (19 millimeters) wire rope.

(e) The spring cable end assembly (compensating device) casting shall meet the requirements of ASTM A 47 Grade 32510 and must have a spring rate of 450-500 pounds/inch (80 – 88 N/millimeters) and a total available throw of 6 inches (150 millimeters) minimum.

(f) Hook bolts, as installed, shall develop an ultimate pull-open strength from 500 pounds to 1,000 pounds (2.2 kilonewtons to 4.5 kilonewtons) applied in a direction normal to the longitudinal axis of the post.

(g) Steel turnbuckle cable end assembly shall be pearlitic malleable iron casting conforming to ASTM A 220 Grade 50005.

(h) Standard hex nuts and lock nuts shall meet the requirements of ASTM A 563 Grade B.

(i) After fabrication, all metal fittings and forged cast fittings required by the plans to be galvanized shall be galvanized to meet the requirements of ASTM A 153.

3. Steel Posts and Welded-Soil Plates: All steel posts and welded-soil plates shall meet the requirements of ASTM A 36. All required holes shall be punched or drilled. After fabrication, all posts and welded soil-plates shall be galvanized to meet the requirements of ASTM A 123.

(a) All welding shall meet ANSI/AASHTO/AWS D1.5.

(b) Weathering steel for posts shall meet Subarticle M.06.02-1 (b). The dimensions of each post shall meet the plans and ASTM A6. All weathering steel posts shall be galvanized after fabrication to meet the requirements of ASTM A 123 and the plans. A single ¾ inch (19 millimeters) diameter hole may be punched or drilled 2 inches (50 millimeters) from the top of each post, in the center of the web, to facilitate the galvanizing process.

4. Anchorages: Class "A" concrete shall meet the requirements of Article M.03.01. Bar reinforcement shall meet the requirements of Subarticle M.06.01-1.

Breakaway anchor angles, washers and anchorage plates shall meet the requirements of ASTM A 36. Anchor bolts and rods for end anchorages shall meet the requirements of AASHTO M 314. Hex nuts shall meet the requirements of ASTM A 563 Grade B. Breakaway anchor-angle tiepin shall be 3/16 inch (5 millimeters) diameter meeting the requirements of ANSI CR1018 and galvanized after fabrication to meet the requirements of ASTM A 123. The angles, rods, top nuts and washers shall be galvanized in accordance with the requirements of ASTM A 153.

**SECTION M.11
MASONRY FACING
CEMENT AND DRY RUBBLE MASONRY
BRICK
MORTAR**

M.11.01—Masonry Facing

M.11.02—Cement Rubble Masonry and Dry Rubble Masonry

M.11.03—Brick Masonry

M.11.04—Mortar

M.11.01—Masonry Facing: The materials for this work shall conform to the following requirements:

1. Masonry Facing Stone: This stone shall be of the kind specified in the proposal or on the plans and shall be of a size, quality and color acceptable to the Engineer. The stone shall be hard and durable, resistant to weathering action, reasonably fine grained, and free from structural defects that would impair its strength or durability. Preferably, the stone shall be from a quarry the product of which is known to be of satisfactory quality. Stone shall be of such character that it may be truly cut to such lines and surfaces, either plain or curved, as may be required. Any stone having defects which have been repaired with cement or other materials will be rejected. Samples of stone shall be submitted when required. Masonry facing stone shall be of two grades: dimensioned masonry stone and ashlar masonry stone.

(a) **Dimensioned Masonry Stone:** Dimensioned masonry stone shall be dressed to true size and shape, in conformity with the requirements of the plans or as ordered. General details and controlling dimensions will be shown on the plans. The Contractor shall prepare such additional detail drawings as he may require for his guidance, and all such drawings shall be approved by the Engineer before construction is started.

(b) **Ashlar Masonry Stone:** Ashlar masonry stone shall be of such sizes and shapes as to produce the general effect shown on the plans.

Surface Finish: For the purpose of these specifications, the finishes of exposed surfaces of masonry facing stone are defined as follows:

Sawed Face: Exposed surfaces shall be true planes with a tolerance of 3/16 inch (5 millimeters) from a straightedge placed on the surface in any direction. All saw-faced stone shall be sandblasted to remove rust stains. Where impractical to saw, the surface shall be six-cut. Face arises of all exposed surfaces shall be true and out of wind.

Six-Cut: Exposed surfaces shall be true planes with a tolerance of 3/16 inch (5 millimeters) from a straightedge placed on the exposed surface in any direction. The exposed surface shall be finished with a tool having six blades to the inch (25 millimeters).

Four-Cut: Same surface tolerance as for 6-cut; exposed surfaces to be finished with a tool having four blades to the inch (25 millimeters).

Fine-Pointed: Projections on fine-pointed finished surfaces shall not exceed 1/2 inch (12.5 millimeters). Exposed edges shall be pitched to true lines.

Rough-Pointed: Projections on rough-pointed finished surface may vary from 1/2 to 1 inch (12.5 millimeters to 25 millimeters). Exposed edges shall be pitched to true lines.

Split-Face: Exposed surfaces shall have face edges pitched to line and shall have no projection of more than 1 1/2 inches (38 millimeters) above the plane of the edges.

Rock-Face or Quarry Face: Exposed surfaces shall be freshly split granite; they shall have no projection of more than 3 inches (75 millimeters). Hollow faces will not be permitted. They shall be pitched to straight and true lines and shall have a chiseled draft on all edges if so indicated on the plans.

Exposed surfaces of face stone shall be given the surface finish indicated on the plans.

2. Vacant:

M.11.02—Cement Rubble Masonry and Dry Rubble Masonry: The materials for this work shall conform to the following requirements:

1. Masonry Stone: This stone shall be of approved quality, sound, durable and free from structural defects or imperfections tending to destroy its resistance to the weather. The individual pieces shall be roughly rectangular in shape, with at least 1 fairly even face, and shall have a volume of not less than 4 cubic feet (0.12 cubic meters), except where smaller pieces are required for closure or where the character of the construction makes the use of smaller pieces necessary.

M.11.03—Brick Masonry: The materials for this work shall conform to the following requirements:

Brick: The brick for use other than the construction of catch basins, manholes and drop inlets shall conform to the requirements of AASHTO M 114, Grading SW.

The brick shall have a fine-grained, uniform, and dense structure, free from lumps of lime, laminations, cracks, checks, soluble salts, or other defects which may in any way impair their strength, durability, appearance, or usefulness for the purpose intended. Bricks shall emit a clear, metallic ring when struck with a hammer.

M.11.04—Mortar: Mortar shall be composed of one part Portland cement and two parts, by volume, of surface dry fine aggregate. Hydrated lime, in an amount not to exceed 4 pounds (1.8 kilograms) of lime to each bag of cement, may be added at the option of the Engineer. Cement and hydrated lime shall conform to the following requirements:

- (a) **Portland cement, Types I, II or IS, and water** shall conform to the requirements of Article M.03.01.
- (b) **Hydrated lime** shall conform to the requirements of ASTM C 6.
- (c) For laying stone, precast units, or for shotcrete, fine aggregate shall conform to Grading A, table below. In all other respects, it shall conform to the requirements of Article M.03.01-2.
- (d) For pointing stone or the precast units and for laying brick or sealing pipe joints, the fine aggregate shall conform to Grading B, table below. In all other respects it shall conform to the requirements of Article M.03.01-2.

Table of Gradation, Fine Aggregate for Mortar

<u>Square Mesh Sieves</u>	<u>Grading</u>	
	A	B
	Percentage Passing by weight (mass)	
Pass 3/8 inch (9.5 millimeters)	100	
Pass #4 (4.75 millimeters)	95-100	
Pass #8 (2.36 millimeters)	80-100	100
Pass #16 (1.18 millimeters)	50-85	
Pass #30 (600 microns)	25-60	
Pass #50 (300 microns)	10-30	10-40
Pass #100 (150 microns)	2-10	0-10

**SECTION M.12
BEARING AREAS
RIPRAP
SLOPE PAVING & SLOPE PROTECTION
WATERPROOFING AND DAMPPROOFING
STONE AND GRANITE SLOPE CURBING
CALCIUM CHLORIDE FOR DUST CONTROL
WOOD**

- M.12.01—Bearing Areas**
- M.12.02—Riprap**
- M.12.03—Slope Paving**
- M.12.04—Waterproofing**
- M.12.05—Dampproofing**
- M.12.06—Stone Curbing**
- M.12.07—Granite Slope Curbing**
- M.12.08—Granite Stone Curbing for Bridges**
- M.12.09—Vacant**
- M.12.10—Calcium Chloride for Dust Control**
- M.12.11—Vacant**
- M.12.12—Concrete Block for Slope Protection**
- M.12.13—Wood**

M.12.01—Bearing Areas: Materials for this work shall conform to the following requirements:

- 1. Vacant**
- 2. Prefabricated Pads:** Prefabricated pads shall consist of cotton duck impregnated with rubber and shall be a single sheet of 1/8 inch (3.2 millimeters) minimum thickness with a tolerance of plus 15% or minus 5%, composed of 8 ounce (227 grams) duck and high quality natural rubber constructed in five or more plies. The breakdown stress for compression perpendicular to the plane of lamination shall be not less than 11,000 pounds psi (76 megapascals).

M.12.02—Riprap: Materials for this item shall consist of sound, tough, durable and angular rock, free from decomposed stones or other defects impairing its durability. The size of a stone as hereinafter specified shall be its least dimension. Broken concrete or rounded stones are not acceptable. The type of material to be used shall be as noted on the plans, in the special provisions or as may be ordered by the Engineer.

- 1. Standard Riprap:** This material shall conform to the following requirements:
 - (a) Not more than 15% of the riprap shall be scattered spalls and stones less than 6 inches (150 millimeters) in size.
 - (b) No stone shall be larger than 30 inches (760 millimeters) in size, and at least 75% of the weight (mass) shall be stones at least 15 inches (380 millimeters) in size.
- 2. Intermediate Riprap:** This material shall conform to the following gradation:

Stone Size	% of the weight (mass)
18 inches (460 millimeters or over)	0
10 inches to 18 inches (255 millimeters to 460 millimeters)	30-50
6 inches to 10 inches (150 millimeters to 255 millimeters)	30-50
4 inches to 6 inches (100 millimeters to 150 millimeters)	20-30
2 inches to 4 inches (50 millimeters to 100 millimeters)	10-20
less than 2 inches (less than 50 millimeters)	0-10

3. Modified Riprap: This material shall conform to the following gradation:

Stone Size	% of the weight (mass)
10 inches (255 millimeters or over)	0
6 inches to 10 inches (150 millimeters to 255 millimeters)	20-50
4 inches to 6 inches (100 millimeters to 150 millimeters)	30-60
2 inches to 4 inches (50 millimeters to 100 millimeters)	30-40
1 inch to 2 inches (25 millimeters to 50 millimeters)	10-20
less than 1 inch (less than 25 millimeters)	0-10

4. Special Riprap: This material shall conform to the gradation of Article M.01.01 for No. 3 stone.

M.12.03—Slope Paving: The stone for this work shall consist of sound, tough, durable rock, free from decomposed stone or other defects impairing its durability. Each piece shall have an area on its exposed surface of not less than 2 square feet (0.2 square meter) and a thickness not less than 9 inches (230 millimeters), except that stone for the two bottom rows shall be of such size that they can be embedded at least 2 feet (610 millimeters) into the ground; and they shall have a thickness of not less than 12 inches (305 millimeters).

Concrete slabs shall conform to the dimensions given above for stone, except that the maximum surface dimensions shall not exceed 10 linear feet (3 meters) in any direction.

The concrete shall conform as regards materials and proportions, to the requirements of Article M.03.01 for Slope Paving Concrete.

M.12.04—Waterproofing: The materials for this work shall conform to the following requirements:

1. Waterproofing Asphalt: For woven glass fabric, the seal coat material shall be an asphalt conforming to ASTM D 449, Type III.

Asphalt flashing cement shall be a compound of asbestos and asphalt conforming to the requirements of ASTM D 2822.

Primer for use with asphalt in waterproofing shall conform to the requirements of ASTM D 41.

2. Fabric: Woven glass fabric saturated with asphalt shall conform to the requirements of ASTM D 1668.

Resin-treated woven glass fabric shall conform to the requirements of ASTM D 1668 and shall be compatible for use with asphalt.

3. Mortar: Mortar shall conform to the requirements of Article M.11.04.

4. Reinforcement: Reinforcement shall conform to the requirements of Article M.06.01.

5. Metal Flashing: Metal flashing shall be of the type and dimensions called for on the plans, and the quality shall be acceptable to the Engineer.

6. Joint Filler: Filler for use in horizontal joints shall be a straight refined petroleum asphalt conforming to the following requirements:

	Min.	Max.
Penetration at 77°F (25°C), 100 grams., 5 seconds	50	60
Flashpoint, open cup method, in °F (°C)	450 (232)	
Softening point, in °F (°C)	120 (49)	130 (55)
Loss on heating, at 325°F (163°C), 50 grams, 5 hours, %		0.5
Ductility, at 77°F (25°C), 5 centimeters per minute	85	
Total bitumen (Sol. in carbon disulphide) %	99.5	

Filler for use in vertical joints shall be an asphalt conforming to above specified requirements, to which

has been added 20%, by weight (mass) of asbestos fiber. The incorporation of the asbestos fiber with the asphalt shall be done at the factory of the manufacturer to insure a uniform distribution of the fiber throughout the mix.

M.12.05—Dampproofing: The materials for this work shall conform to the following requirements:

Asphalt for Primer: Asphalt for primer shall conform to ASTM D 41.

Asphalt for Seal Coat: The asphalt for seal coat shall meet one of the following:

1. Hot-applied asphalt seal coat—ASTM D 449, Type 1
2. Cold-applied asphalt seal coat—ASTM D 4479, Type 1 (Asbestos Free)
3. Cold-applied emulsified asphalt seal coat—ASTM D 1227, Type III or IV

M.12.06—Stone Curbing: The materials for this work shall conform to the following requirements:

1. Granite Curbing: Stone for this work shall be hard and durable granite, fundamentally of light color, of general uniform texture, of smooth splitting appearance, free from seams or imperfections that would impair its structural reliability and containing only such color variations as in the opinion of the Engineer would reasonably be characteristic of the material source. The Contractor shall submit for approval, the name of the quarry and the type of curb which the Contractor proposes to use. Samples of curbing shall be submitted for approval only when requested by the Engineer. Such submission shall be made sufficiently in advance of ordering so that the Engineer may have an opportunity to judge the stone, both as to quality and appearance. No stone from any other quarry shall be used unless it has been properly approved.

The finish and surface dimensions for the curb shall conform to the following requirements:

The curbstone shall have a top surface free from wind; it shall be pointed, peen-hammered or sawed to an approximately true plane, and shall have no projections or depressions greater than 1/8 inch (3.2 millimeters). The front and back arris lines shall be pitched straight and true.

On the back surface of the curbstone there shall be no projection for 3 inches (75 millimeters) down from the top which would fall outside of a plane having a batter of 4 inches in 12 inches (100 millimeters in 305 millimeters) from the back arris line.

The front face shall be at right angles to the plane of the top and shall be smooth quarry-split, free from drill holes in the exposed face. There shall be no projections greater than 3/4 inch (19 millimeters), or depressions greater than 1/2 inch (12.5 millimeters), measured from the vertical plane of the face through the top arris line for a distance of 8 inches (200 millimeters) down from the top. For the remaining distance, there shall be no projections or depressions greater than 1 inch (25 millimeters) measured in the same manner. The arris lines at the ends shall be pitched with no variation from the plane of the face greater than 1/8 inch (3.2 millimeters).

The ends of all stones shall be square with the planes of the top and face and so finished that, when the stones are placed end to end as closely as possible, no space more than 1/2 inch (12.5 millimeters) shall show in the joint for the full width of the top or down on the face for 8 inches (200 millimeters). On curbstones having a length of 6 feet (1.8 meters) or more, the remainder of the end may break back not over 9 inches (230 millimeters); whereas, on shorter curbstones, they shall not break back more than 6 inches (150 millimeters).

If sawed, the curbstones shall be thoroughly cleaned of any iron rust or iron particles.

For straight curbing, 80% of the stones shall be furnished in lengths of not less than 6 feet (1.8 meters), and the remaining 20% in lengths of not less than 4 feet (1.2 meters), interspersed at random, to allow for closures.

Curbstones to be set on a radius of 100 feet (30 meters) or less shall be cut to the curve required, and their ends shall be cut on radial lines. Requirements for length of individual stones in curved curbing vary with radii of curves.

2. Bluestone Curbing: Stone for this work shall be of a good grade, free from structural defects, and shall be approved by the Engineer.

It shall conform to the requirements contained hereinbefore for granite curbing, except that the top surface and the top 8 inches (200 millimeters) of the front face shall be "fine-pointed" in conformity with the requirements of Article M.11.01 for masonry facing stone.

M.12.07—Granite Slope Curbing: The materials for this work shall conform to the following requirements.

1. Granite Slope Curbing: Stone for this work shall be hard and durable granite, fundamentally of light color, of general uniform texture, of smooth-splitting appearance, free from seams or imperfections that would impair its structural reliability and containing only such color variations as, in the opinion of the

Engineer, would reasonably be characteristic of the material source. The exposed face of all curbing shall be smooth, quarry-split to an approximate true plane, and shall have no projections or depressions which will cause over 1 inch (25 millimeters) to show between a 2-foot (610-millimeter) straightedge and the face when the straightedge is placed as closely as possible on any part of the face. If projections on the face are more than that specified, they shall be dressed off. The top arris line at the face shall be pitched to a line which shall not show over 1 inch (25 millimeters) in any direction between the stone and a straightedge the full length of the stone. The bottom arris line at the face shall be pitched so that not over 1 inch (25 millimeters) shall show between the stone and a straightedge, the full length of the stone, when viewed at right angles to the plane of the face. The ends shall be square to the plane of the face and so finished that when the stones are placed end to end as closely as possible, no space more than 1 1/2 inches (38 millimeters) shall show in the joint for the full width of the face. The arris lines at the ends shall be pitched with no variation from the plane of the face more than 1/4 inch (6.4 millimeters). Drill holes not more than 3 1/2 inches (90 millimeters) in length of 1/2 inch (12.5 millimeters) in depth will be permitted. The sides shall not be under the square more than 4 inches (100 millimeters) or over the square at the back more than 1 inch (25 millimeters).

The straight slope curbing shall be in lengths of not less than 2 feet (610 millimeters). The curved slope curbing shall be in lengths of at least 6 inches (150 millimeters). The curbing shall have a minimum thickness of 3 inches (75 millimeters) and a maximum thickness of 6 inches (150 millimeters).

When the slope curbing is set adjacent to concrete pavement or gutters, the width of the face of the curbing shall be 12 inches (300 millimeters), with a tolerance of plus or minus 1/2 inch (12.5 millimeters). When set adjacent to surfaces other than concrete, the curbing finished shall have a face width of not more than 13 inches (330 millimeters) and not less than 11 inches (280 millimeters).

2. Mortar: The mortar for this work shall conform to Article M.11.04.

3. Gravel Base: The gravel base under the slope curbing shall be gravel fill conforming to Article M.02.03.

M.12.08—Granite Stone Curbing for Bridges: The materials for this work shall conform to the following requirements:

1. Granite Curbing: Stone for this work shall be hard and durable granite, fundamentally of light color, of general uniform texture, of smooth-splitting appearance, free from seams or imperfections that would impair its structural reliability, and containing only such color variations as in the opinion of the Engineer would be reasonably characteristic of the material source. When so directed by the Engineer, the Contractor shall submit samples of the type of curb he proposes to use.

The finish and surface dimensions for the curb shall conform to the requirements shown on the plans.

The ends of all stone shall be jointed square with the planes of the top and face and finished smooth except that, if so noted on plans, the extreme end face of the curbing shall be finished to a radius as shown on the plans.

The minimum length of a stone shall be 4 feet (1.2 meters), except that stones of lengths less than 4 feet (1.2 meters) will be so noted on the plans.

The maximum length of stone to be used on horizontal and vertical curves shall be such as to produce the effect of a smooth, continuous curve. Curbs to be set on a radius of 160 feet (50 meters) or less shall be cut to the curve required, and their ends shall be cut on radial lines.

Detailed cutting plans or schedule shall be submitted for approval of the Engineer prior to cutting stones.

2. Mortar: The mortar for this work shall conform to Article M.11.04.

3. Metal Anchors: Metal anchors shall be steel conforming to the requirements of Article M.06.01-1 bar reinforcement and shall be thoroughly galvanized by the hot-dip process after fabrication.

M.12.09—Vacant

M.12.10—Calcium Chloride for Dust Control: Calcium chloride shall conform to AASHTO M 144, except that the pellet form and the flake form shall be equally acceptable.

M.12.11—Vacant

M.12.12—Concrete Block for Slope Protection: Concrete blocks shall be solid, precast, rectangular blocks 16 inches (406 millimeters) in length, 8 inches (203 millimeters) in width, and 4 inches (100 millimeters) in thickness. No dimensions shall differ from the theoretical block size specified by more than 1/2 inch (12.5 millimeters). The blocks shall achieve 3,000 psi (21 megapascals) at 28 days. The concrete mix shall use 3/8 inch (No. 8) or larger coarse aggregate.

M.12.13—Wood: The materials for this work shall conform to the following requirements and shall have a Material Certificate, Certificate of Compliance and Certified Test Report in conformance with 1.06.07.

1. Wood in contact with or immersed in water, such as piers, docks, ferry slips, boardwalks, wharfs, bridges, etc. shall be one of the following: Bongossi, Ekki, or Azobe (*Lophira Alata*, *Lophira Procera*), Bonalim (*Dinizia Excelsa*) or Greenheart (*Ocotea Podiaei*).

Piles, dolphins, bulkheads or lead-in jetties shall be one of the following: Basralocus (*Dicorynia guianensis*, *Dicorynia paraensis*), Greenheart (*Ocotea Podiaei*) or Bongossi, Ekki or Azobe (*Lophira Alata*, *Lophira Prozera*) in order of preference.

2. Wood in contact with the ground such as piles, noise-wall or safety wall poles or posts, bulkheads, etc. shall be one of the following: Bongossi, Ekki or Azobe (*Lophira Alata*, *Lophira procera*), Bonalim (*Dinizia Excelsa*), Greenheart (*Ocotea Rodiaei*), Pressure Treated Southern Yellow Pine or Pressure Treated Douglas Fir-Larch. Pressure treatment shall be CCA in accordance with AWP A P-5, 0.60 pounds per cubic foot (9.6 kilograms/cubic meter) or Pentachlorophenol in accordance with AWP A P-9, Type B (L.P.G.), 0.50 pounds per cubic foot (8.0 kilograms/cubic meter).

3. Wood in above ground use such as decking, railings, bridges, noise or safety walls and platforms shall be one of the following: Bongossi, Ekki or Azobe (*Lophira Alata*, *Lophira Procera*), Bonalim (*Pinizia Excelsa*) or Greenheart (*Ocotea Rodiaei*).

Pressure treated wood, where specified shall be No. 1KD or better Southern Yellow Pine or Douglas Fir-Larch. Pressure treatment shall be CCA in accordance with AWP A P-5, 0.40 pounds per cubic foot (6.4 kilograms/cubic meter) or Pentachlorophenol in accordance with AWP A P-9, Type B (L.P.G.), 0.50 pounds per cubic foot (8.0 kilograms/cubic meter). Pressure treated wood shall be stained or painted in conformance with the plans or special provisions.

**SECTION M.13
ROADSIDE DEVELOPMENT**

M.13.01—Topsoil

M.13.02—Agricultural Ground Dolomitic Limestone

M.13.03—Fertilizer

M.13.04—Seed Mixtures

M.13.05—Mulch Materials

M.13.06—Compost

M.13.07—Plant Materials

M.13.08—Sod

M.13.09—Erosion Control Matting

M.13.01—Topsoil: The term topsoil used herein shall mean a soil meeting the soil textural classes established by the USDA Classification System based upon the proportion of sand, silt, and clay size particles after passing a No. 10 (2 millimeter) sieve and subjected to a particle size analysis. The topsoil shall not contain less than 6% nor more than 20% organic matter as determined by loss on ignition of oven-dried samples dried at 221° F (105° C).

The following textural classes shall be acceptable:

Loamy sand, including coarse, loamy fine, and loamy very fine sand

Sandy loam, including coarse, fine and very fine sandy loam

Loam

Silt loam, with not more than 60% silt

The topsoil to be furnished by the Contractor shall be loose and friable and free from refuse, stumps, roots, brush, weeds, rocks and stones over 1 1/4 inches (30 millimeters) in diameter. The topsoil shall also be free from any material that will prevent the formation of a suitable seedbed or prevent seed germination and plant growth.

The Contractor shall notify the Engineer of the location from which he proposes to furnish topsoil to the project at least 15 calendar days prior to delivery.

The topsoil and its source shall be inspected and approved by the Engineer before the material is delivered to the project. Any material delivered to the project, which does not meet specifications or which has become mixed with undue amounts of subsoil during any operation at the source or during placing and spreading, will be rejected and shall be replaced by the Contractor with acceptable material.

When topsoil is not furnished by the Contractor, it shall be material that is stripped in accordance with Section 2.02 or is furnished by the State from areas adjacent to the project, and shall meet the above specifications.

1. Planting Soil: Soil Material to be used for plant backfill shall be one of the following textural classes:

Loamy sand, with not more than 80% sand

Sandy loam

Loam

Silt loam, with not more than 60% silt

Clay loam, with not more than 30% clay

Sandy clay loam, with not more than 30% clay

Planting soil shall be made loose and friable, shall be free from refuse, stumps, roots, brush, weeds, rocks and stones 2 inches (50 millimeters) in diameter. The material shall also be free from any material that will prevent the proper planting of the plant material, or prevent the growth of plants.

- (a) For ericaceous plants and broad-leaved evergreens requiring an acid soil, planting soil shall have a true pH of 4.5 to 5.5. If it has not, it shall be amended by the Contractor at his own expense to the proper pH range by mixing with sulphur.
- (b) Planting soil for general planting of nonacid-loving plants shall have a true pH value of 5.6 to 6.5. If it has not, it shall be amended by the Contractor at his own expense to the proper pH range by mixing with dolomitic limestone.

The amount of either sulphur or limestone required to adjust the planting soil to the proper pH range (above) shall be determined by the Engineer on the basis of agronomic tests. The limestone shall conform to the requirements of Article M.13.02. The sulphur shall be commercial or flour sulphur, unadulterated, and shall be delivered in containers with the name of the manufacturer material, analysis and net weight (mass) appearing on each container.

The Engineer reserves the right to draw such samples and to perform such tests as he deems necessary to assure that these specifications are met.

M.13.02—Agricultural Ground Dolomitic Limestone: Agricultural ground dolomitic limestone shall conform to the standards of the Association of Official Agricultural Chemists, and must comply with all existing State and Federal regulations.

The material must comply with the following gradation:

Square Mesh Sieves	Percent Passing By Weight (Mass)
Pass #10 (2.0 millimeters)	100
Pass #20 (850 microns)	90
Pass #100 (150 microns)	40
The minimum calcium carbonate equivalent shall be	90

The Engineer reserves the right to draw such samples and perform such tests as he deems necessary to assure that these specifications are met.

M.13.03—Fertilizer: Fertilizer shall be commercial grade granular 10-10-10 fertilizer. The fertilizer shall be delivered to the project in new, clean, sealed containers which bear a label fully describing the contents, the chemical analysis of each nutrient, the fertilizer grade, the net bulk, the brand, and the name and address of the manufacturer. The fertilizer and labels shall conform to all existing State and Federal regulations, and shall meet the standards of the AOAC.

The delivery of each shipment of fertilizer to the project shall be accompanied by a properly executed and acceptable affidavit of the form shown herein. The affidavit shall be submitted to the Engineer. The Engineer reserves the right to draw such samples and perform such tests as may be deemed necessary to insure compliance with these specifications.

Form for Affidavit—Fertilizers (Official Stationery of Supplier)

Date

To Whom It May Concern:

I hereby certify that I have sold and deliveredtons
of commercial fertilizer ofgrade. This material is designated as our batch
number(s).....
and was delivered to.....
for

(Contractor's Name)

Connecticut Department of Transportation Project Number(s):

.....

at, Connecticut. The material was delivered
on The labels and contents meet all State and
Federal regulations.

(List analyses of each major plant nutrient as percent by weight (mass).)

Signature

Company Official

Signature and Seal.....

Notary Public

Should the material fail to conform with these specifications, the Contractor shall supply additional acceptable material and perform such work necessary to rectify the deficiencies without cost to the State.

M.13.04—Seed Mixtures: (a) The grass seed mixture shall conform to the following:

<u>Species</u>	<u>Proportion By Weight (Mass) Pounds (kilograms)</u>	<u>Minimum Purity (Percent)</u>	<u>Minimum Germination (Percent)</u>
CHEWINGS FESCUE, <u>(FESTUCA RUBRA VAR. COMMUTATA)</u> CERTIFIED VARIETY: JAMESTOWN, ATLANTA, VICTORY, SHADOW OR EQUAL CERTIFIED VARIETY; NAME THE VARIETY	35 (15.9)	97	80
HARD FESCUE, <u>(FESTUCA LONGIFOLIA)</u> CERTIFIED VARIETY: RELIANT, SPARTON, SCALDIS OR EQUAL CERTIFIED VARIETY; NAME THE VARIETY	30 (13.6)	96	85
COLONIAL BENTGRASS, <u>(AGRASTIS TENUIS)</u> CERTIFIED VARIETY: HIGHLAND OR EQUAL CERTIFIED VARIETY; NAME THE VARIETY	5 (2.3)	95	90
BIRDSFOOT TREFOIL, <u>(LOTUS CORNICULATUS)</u> VARIETY ARVENIS, CERTIFIED VARIETY: EMPIRE OR EQUAL LOW GROWING VARIETY; NAME THE VARIETY	10 (4.5)	96	90
PERENNIAL RYEGRASS, <u>(LOLIUM PERENNE)</u> TRUF TYPE, CERTIFIED VARIETY: NAME THE VARIETY	20 (9.1)	98	90

The Birdsfoot Trefoil will be inoculated before planting. Under no circumstances should annual Ryegrass, Italian Rye, or any other seed be added to the seed mixture.

(b) The "temporary" grass seed shall be perennial ryegrass (*Lolium perenne*) or an improved variety thereof, such as Manhattan, having a minimum purity of 98% and a minimum germination of 90%.

The seed mixture shall be delivered in new, clean, sealed containers. Labels and contents shall conform to all State and Federal regulations. Seed shall be subject to the testing provisions of the AOSA.

The seed shall be delivered to the project accompanied by a properly executed affidavit for each type and shipment of seed. The affidavit shall be of the form shown herein. The Engineer reserves the right to take such samples and to make such tests as he may deem necessary to insure compliance with these specifications. The Contractor shall supply such additional acceptable material and perform such work as

required to rectify any deficiencies without cost to the State.

Form for Affidavit—Seed (Official Stationery of Supplier)

Date

To Whom It May Concern:

I hereby certify thatpounds. (kilograms) of seed mixture, lot number, (Label attached) has been sold and delivered to for.....

(Contractor's Name)

Connecticut Department of Transportation Project number(s)

..... at, Connecticut. The material was delivered on The labels and contents meet all State and Federal regulations. The mixture consists of:

(State component parts, proportions, minimum purity, minimum germination.)

Signature

Company Official

Signature and Seal.....

Notary Public

M.13.05—Mulch Materials:

1. Wood Chips: Wood chips shall be obtained from sound, green wood, and shall be 1/8 inch (3 millimeters) nominal thickness with not less than 50% of the chips having an area of not less than one square inch (650 square millimeters), nor more than 6 square inches (3900 square millimeters). The material shall be free from rot, leaves, twigs, shavings, debris, and any material injurious to plant growth.

2. Hay: Hay shall be from acceptable grass or legume mowings, free from weeds, reeds, twigs, debris or other objectionable material. It shall be free from rot or mold, and shall have a moisture content of not more than 15% when delivered to the project. No salt hay shall be used.

3. Wood Fiber Mulch: Wood fiber mulch or wood cellulose fiber mulch shall be material manufactured for mulching seeded areas. The material may be made from coniferous or hardwood trees. It shall be free from shavings, rot, mold, foreign material or debris. It shall be of uniform texture. It may contain a nontoxic marking dye. The moisture content of the material when delivered to the project shall not be more than 12% by weight (mass). It must be capable of forming a homogeneous slurry when mixed in water. It shall be delivered to the project in clean, new, sealed containers bearing the brand, net weight (mass), and name and address of the manufacturer.

The Engineer reserves the right to draw such samples and perform such tests on any mulch material as deemed necessary to assure that the material meets all requirements.

M.13.06—Compost: Compost shall be a stable, humus-like organic material produced by the biological and biochemical decomposition of source-separated compostable materials, separated at the point of waste generation, that may include, but are not limited to, leaves and yard trimmings, food scraps, food processing residuals, manure and/or other agricultural residuals, forest residues and bark, and soiled or non-recyclable paper. Compost shall not be altered by the addition of materials such as sand, soil and glass. Compost shall contain no substances toxic to plants and shall not contain more than 0.1% by dry weight (mass) of man-made foreign matter. Compost shall pose no objectionable odor and shall not closely resemble the raw material from which it was derived. Compost shall have a minimum organic matter content of 30% dry unit weight (mass) basis as determined by loss on ignition in accordance with ASTM D 2974. Compost shall be loose and friable, not dusty, have no visible free water and have a moisture content

of 35 – 60% in accordance with ASTM D 2974. The particle size of compost shall be 100% less than 1 inch (25 millimeters) in accordance with AASHTO T 27 and shall be free of sticks, stones, roots or other objectionable elongated material larger than 2 inches (50 millimeters) in greatest dimension. The pH of compost shall be in the range of 5.5 - 8.0. The maturity of the compost shall be tested and reported using the Solvita Compost Maturity Test and must score 6 or higher to be acceptable. The soluble salt content of compost shall not exceed 4.0 mmhos/centimeter as determined by using a dilution of 1 part compost to 1 part distilled water. Compost may be either commercially packaged or used in bulk form. All compost shall be from DEP regulated, permitted or approved facilities. All compost material must be environmentally acceptable and must be accompanied by a Materials Certificate and Certified Test Report in accordance with Section 1.06.07. The Engineer reserves the right to draw samples and perform tests as may be deemed necessary to assure that the material conforms to these specifications.

M.13.07—Plant Materials: The materials for this work shall conform to the following requirements:

1. General: For the most part, "Standardized Plant Names," 1942 edition prepared by the Editorial Committee of the American Joint Committee on Horticultural Nomenclature, shall be the authority for all botanical plant names.

All plants shall be first-class representatives of their normal species or varieties. They shall have well-furnished branch systems together with vigorous fibrous root systems.

Plants shall be free from all insect pests, plant diseases, disfiguring knots, stubs, sun-scalds, abrasions of the bark or any other form of injury or objectionable disfigurements. All plant material shall comply with the State and Federal laws with respect to inspection for plant diseases and insect infestations.

Plants shall not be pruned before delivery and no plants shall be cut back from larger sizes to meet the sizes specified.

Plants shall be nursery grown unless otherwise specified and bear evidence of proper nursery care, including adequate transplanting and root pruning.

No plant will be considered to be nursery grown unless it has been growing in a nursery for at least two years and unless it has been root pruned or transplanted no more than five years prior to digging.

2. Nursery-Grown Plants: Nursery-grown plants shall conform with the requirements as specified in the current edition of "U.S. American Standards for Nursery Stock," or as further specified in the plans. Nursery-grown trees shall have no cuts which are not healing, no cuts over 3/4 inch (19 millimeters) in diameter which have not completely calloused over and no abrasions of the bark. They must have good fibrous root systems characteristic of the kind.

Trees shall have straight trunks, well-balanced tops and a single leader or as may be characteristic of the species.

Trees in which the leader or branches have been cut back or otherwise topped or de-horned will not be accepted. The caliper of shade trees up to and including 4 inches (100 millimeters) in diameter shall be measured above the root collar (or swelling at the ground) 6 inches (150 millimeters) above ground level. Caliper shall be the determining measurement in grading. Height measurements shall be given in single feet (half meters) in sizes up to and including 6 feet (2 meters) (e.g. 1.5-2 meters) and single meters in larger sizes (e.g. 2-3 meters).

Small deciduous trees shall be completely natural. Tree "clumps" shall have three or more main stems starting from the ground. Bush from trees shall be those with branches which start from the main trunk close to the ground in the manner of a shrub.

Vines and groundcover plants shall be well-furnished with vigorous root systems. They shall be field-grown unless otherwise specified. Plants grown in pots or bands shall have sufficient roots to retain the soil in which they are growing when such plants are removed from their containers. However, such plants shall not be root-bound.

3. Collected Plants: Collected plants specified to be collected from a natural environment, or from a site where they were planted as seedlings or transplants and where they may not have received subsequent care, shall be clean, sound stock free from any form of injury. The quality of balled and burlapped (B & B) trees and shrubs shall be identical with that specified for nursery-grown B & B and balled, burlapped and platformed material.

Preference will be given to plants which have been previously transplanted or root pruned at sufficiently frequent intervals to have developed a fibrous root system as follows:

- (a) No tap root shall be present.
- (b) The majority of lateral roots extending beyond the dimensions of the ball shall be fibrous or pliable enough to allow combing out and saving. (This means that said roots must be pliable enough to bend

around the ball of the plant without breakage or rupture).

A lateral root over 3/4 inches (19 millimeters) in diameter at its protrusion beyond the dimension of the ball shall not be considered pliable enough to save.

The length of the majority of lateral roots protruding beyond the ball shall not be greater than will allow the smallest fibrous rootlets at their tips to be saved. Lateral roots, which extend beyond the ball more than approximately one-half the given diameter of the ball, shall not be considered practical to save.

Root-pruning shall consist of the complete severance of the bottom tap roots and side roots. No plant will be accepted if it has not completely recovered from the shock of its last root pruning. (Recovery may take one or more growing seasons).

Plants not meeting these transplanting and root pruning requirements, but acceptable to the State in all other particulars as to size and quality, may be accepted, provided the diameter of the ball furnished is at least one-third greater than that specified above for nursery-grown plants of the same kind and size, or as the Engineer may specifically direct in writing. The specified dimensions for the size of ball shall not be decreased except in specific cases and only by special permission of the Engineer.

Plants specified as clumps shall be collected from good soil which has produced a fibrous root system typical of the nature of the plant. The clumps shall be dug with earth and incidental vegetation adhering to the roots.

4. Inspections: All plants shall be subject to inspection by the Engineer. The Contractor shall designate his wholesale plant material source(s) of supply to the Engineer in writing at least one month in advance of each planting season to facilitate an orderly and timely inspection of the items to be installed. The Contractor shall be represented during such inspection. Inspection may be made at the nursery, plantation, or collecting field by the Engineer. The Department reserves the right to make inspections outside the State of Connecticut, at all contractor designated plant material sources of supply.

Further inspections will be made when the materials are delivered to the project site or storage area. All tagged samples shall be delivered to the project for which they were sampled. All deliveries to the planting site shall be accompanied by both the vendor's invoice, designating kind, size, quantity and sources of supply and certificates of inspection in accordance with M.13.07-8 (Certificates of Inspection). The State reserves the right to inspect all plant materials at the growing sites.

5. Substitutions: No change in size, kind or quality of plants from those specified will be permitted without written approval of the Engineer. The Contractor shall submit a written request for permission to make a substitution. Upon receipt of this letter, the Engineer will suggest plants meeting the requirements of the contract as to function, size and type and indicate the reduced cost to the State as the result of said substitution. In no case shall the price for substitutions exceed the bid price of those replaced.

The Engineer may approve, on the basis of unavailability, the substitution of plantation-grown or collected plant materials for specified nursery-grown materials at price reductions of 10% and 20% respectively below the contract unit bid price to the State.

Plantation-grown stock are plants which have been systematically set out in clean, open, tillable, agricultural soil, but where a minimum of aftercare has been carried out.

Collected stock are plants of natural origin (not planted by man) with little or no subsequent care.

6. Digging Plants: Plants shall be dug immediately before shipment. Special precaution shall be taken to avoid any unnecessary injury to or removal of fibrous roots. Damaged roots shall be cut off clean. No cold storage plants will be accepted unless authorized by the Engineer.

- (a) After deciduous bare-root plants are dug, their roots shall be protected from exposure to sun, wind and freezing temperatures. All bare roots of trees, shrubs and vines, unless otherwise directed, shall be puddled in a wet clay mixture which will cover and adhere to the entire root system. Bare roots shall be further protected by wrapping them in wet straw, moss, burlap or other suitable material, or by heeling them in and watering them in order to keep them fresh and viable.
- (b) Balled and burlapped plants shall be lifted so as to retain as many fibrous roots as possible. All B & B plants must come from soil which will hold a firm ball. The latter shall be wrapped with burlap, or similar approved material, and tightly laced in such a manner as to hold the balls firm and intact. All B & B material arriving with broken or loose balls, or with manufactured balls, will be rejected.

7. Transportation and Labeling: Plants transported by open vehicles shall be covered by tarpaulins or other suitable covers securely tied to the body of the vehicle. Closed vehicles shall be adequately ventilated to prevent overheating of the plants. The heads of trees shall be tied in carefully to prevent breakage of the leaders and the branches. Trunks and branches shall be adequately supported on padding to prevent their being scraped or bruised.

Legible labels shall be attached to all separate plants, boxes, bundles, bales or other plant containers, indicating the name, size, and quantity of units in each container and other information necessary for inspection.

8. Certificates of Inspections: Certificates of inspections, issued by Federal or State authorities (or both) attesting to the freedom of the plant material from diseases and insect infestations, shall accompany each shipment, invoice or order of stock. On arrival of shipment, such certificates shall be filed with the Engineer.

9. Delivery: Notice of delivery of plants shall be given to the Engineer by the Contractor at least 48 hours in advance of the anticipated delivery date, unless otherwise authorized. The Engineer shall be furnished a legible copy of the invoice for each shipment showing kind, sizes and quantities of materials.

All plant materials which are delivered in such a stage as to reasonably endanger their survival will not be accepted.

All plant materials shall be produced in a latitude north of Washington, D.C. and in a longitude east of the Mississippi River.

10. Spring Planting: All deciduous plants shall be received with buds unopened and intact; evergreen plants with the new growth retarded.

11. Fall Planting: Deciduous plants shall not be dug before the plants have hardened off.

12. Water: Water shall be free from oil, acid, alkalis, salts and any other substances harmful to plants. Water from streams shall not be used unless authorized by the Engineer.

13. Peat:

- (a) Peat shall be commercially packaged peat from sedge, sphagnum or reed sources. Material shall be in such physical condition that it may be rudded through a 1/2-inch (12.5-millimeter) mesh screen, and may be readily mixed with soil material. It shall be free from sticks, roots, stones and other objectionable material. It shall be delivered to the project in clean, new, sealed containers bearing the brand, net bulk, and name and address of the packer. The material shall have an acidity that falls in the pH range of 3.0 to 7.0. It shall have a minimum organic content of 90% and a minimum water-absorbing capacity of 1000%. The Engineer reserves the right to draw such samples and perform such tests as may be deemed necessary to assure that the material conforms to these specifications.
- (b) Compost conforming to Article M.13.06 may be substituted for peat.

14. Miscellaneous:

- (a) Anchor stakes for guying trees shall be of sound hardwood with a minimum length of 2 feet (610 millimeters) and minimum diameter of 2 inches (50 millimeters) at the smaller end. Stakes made from lumber shall measure no less than 2 inches x 2 inches (50 millimeters x 50 millimeters) in section throughout their lengths. Trees over 3 1/2 inches (90 millimeters) in caliper shall require either stakes or dead-men for support as approved by the Engineer. The type of stake used shall be uniform throughout the job.
- (b) Tree support posts shall be sawed posts cut to a uniform square cross-section of 2 inches x 2 inches (50 millimeters x 50 millimeters) throughout their lengths. They shall be cut from sound, hard, clean, straight wood free from crooks, 8 feet (2.5 meters) long for major trees and 4 - 5 feet (1.2 meters - 1.5 meters) long for minor trees or as approved by the Engineer.
- (c) Hose for protecting the bark of major and minor trees from guy wires shall be of good quality rubber or plastic hose acceptable to the Engineer, with a minimum inside diameter of 3/8 inch (9.5 millimeters) and a maximum inside diameter of 3/4 inch (19 millimeters).
- (d) Guy wire shall be pliable, new, annealed, galvanized, 12-gage, for staking trees and 10-gage for guying.
- (e) Flags shall be white cotton cloth or white plastic ribbon, 2 inches (50 millimeters) wide and 18 inches (460 millimeters) long. Gauze is not acceptable.
- (f) Tree wound paint shall be waterproof tree paint approved by the Engineer.
- (g) Anti-desiccant shall be an emulsion such as will provide a film over plant surfaces, permeable enough to permit transpiration. Anti-desiccant shall be delivered in containers of the manufacturer and shall be mixed according to the manufacturer's instructions.
- (h) Wrapping material for tree trunks shall be treated, laminated tree wrapping paper in rolls, four inches (100 millimeters) wide, or as approved by the Engineer.
- (i) Twine for tying wrapping material to trees shall be jute twine not less than 2-ply for trees under 3 inches (75 millimeters) in caliper, and not less than 3-ply for trees of larger caliper.

M.13.08—Sod: Sod shall be living sod procured from areas where the soil is reasonably fertile and from

areas similar in the degree of moisture to the area to be planted. It shall be cut or stripped, by approved methods, from turf areas relatively free of large stones, roots or other materials which might be detrimental to the sodding operation or to future maintenance. The sod shall contain a sufficient proportion of pasture grasses to insure a good mat of roots and a reasonably dense turf unless Type No. 1, which is a superior quality, is specified on the plans.

Any growth more than 3 inches (75 millimeters) in height shall be mowed to a height of 3 inches (75 millimeters) not more than 5 days before the sod is lifted.

Sources of sod shall be made known to the Engineer at least 5 days before cutting and shall be approved before mowing. The sod shall be cut into squares or rectangular portions which shall be 12 inches (300 millimeters) wide and may vary in length, but must be of a size which will permit them to be lifted without breaking. The sod shall be sufficiently moist so the soil will adhere firmly to the roots when it is handled and may require watering before lifting. Field grown sod shall be cut to a minimum depth of 1 1/2 to 2 inches (38-50 millimeters). Where Type No. 1 Sod is specified, it shall be cut to a minimum depth of 1 to 1 1/2 inches (25-38 millimeters).

Type No. 1 Sod shall be obtained from inspected and approved commercial sod farm sources of supply and shall be free from noxious weeds, insect infestations, and fungus and bacterial diseases.

M.13.09—Erosion Control Matting: Erosion control matting shall be from the Department's Qualified Products List. Staples shall conform to the Manufacturer's requirements. Material which shows signs of degradation shall not be used and shall be removed from the project.

SECTION M.14
PRESTRESSED CONCRETE MEMBERS

M.14.01—Materials: Materials for pretensioned members shall conform to the following requirements:

1. Concrete: The concrete for the members shall be air-entrained concrete composed of Portland cement, fine and coarse aggregates, admixtures and water. The air-entraining feature may be obtained by the use of either air-entraining Portland cement or an approved air-entraining admixture. The entrained air content shall be not less than 4% or more than 6%.

The Contractor shall design and submit to the Engineer a concrete mix which shall attain a minimum 28-day strength (f_c) as shown on the plans. The compressive strength (f_{ci}) at the time of transfer of prestressing load shall be as shown on the plans. The Contractor shall further provide a certificate stating that the mix submitted shall meet the requirements. Its ultimate strength at 28 days (f_c) shall have the minimum value shown on the plans.

a) Coarse Aggregate shall consist of broken stone, having a maximum size of 3/4 inch (19 millimeters), conforming to the requirements of Article M.03.01.

b) Fine Aggregate, Water, Air-Entraining Admixture and Retarder Admixture shall conform to the requirements of Article M.03.01.

c) Portland Cement for the members shall conform to the requirements of M.03.01, except that Type III or Type IIIA Portland cement may be used at no additional cost to the State.

d) Water-Reducing Admixture: The Contractor may submit, for the approval of the Engineer, water-reducing admixture for the purpose of increasing workability and reducing the water requirement for the concrete.

When the Engineer has previously approved the use of a high range water reducer in the concrete mix, the entrained air content shall be not less than 5% nor more than 8%.

(e) Calcium Chloride: The addition to the mix of calcium chloride or admixture containing calcium chloride will not be permitted.

2. Prestressing Steel: Prestressing elements shall be uncoated, high tensile strength, seven-wire strand conforming to the requirements of AASHTO M 203.

Before incorporating the elements into the work, a minimum of one sample, 7 feet (2.2 meters) in length and one sample, 1 foot (25 millimeters) in length from each reel shall be furnished to the Engineer for testing. When reel packs are identified with the same heat number, only one reel pack need be tested for every 5 reel packs.

3. Reinforcing Steel and Tie Wire: All deformed bars, stirrups, dowels, threaded dowels and tie wire shall conform to the requirements of Article M.06.01-1.

4. Paint for the main prestressing strand ends shall conform to the requirements of Article M.08.01-5 for coating material.

5. Strapping for the beams shall be 3/4 inch x 0.035 inch (19 millimeter x 0.9 millimeter), uncoated or galvanized, heavy-duty steel strapping having a minimum ultimate tensile strength of 110,000 psi (760 megapascals). Strapping shall be obtained from a manufacturer approved by the Engineer.

Before incorporating the strapping in the work, samples of the strapping at least 3 feet (1 meter) long shall be furnished from each coil for testing. Approval of the material shall be obtained before the material is incorporated in the work.

6. Lifting Hooks, Pipe Sleeves, Base Protective Plates, Threaded Inserts, devices and attachments shall be of the size indicated on the plans or of a design satisfactory for the purpose intended.

7. Transverse Tie Strands shall be galvanized 7-wire strand, of the size noted on the plans, specially manufactured for prestressing, and shall conform to the pertinent requirements of Article M.14.01-2. The tie strands shall be coated with an approved high quality corrosion-resistant mastic and inserted into a black polyethylene tube having a minimum wall thickness of 0.032 inch (0.9 millimeter). The strands shall be clamped at each end by an aluminum strand vise coated with clean vinyl paint or an approved equal.

8. Nonshrink Grout for Longitudinal Shear Keys between Deck Units and for Recesses at Ends of Transverse Tie Strands and Deck Units. The grout shall conform to the requirements of Article M.03.01-12. At exposed locations, the grout used for patching shall match the color of the adjacent surface.

9. Void Forms: Internal voids may be formed by the use of heavy paper or fiber forms, specially made for this purpose, or with an alternate acceptable to the Engineer. These forms must be of substantial construction and adequately waterproofed in order to maintain their shape during the entire construction cycle. The end caps shall also be of similar construction. Before incorporation of the forms in the work, a sample 4 feet (1.2 meters) in length with end caps shall be furnished the Engineer for testing. Approval of the material shall be obtained before the material is incorporated in the work.

**SECTION M.15
HIGHWAY ILLUMINATION**

- M.15.01—General Requirements**
- M.15.02—Anchor Bolts**
- M.15.03—Rock Anchors**
- M.15.04—Light Standards**
- M.15.05—Roadway Luminaire**
- M.15.06—Vacant**
- M.15.07—Underbridge Luminaire**
- M.15.08—Vacant**
- M.15.09—Electrical Conduit:**
- M.15.10—Cast Iron Junction Box**
- M.15.11—Single Conductor**
- M.15.12—Cable in Duct**
- M.15.13—Bare Copper Grounding Conductor**
- M.15.14—Vacant**
- M.15.15—Service Entrance Cabinets**
- M.15.16—Navigation Light**

M.15.01—General Requirements: The contractor may use material and products of any manufacturer provided they meet the design standards and are approved by the department. Materials requiring approval are as follows:

1. Light standards
2. Luminaires
3. Service Items
4. Junction Box
5. Single Conductor
6. Cable in Duct
7. Navigation Lights

M.15.02—Anchor Bolts:

1. Light Standard Base: Anchor bolts shall be high strength steel having a minimum yield point of 50,000 psi (345 megapascals). Each anchor bolt shall have a thread 6 inches (150 millimeters) long. The dimensions shall be as shown on the plans. A hexagon nut, hold down washer, and lock washer, shall be furnished with each bolt. The threads and hexagon nuts shall be hot-dip galvanized as per ASTM A 153/A 153M

2. Pedestal and Controller Foundation: The anchor bolts shall be ASTM A 36 steel rods having a minimum yield of 36,000 psi (250 megapascals). The dimensions shall be as shown on the plans. Each anchor bolt shall have a 90-degree bend at one end and shall be threaded at the other end for a sufficient length to properly mount the pedestal or controller. Threads, nuts, flat washers and lock washers shall be galvanized as per ASTM A 153/A 153M.

3. Span Pole and Mast Arm Foundations: Anchor bolts shall meet the requirements of AASHTO Specification M 314. In addition, only Grade 55 or Grade 105 material may be used. The threaded end of Grade 55 material must be painted yellow. The threaded end of Grade 105 material must be painted red. Steel conforming to ASTM Specifications A 675 Grade 90, A 449 or A 687 is also acceptable and, if used, shall be clearly designated as such on the submitted shop drawings, and properly annotated on all certifications.

The chemical requirements for all categories are a maximum Phosphorous content of 0.04% and a maximum Sulfur content of 0.05%.

Anchor bolts shall have a diameter of at least 1 1/2 inches (38 millimeters). The dimensions shall be as shown on the plans or as recommended by the manufacturer. Each anchor bolt shall be furnished with two nuts, two flat washers, and one lock washer. The threads, nuts and washers shall be hot-dip galvanized in accordance with the requirements for Class C of AASHTO M 232 (equivalent to ASTM A 153/A 153M). The nuts shall conform to the requirements for nuts within AASHTO M 314.

Field welding and field bending of anchor bolts is prohibited. If anchor bolts do not fit with the base plate, the Contractor shall replace the foundation or use a remedy recommended by the pole manufacturer and approved in writing by the Engineer.

The Contractor shall ensure plumbness of the hooked anchor bolts in the foundation. A minimum anchor bolt embedment of at least 4 feet (1.2 meters) is required. The amount of threading shall be as shown on the typical drawings.

Bolt Sampling Requirements:

1. Submit samples marked by manufacturer or fabricator.
2. Submit one sample of each size and heat number.
3. Submit a proper Materials Certificate for each sample.
4. Submit a proper Certified Test Report for each sample.

M.15.03—Rock Anchors: Rock anchors shall be malleable iron dipped in corrosion-resistant asphalt paint.

M.15.04—Light Standards: (anchor base and transformer base), (aluminum).

(a) **General:** Each light standard with appurtenances attached thereto shall be fabricated of aluminum alloy, designed and constructed in accordance with the plans and current requirements of AASHTO "Standard Specification for Structural Support for Highway Signs, Luminaires and Traffic Signals." Light standards with brackets and luminaires shall be designed to withstand a wind speed of 90 mph (145 kilometers per hour).

(b) **Base:** Light standard with transformer base shall conform to the breakaway requirements of the current AASHTO "Standard Specifications for Structural Support for Highway Signs, Luminaires and Traffic Signals" and shall be identified with visible markings. The transformer base shall be approximately 17 inches (430 millimeters) high with a door having an approximate opening of 9 inches x 12 inches (250 millimeters x 300 millimeters).

A bonding lug shall be provided in each transformer base and each anchor base shaft shall have the handhole frame or anchor base tapped for bonding. All castings shall be clean and smooth with all details well-defined and true to pattern. It shall be the Contractor's responsibility to verify existing bolt circle diameters by field checking that the bolt circle of the light standard base will match the anchor base on the foundation or structure.

(c) **Shaft:** Shaft shall be fabricated of aluminum alloy 6063-T6 or 6005-T5 as specified under AASHTO, current edition. Each shaft shall be seamless, tapered, circular in cross section. The shaft shall be one piece, however shafts over 40 feet (12 meters) may be fabricated from two pieces and factory joined, welded, grounded to appear as one piece and have a smooth continuous finish.

Each shaft shall be designed and fabricated in such a manner that each shaft-bracket connection will accommodate single member type brackets 2 to 8 feet (1 meter to 2 meters) in length, or truss type brackets 10 feet to 15 feet (3 meters to 5 meters) in length. Each shaft designed to 2 feet to 8 feet (1 meter to 2 meters) single member bracket shall have the wall thickness of that required for the 8-foot (2-meter) bracket, and each shaft for the 10-foot to 15-foot (3-meter to 5-meter) truss type bracket shall have the wall thickness of that required for the 15-foot (5-meter) bracket.

Each shaft shall be provided with an aluminum pole cap with self-tapping screws and an internal vibration damper. The internal vibration damper shall be factory installed, location and size as determined by the pole manufacturer.

The shaft shall be finished with a uniform surface having the natural color of aluminum. The shaft shall have a smooth, uniform finish, free from disfiguring scratches, dents and similar markings.

(d) **Bracket Arms:** The bracket arms shall have an upsweep design and shall accommodate a 2-inch (50-millimeter) slipfitter type luminaire, fabricated of tubular elliptical aluminum which after fabrication shall have a mechanical strength not less than that of T-6 temper for 6063 alloy and T-5 temper for 6005 alloy. Truss type brackets shall have an aluminum end cap on the bottom member and a 1/8-inch (4-millimeter) weep hole located in the vicinity of the lowest point of the bottom member. The bracket arms shall be a truss-type for lengths 10 feet (3 meters) and longer and shall consist of a single member for shorter lengths. The bracket arm shall be furnished with a finish similar to that of the shaft to insure uniformity of appearance. The maximum upsweep for brackets up to 15 feet (5 meters) in length shall not exceed 3 feet 6 inches (1 meter). Bracket arm lengths shall be as indicated on the plans.

(e) **Handhole:** Each anchor base light standard shall have a handhole with a reinforced frame and cover approximately 4 inches x 6 inches (100 millimeters x 150 millimeters) located approximately 12 inches (300 millimeters) up from the base of the pole and placed 90 degrees from the bracket arm on the far side of the traffic flow.

(f) **Isolation Pad:** Each light standard mounted on any bridge structure shall have 1/2-inch (12-

millimeter) thick elastomeric pad of the same surface area as pole base, installed between the pole base and the structure, with four 11/32-inch (10-millimeter) thick by 2-inch (50-millimeter) O.D. minimum elastomeric washers installed on the top side of the base, between two standard galvanized flat washers. Elastomeric pads and washers shall conform to Article M.17.01.

- (g) **Hardware:** All screws, nuts, bolts, washers and miscellaneous hardware used to assemble the light standard, base and brackets shall be stainless steel with the exception of washers and nuts for anchor bolts. Stainless steel bolts and washers shall conform to the requirements of ASTM A193, Grade B8. Stainless steel nuts shall conform to the requirements of ASTM A 194, Grade 8.
- (h) **Design Requirements:** The pole manufacturer shall certify on the catalog cuts or shop drawings that the light standard, with appurtenances, conform to all pertinent requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" including the latest AASHTO breakaway requirements and in accordance with definition given to the latest edition of AWS, as specified under AASHTO, Section 5, Article 1.5.5., Fabrication of Welded Aluminum Structure.

M.15.05—Roadway Luminaire: The luminaire shall be of the "cobra-head" type for roadway lighting with gray finish. The housing shall be die-cast aluminum with refractor door hinged on one end and latched on the other. It shall have a 2-inch (50-millimeter) slip fitter for end mounting and factory-installed bird guard. Reflector is to be aluminum, refractor to be glass. The optical assembly shall have a captive, non-wicking gasket to filter air. There shall be no photoelectric control receptacle unless specifically required for the application, and there shall be no open holes in the housing. The socket shall be porcelain enclosed for mogul base lamp and adjustable to provide IESNA Light distribution type as shown on the plans.

The integral ballast shall be the regulator type with high power factor (above 90%) and in full compliance with current ANSI lamp/ballast specifications. Starting current shall be less than operating current. The ballast shall be capable of starting and operating a specified lamp at -20°F (-28°C). The unit shall be designed to operate under ±10% line voltage variation. The ballast shall operate at the specified circuit voltage. The entire ballast and starter unit shall be pre-wired and quick-disconnect type for ease of maintenance.

Conductors shall be #10 AWG in accordance with Article M.15.11. Insulation shall be THHN.

The breakaway-type fuse holders shall be of rubber or molded plastic housing which is watertight, as detailed on the plans. They shall be rated at 600 volts. Fuses shall be UL listed, fast-acting, current-limiting and rated at 10 amp, 600 volt and 100,000 AIC.

The luminaire shall have an identification sticker indicating the lamp type and wattage located on the underside of the luminaire, in accordance with current ANSI Standards.

The lamp shall be all position of the source and wattage called for on the plans, and in accordance with the current ANSI specification. The lamp shall be new and unused at the time of installation.

M.15.06—Vacant

M.15.07—Underbridge Luminaire: The luminaire shall be wall or pendent mounted with distribution type, wattage and voltage as specified on the plans.

The wall-mounted luminaire shall be complete with an optical assembly consisting of an anodized aluminum reflector and a single piece prismatic refractor made of thermal shock-resistant borosilicate glass protected by a clear polycarbonate shield. If specified, a steel wire guard shall be placed over the polycarbonate shield or used in lieu of the polycarbonate shield. The door shall be die-cast aluminum, self-hinged and secured by two captive stainless steel threaded fasteners. The housing shall be die-cast aluminum with a 3/4-inch (19-millimeter) threaded top entry and a captive non-wicking filtering gasket against which the door shall seat when closed. The luminaire shall provide a maximum vertical candle-power under 75 degrees and shall be UL listed as suitable for wet locations.

The pendant mounted luminaire shall be complete with a prismatic polycarbonate refractor and UL listed as suitable for wet locations. The housing shall be die-cast aluminum with a 1 1/4-inch (32-millimeter) threaded top entry and a die-cast aluminum refractor holder hinged to the luminaire housing in a manner that allows easy removal of the assembly. The refractor shall be securely held by means of a stainless steel hinge and a positive acting spring loaded latch which will permit single action release and closing with a snap action.

The lamp socket shall have a porcelain enclosed mogul base. The socket for a pendent mounted luminaire shall be adjustable to provide the IESNA light distribution type called for on the plans.

The integral ballast shall be the regulator type with high power factor (above 90%) and in full compliance with current ANSI lamp/ballast specifications. The ballast shall be capable of starting and operating a

specified lamp at -20°F (-28°C). Starting current shall be less than operating current. The unit shall be designed to operate under ± 10% line voltage variation. The ballast shall operate at the circuit voltage specified on the plans. The entire ballast and starter unit shall be pre-wired.

Conductors shall be #10 AWG, 600V, in accordance with Article M.15.11. Insulation shall be THHN.

Fuse holders shall be of rubber or plastic molded housing which is watertight and shall be used in each branch circuit supplying a luminaire or luminaires. They shall be rated at 600 volts. Fuses shall be UL listed, fast-acting, current-limiting and rated at 10 amp, 600 volt and 100,000 AIC.

Mounting materials and hardware shall be as indicated on the plans or as directed by the Engineer.

Conduit shall be in accordance with Article M.15.09.

The luminaire shall have an identification sticker indicating the lamp type and wattage in accordance with current ANSI Standards.

The lamp shall be all position of the source and wattage called for on the plans, and in accordance with the current ANSI Standard. The lamp shall be new and unused at the time of installation.

M.15.08—Vacant

M.15.09—Electrical Conduit:

1. Rigid Metal Conduit: Rigid Metal Conduit (RMC) and fittings shall be galvanized steel. Each section of conduit shall be labeled as UL listed, and shall conform to the requirements of the latest UL and ANSI standards for Rigid Metal Conduit. Set-screw or compression fittings shall not be used.

2. Intermediate Metal Conduit: Intermediate Metal Conduit (IMC) and fittings shall be galvanized steel. Each section of conduit shall be labeled as UL listed, and shall conform to the requirements of the latest UL and ANSI standards for Intermediate Metal Conduit. Set-screws or compression fittings shall not be used.

3. Polyvinyl Chloride Conduit: Polyvinyl Chloride Conduit (PVC) and fittings shall be UL listed, and shall conform to the requirements of the latest UL and ANSI standards for Polyvinyl Chloride Conduit. Schedule 40 grade shall be used where underground, Schedule 80 grade shall be used on surface.

4. Liquid Tight Flexible Metal Conduit: Liquid tight flexible metal conduit shall consist of a continuous strip of flexible galvanized metal, coated with an extruded jacket of polyvinyl chloride. Liquid tight flexible metal conduit shall be suitable for use in wet locations and shall meet the requirements of the latest UL and ANSI standards for liquid tight flexible metal conduit.

M.15.10—Cast Iron Junction Box: Junction Boxes shall be cast iron constructed to NEMA Type 4 requirements. The junction box cover shall be attached with approved stainless steel bolts and sealing washers, and shall be equipped with a neoprene cover gasket. For an 18-inch x 12-inch x 8-inch (450-millimeter x 300-millimeter x 200-millimeter) cast iron junction box, cover bolts shall be 1/4 inch x 5/8 inch (6 millimeters x 16 millimeters); threads shall be 20 N.C.; and the head shall be hex type and shall accept a 7/16-inch (11-millimeter) socket.

The covers for cast iron junction boxes shall be 1/4 inch (6 millimeter) thick steel conforming to the requirements of ASTM A 36 and shall be galvanized in accordance with ASTM A 123. Holes for the cover bolts shall be recessed in the cover plate to accept a 7/16-inch (11-millimeter) socket wrench.

All junction boxes recessed in concrete shall have an outside flush flange with a recessed cover and the conduit entrance holes shall be slip fit.

Junction boxes which are for surface mounting shall have threaded hubs or threaded bosses with a minimum of 5 full threads. All boxes and covers shall be hot-dip galvanized conforming to the requirements of ASTM A 153.

Rigid metal conduit for drain pipe shall conform to the requirements of Article M.15.09-1.

M.15.11—Single Conductor:

1. Insulation: Insulation type, size, and voltage rating shall be as shown on the plans. Insulation shall be permanently color identified throughout its entire length. Color shall be as called for on the plans. A green, white or natural gray color shall not be used unless it is a grounded conductor. The rating, type, size, and manufacturer shall be durably marked in accordance with the NEC.

2. Conductor: Conductors shall be single conductor, stranded, copper, meeting the latest ICEA, UL, NEMA, and FS for the type specified.

M.15.12—Cable in Duct: The materials for this item shall consist of single conductors in a flexible non-metallic conduit, the whole unit shall be pre-assembled for direct burial. The size, number and type of single conductors shall be as called for on the plans and shall conform to Article M.15.11. The conductors shall be laid parallel, not twisted, so they may be individually removed.

The duct size shall be governed by the number and size of the single conductors contained as listed below.

Nominal duct size shall be as follows unless otherwise noted on the plans:

- 1 1/4 inches (32 millimeters) with minimum bending radius of 18 inches (460 millimeters) for up to four No. 2 conductors.
- 2 inches (50 millimeters) with minimum bending radius of 24 inches (600 millimeters) for more than four No. 2 conductors and through four No. 2/0.

The duct material shall be polyethylene and meet the requirements of Schedule 40. The duct shall meet all applicable standards of the latest NEMA Standard Publications no. TC-2 and TC-7.

M.15.13—Bare Copper Grounding Conductor: The conductor shall be 7-strand, soft-drawn, bare copper wire of the size specified on the plans.

M.15.14—Vacant

M.15.15—Service Entrance Cabinets:

1. Cabinets: The service entrance cabinet and the lighting control cabinet shall be sheet aluminum and conform to NEMA type 3R enclosure requirements. Type and dimensions are as called for on the plans. The doors shall be hinged, weatherproof gasketed, with handle and Conn-1 lock for the lighting control cabinet, and a stainless steel door handle with hasp for utility company padlock for the service entrance cabinet. The cabinet shall have a full-size backboard of 3/4-inch (19-millimeter) smooth marine grade plywood, painted black.

2. Instrument Transformer Cabinet: The instrument transformer cabinet shall conform to the requirements for the service cabinet.

3. Meter Socket and Enclosure: The meter socket and enclosure shall conform to utility company specifications.

4. Pedestal: For pedestal mounted cabinets, the pedestal shall conform to Article M16.03.2.

5. Foundations: Concrete shall conform to Article M.03.01—Class "A." Anchor bolts shall conform to Article M.15.02.2. Pedestal foundation may be precast.

6. Transformer Pad: Concrete shall conform to Article M.03.01—Class "A." The pad may be pre-cast. This item shall conform to Utility Company requirements.

7. Ground Rod: The ground rod shall be dimensioned as shown on the plans, copper clad steel. The clamp shall be a square head bolt type.

8. Conduit: Conduit shall be of the type called for in the plans and conform to Article M.15.09.

9. Conductors: Conductors shall conform to Article M.15.11.

10. Photoelectric Control: The photoelectric control shall have an adjustable turn on setting set at approximately 2 foot-candles (20 lux) with a time delay of at least 3 to 5 seconds. The control relay shall have single pole double throw contacts rated for 1000 watts. The coil shall operate at 120 Volts AC. It shall be applicable to the electrically operated, mechanically held contactor. Conductors shall be #12 AWG conforming to Article M.15.11. The manual switch shall be a three-way toggle switch mounted in a single gang utility box.

11. Contactor: The control contactor shall be of the size, rating and number of poles, as shown on the plans. It shall be electrically operated (120 volt), and mechanically held.

12. Control Transformer: The transformer shall be dry type, single-phase, two winding for wall mounting, of the size rating and voltages as called for on the plans.

13. Circuit Breakers: Circuit breakers shall be thermal magnetic type, non-enclosed, front-connecting, for mounting to the backboard. The number of poles, voltage rating and current rating shall be as shown in the plans.

14. A utility light shall be mounted in the cabinet with porcelain or plastic base, pull chain and incandescent lamp.

15. Ground Fault-Circuit Interrupter Receptacle: The ground fault-circuit interrupter receptacle shall be 20 amp, 125 volt, 60 HZ Class A, and shall be UL listed.

16. Main Disconnect Safety Switch: The main disconnect safety switch shall be a heavy-duty, fused, three pole, single throw switch, with a manual lever, appropriate service grounding kit, rated for 480 volts, with a current rating as shown on the plans, NEMA Type 1 housing, UL-listed, and suitable for use as service equipment.

M.15.16—Navigation Light: The navigation light shall be of a type approved by the United States Coast Guard and shall be in accordance with their regulations for lighting bridges.

The navigation light shall be made with a bronze casting and shall be entirely weatherproof. It shall be ventilated to prevent sweating of the lens, and the vent shall be screened to prevent entry of bugs and insects. All parts of the lamp shall be interchangeable so that each lamp can be assembled with a 180-

degree or 360-degree 8-inch (200-millimeter) Fresnel lens.

Each navigation light shall be equipped with 2 100-watt, 120-volt lamps and a lamp failure relay. The green navigation lights shall have a 360-degree green Fresnel lens. The red navigation lights on the structure or pier shall have 180-degree red Fresnel lens.

Flexible cords shall be type S.O. three conductor #10 AWG rated at 600 volts.

SECTION M.16
TRAFFIC CONTROL SIGNALS

M.16.01—General Requirements

M.16.02—Vacant

M.16.03—Pedestals

M.16.04—Poles

M.16.05—Mast Arm Assembly

M.16.06—Traffic Signals

M.16.07—Pedestrian Signal

M.16.08—Pedestrian Push Button

M.16.09—Controllers

M.16.10—Flasher Cabinet

M.16.11—Vacant

M.16.12—Loop Vehicle Detector and Sawcut

M.16.13—Magnetic Vehicle Detector

M.16.14—Control Cable

M.16.15—Messenger and Span Wire

M.16.16—Vacant

M.16.17—Illuminated Signs

M.16.01—General Requirements: Where reference is made to certain manufacturers' material or products, it is not the intent to preclude the use of others, but rather to establish minimum acceptable design standards. The Contractor may substitute material and products of other manufacturers, provided they meet the minimum design standards and are approved by the Engineer.

M.16.02—Vacant

M.16.03—Pedestals: The materials for this work shall conform to the following requirements:

1. Vacant

2. Aluminum Pedestals:

(a) **Shaft:** The shaft shall be made of ASTM B 210 Grade 6063-T6 or ASTM B 221 Grade 6005-T5 aluminum alloy and shall be either a seamless tapered tube with a 6-inch (150-millimeter) outside diameter at the base and a 4 1/2-inch (115-millimeter) outside diameter at the top, or a seamless straight tube with a 4 1/2-inch (115-millimeter) outside diameter. The height of the pedestal shall be as required by the item. The shaft shall have a minimum wall thickness of 125 inches (3.2 millimeters) and shall be devoid of welding except at the base. The shaft shall be satin brush finished and each shaft shall be individually protected from scratches, dents and abrasions during handling and shipping.

(b) **Base:** The base shall be a permanent mold casting of 356 aluminum alloy conforming to ASTM B 108 and shall be of the dimensions shown on the plans. The tapered shaft shall be secured to the base by means of a circumferential fillet weld on the inside of the base top, and the straight shaft shall be secured by means of threads and machine screws, which when set, shall be flush with the base top. The base shall be provided with a cast aluminum door with dimensions shown on the plans, which shall be held in place by an approved locking device. Each base shall be provided with a grounding stud. All hardware used on the pedestal shall be 304 stainless steel conforming to ASTM A 276.

M.16.04—Poles: The materials for this work shall conform to the following requirements:

1. Steel Poles:

(a) **Round Continuously Tapered Shaft:** The continuously tapered shaft must have a maximum of 2 longitudinal continuous arc welds. No intermediate horizontal joints or welds will be allowed. Poles shall have a uniform wall thickness that tapers uniformly. All cross sectional shapes will be allowed, but multisided poles are required to be equilateral with a minimum of 8 sides. The shaft diameter must decrease from the butt end at the rate of not less than 0.07 inches (6 millimeters) and not more than 0.14 inches per foot (12 millimeters/meter) of length. Laminated pole designs (e.g. 2-ply pole shafts) will not be permitted.

The shaft shall be placed under sufficient pressure to flatten the weld and increase the physical characteristics to a minimum guaranteed yield strength of 48,000 psi (331 megapascals).

(b) **Round Step Tapered Shaft:** Round step tapered shafts shall be fabricated from round pipe sections with a maximum of one longitudinal seam. Horizontal seams must be joined by a hot-swaged shrink fit and continuously seal welded to prevent the entrance of water.

The shaft diameter must decrease from the butt end at the rate of not less than 0.07 inches (6 millimeters)

and not more than 0.14 inches per foot (12 millimeters/meter) of length. This is accomplished through the use of decreasing diameter round pipe sections.

(c) **Base:** The base shall telescope the shaft and shall have two continuous transverse arc welds, one being on the inside of the base at the end of the shaft and the other weld on the outside at the top of the base. The welded construction shall develop the full strength of the adjacent section resistant to bending action.

The anchor base shall have four holes to receive the anchor bolts and four holes directly behind each anchor bolt hole for ventilation. The anchor bolt holes shall be .375 inches (9.5 millimeters) larger than the diameter of the anchor bolt.

(d) **Pole Size:** The traffic signal span pole shall have the yield strength, bolt circle, and length indicated on the plans.

(e) **Span Clamp:** The span clamp shall be made of steel capable of supporting a minimum load of 12,000 pounds (53.5 kilonewtons) without sustaining permanent distortion. There shall be one span clamp per span wire attachment. Additional span clamps shall be provided as required.

(f) **"J" Hook:** The "J" Hook shall be affixed inside the top of the pole for handling and cable support.

(g) **Luminaire Bracket:** The type and spread of the luminaire bracket shall be as indicated in the details on the plans. The bracket shall be the single-arm type for brackets 8 feet (2.5 meters) and under in length and the truss type for brackets 10 feet (3 meters) and longer in length unless otherwise specified.

The truss type shall consist of an upper and lower galvanized steel member securely joined by means of a vertical strut steel pipe without ornamental steel scroll.

The brackets shall be attached to the pole by means of a bolted clamp so that the angle for the arm may be adjusted in the field.

(h) **Handhole:** A steel handhole reinforcing frame a minimum size 4 x 6.5 inches (100 x 165 millimeters), complete with removable cover, shall be welded to the shaft approximately 15 inches (380 millimeters) above the base. The cover shall be fabricated from galvanized steel.

(i) **Wire Entrance Fitting:** All steel span poles shall include wire entrance fittings. The number and size of the wire entrance fittings shall be as shown on the plans. A neutral bracket and 1-inch (25-millimeter) entrance fitting shall be provided for service cables. A separate fitting will also be required for any communications cable. These couplings will be continuously welded to the pole at a 45-degree angle to the pole shaft.

(j) **Anchor Bolt Covers:** Four removable galvanized ferrous or aluminum anchor bolt covers that attach to the pole base shall be provided. The anchor bolt covers shall be attached by a tapped hole and screw to either the pole base or pole shaft. The covers shall fit snugly and have a neat appearance.

(k) **Electrical Ground:** Each span pole shall be electrically grounded to a ground rod. The span pole will be connected to the ground rod by a #8 AWG copper wire. The wire shall be connected to the pole by a stainless steel bolt and to the ground rod by a square head bolt clamp, conforming with the NEC.

(l) **Identification:** Span pole information (as described below) shall be included on the poles in the form of a stamp on the top of the base plate, or an aluminum tag riveted to the base of the pole or to the pole shaft below the handhole.

- (a) Minimum load at yield
- (b) Name of manufacturer
- (c) Year of manufacture
- (d) Height of the pole

(m) **Fabrication:** The steel pole shall be fabricated in conformance with the current AASHTO "Standard Specification for Structural Support for Highway Signs, Luminaires and Traffic Signals." The pole manufacturer shall include a statement on his materials certificates stating that the welding design and fabrication is in accordance with the AWS Structural Welding Code D1.1-Steel.

(n) **Finish:** The steel span pole (shaft and base and luminaire bracket) shall be hot-dip galvanized, conforming to the requirements of ASTM A123/A 123M. Pole cap, bolt covers, handhole covers, span clamps, bolts, screws, washers, nuts, and wire entrance fittings shall be galvanized as per ASTM A153/A 153M.

2. Wood Poles:

(a) **Pole:** Wood poles shall conform to the requirements of ANSI 05.1 and AWPA C-1 and AWPA C-4. The pole shall be class 3 and of sufficient length to obtain the necessary height of the signals above the pavement or the mounting height of luminaires above the pavement.

The poles shall be trimmed by machine without materially changing their size or taper. Poles shall be

branded on the face, have a flat roof, and shall be aluminum tagged on the butt in accordance with ANSI 05.1. The arrangement and order of the code letters and figures shall be as the following example indicates.

PTC	Supplier's code or trademark
F-78	Plant location and year of treatment
SPC	Species and preservative code
3-35	Class and size

The dimensions for the poles required shall not be more than 3 inches (75 millimeters) shorter or 6 inches (150 millimeters) longer than the nominal length. The length shall be measured between the extreme ends of the pole. The minimum bottom circumference shall be measured at a point 6 feet (2 meters) from the butt and the minimum dimensions for the poles shall be as follows:

Length	Bottom Circumference	Top Circumference
30' (9.1 m)	32" (813 mm)	23" (584 mm)
35' (10.7 m)	34" (864 mm)	23" (584 mm)
40' (12.2 m)	36" (914 mm)	23" (584 mm)
45' (13.7 m)	37.5" (953 mm)	23" (584 mm)
50' (15.3 m)	39" (990 mm)	23" (584 mm)

The preservative treatment of the pole shall be done in accordance with the Standard Specification for Preservatives and Pressure Treatment Process for Timber, AASHTO M 133. The following named preservatives are acceptable. The properties shall be those set forth in the referenced AWPA standards:

1. Creosote	AWPA	P-1
2. Pentachlorophenol	AWPA	P-8
3. Chromated Copper Arsenate - Type C	AWPA	P-5

(b) Anchor: The anchor to be used for guying the pole shall be a four-way sliding plate as indicated on the plans.

(c) Anchor Rod: The anchor rod to be used for guying the pole shall be of drop steel and shall be hot-dip galvanized. It shall be as indicated on the plans. It shall conform to one of types as listed in the special provisions.

(d) Anchor Guy Strand Wire: The anchor guy strand wire shall be 3/8-inch (10-millimeter) 7-wire strand, supplied with a zinc coating by the hot-dip galvanized process in accordance with ASTM A 475 for zinc-coated steel wire strand, and shall have a minimum breaking strength of strand of 11,200 pounds (50 kilonewtons) for utilities grade.

(e) Guy Wire Protector: The guy wire protector to be used shall be the half-round type either fabricated from a minimum of 16-gauge hot-dip galvanized steel or from high impact 13454A Polyvinyl Chloride ASTM D 1784 compound standard. It shall have hot-dip galvanized steel clamps. The steel clamps shall conform to ASTM requirements A36 for steel and A123 for galvanization. There will be 3 clamps which will accept any strand size 1/4-inch (6.4-millimeter) diameter and larger, and any anchor rod up to a 1-inch (25-millimeter) diameter.

M.16.05—Mast Arm Assembly: The materials for this work shall conform to the following requirements:

1. Aluminum:

(a) Shaft: The shaft shall be 6005-T5 Aluminum Alloy as specified by ASTM B 221 or approved equal, and shall be a seamless tube tapered by cold working. The shaft wall thickness, length and tube diameters shall be as indicated on the Plans. The shaft shall have a satin brush finish and shall be suitably protected during handling and shipping.

(b) Arm: The arm shall be of tapered elliptical truss-type design. The arm shall consist of an upper and lower member joined by vertical braces and clamps of 356 Cast Aluminum Alloy conforming to ASTM B 108 for attachment to the Shaft. All necessary fittings and adjustable signal mounting assemblies required for attachment of the signal heads shall be included with the arm. The arms and struts shall be fabricated of 6005-T5 wrought aluminum alloy as specified by ASTM B-221 or approved equal. The arm shall be formed to dimensions as shown on the plans. The wall thickness shall be as shown on the plans. All vertical braces shall be 2 3/8 inches (60 millimeters) O.D. having a .140-inch (3.6-millimeter) wall thickness and elliptically shaped to a cross-section of 3 inches x 1 3/4 inches (76 millimeters X 44.5 millimeters). The clamp castings shall withstand the design load of the arm assembly as shown on the shop drawings.

(c) Shoe Base: The shoe base shall be 356 cast aluminum, conforming to ASTM B 108 of adequate

shape and size to develop the full strength of the adjacent shaft section. The base shall be secured to the lower end of the shaft by two continuous welds. The base shall telescope the shaft, and one weld shall be on the inside of the base at the end of the shaft and the other weld shall be on the outside at the top of the base. The base shall be provided with four holes for mounting on the 16-inch (406-millimeter) bolt circle and four cast aluminum bolt covers which shall be attached to the base by means of stainless steel screws.

(d) Transformer Base: The transformer base shall be a permanent mold casting of 356-T5 aluminum alloy conforming to ASTM B 108 and shall be of sufficient size to withstand the full design load of the shaft. The transformer base shall have a door of dimensions shown on plans attached to the base by means of cast lugs at the bottom and a stainless steel socket head cap screw with a wrought aluminum latch at the top. The bottom of the base shall have provision for anchorage at the corners to accept four anchor bolts.

(e) Welding: Welding of aluminum shall conform to the AASHTO "Specifications for the Design and Construction of Structural Supports for Highway Luminaires," Section 10—Fabrication of Welded Aluminum Structures.

2. Steel:

(a) Shaft: The shaft shall be made from one length of sheet steel not less than the gauge specified. There shall be a maximum of two longitudinal continuous arc welds. There shall be no intermediate horizontal joint or weld. The length of sheet steel shall be formed into a continuously tapered shaft, having a taper of approximately 0.14 inches per foot (12 millimeters/meter). The arm sizes are as shown on the Plans.

After the welding and cold-rolling, the shaft shall be placed under sufficient pressure to flatten the weld and increase the physical characteristics of the shaft so the metal will have a minimum yield of 48,000 psi (331 megapascals). Cross-sectional shapes other than round will be allowed. A steel handhole reinforcing frame a minimum size 4 inches x 6.5 inches (100 millimeters x 165 millimeters), complete with removable cover, shall be welded to the shaft approximately 15 inches (380 millimeters) above the base. The cover shall be galvanized steel. There shall be a 0.5-inch (12.5-millimeter) tapped hole near the base of the shaft for the grounding bolt.

A round step tapered shaft will also be acceptable. The shaft shall be fabricated from round pipe sections with not more than one longitudinal seam, joined by a hot-swaged shrink fit, continuously seal-welded to prevent the entrance of water. Stepped round shafts must decrease in diameter from the butt end at the rate of not less than 0.07 inches (6 millimeters) and not more than 0.14 inches per foot (12 millimeters/meter) of length by use of decreasing diameter round pipe sections. The minimum yield strength of the material shall be 48,000 psi (331 megapascals).

A flange plate, a minimum of 1.250 inch (32 millimeters) thick, shall be welded to the pole near the top supported by side plates tangent to the pole and gusset plates, both top and bottom. The flange plate shall have a 2.50-inch (64-millimeter) diameter wiring hole and four tapped holes for 1 1/4-inch (32-millimeter) high tensile bolts.

A device shall be provided near the top, inside of the pole, to relieve the strain on the cable feeding the signals. The pole cap shall be secured by means of set screws.

Where shown on the plan, there shall be provided a steel tapered luminaire bracket. The bracket shall be the single arm type for brackets 8 feet (2.4 meters) and under in length and truss type for brackets 10 feet (3 meters) and longer. The truss type shall consist of an upper and lower member securely joined by means of a vertical strut. The upper and lower members shall be 2-inch (50-millimeter) I.P.S. steel pipe without ornamental steel scroll. The length of the bracket shall be as shown on the plans.

(b) Anchor Base: A one-piece steel anchor base of the adequate strength, shape and size shall be secured to the lower end of the shaft by two continuous electric arc welds. The base shall telescope the shaft, and one weld shall be on the inside of the base at the end of the shaft, while the other weld shall be on the outside at the top of the base. The 2 welds shall be approximately 2 inches (50 millimeters) apart, and the design shall be such that the welded connection shall develop the full strength of the adjacent shaft section to resist bending action.

The base shall be provided with four holes to receive the anchor bolts, and four tapped holes for attaching the anchor bolt covers.

(c) Mast Arm: The mast arm may be made of one length or two lengths of steel. There shall be a maximum of 2 longitudinal continuous arc welds. The length of sheet steel shall be formed into a continuous taper shaft having a taper of approximately 0.14 inch per foot (12 millimeters/meter). After the welding and cold-rolling, the mast arm shall be placed under sufficient pressure to flatten the weld and increase its physical characteristics so that the metal will have a guaranteed minimum yield strength of

48,000 psi (331 megapascals).

A flange plate, 1.25 inches (32 millimeters) thick, shall telescope the large end of the mast and be welded by two continuous electric arc welds. One weld shall be on the outside of the plate, adjacent to the shaft, and the other weld on the inside at the end of the tubular cross-section. The flange plate shall have four holes for the 1.25-inch (32-millimeter) high tensile bolts, which shall match the four tapped holes in the mounting plate on the pole.

Mast arms for step tapered shafts may be two-piece construction with a telescoping joint secured by a thru-bolt and lock nut. Arms less than 35 feet (10.7 meters) in length need not be tapered. The arm shall be not less than the gauge specified. The minimum yield strength of the material shall be 48,000 psi (331 megapascals).

Each mast arm shall be drilled in the field on the bottom surface for wire outlet holes and signals positioned at the location indicated on the signal plans. Rubber grommets shall be provided and installed by the Contractor at each field drilled hole to protect the signal cables from chafing.

A steel removable cap shall be attached to the end of the arm by a set screw. For each required signal, a clamp and clevis with 3/4-inch (19-millimeter) diameter hole shall be furnished.

(d) Finish: The steel mast arm assembly and luminaire bracket shall be hot-dip galvanized, conforming to the requirements of ASTM A 123/A 123M unless otherwise specified. Pole Cap, bolt covers, handhole covers, bolts, washers, nuts and screws shall be galvanized, conforming to the requirements of ASTM A 153/A 153M.

(e) Fabrication: The steel Mast Arm Assembly shall be fabricated in conformance with the current AASHTO "Standard Specification for Structural Support for Highway Signs, Luminaires and Traffic Signals." The manufacturer shall include a statement on his materials certificates stating that the welding design and fabrication is in accordance with the AWS Structural Welding Code D1. 1 Steel.

3. Identification: Mast Arm identification (as described below) shall be included in the form of a stamp on the top of the base plate, or an aluminum tag riveted to the base of the shaft below the handhole.

- (a) Maximum equivalent end load (mass and area)
- (b) Name of manufacturer
- (c) Year of manufacture
- (d) Arm length

M.16.06—Traffic Signals: The materials for this work shall conform to the following requirements:

1. General: The components of a traffic control signal head assembly or unit shall conform to the I.T.E. requirements for Adjustable Face Traffic Control Signal Head Standards Technical Report of the latest issue.

2. Traffic Control Signals: Each signal head shall be of the adjustable, vertical type with the number and type of sections and lamps as shown on the plans, shall provide a light indication in one direction only; and shall be adjustable through 360 degrees without the removal from the mounting bracket; and shall be mounted at the locations, and in the manner as shown on the plans. Unless otherwise indicated on the plans, all signal heads shall be standard and shall contain three lights arranged as follows: Red-top; Amber-center; Green-bottom. All signal heads in this contract shall be of the same make and type.

3. Housing: The signal head housing shall be made of a die-cast aluminum alloy per ASTM B 85. The signal head housing shall consist of an assembly of three or more separate sections, expandable type, for vertical mounting, substantially secured together in a watertight and rigid manner to form a unit of pleasing appearance.

Each section shall house an individual optical unit. The signal head shall be so designed that sections may be added or removed from the head assembly by the use of simple tools.

The housing shall be a die casting, rigidly constructed with a smooth outer surface. There shall be a round opening in the top and bottom of each head to receive a 1 1/2-inch (38-millimeter) supporting pipe frame. The portion of the housing section around the opening shall be reinforced and serrated so that serrated fittings may be used to secure the housing. The top and bottom of the housing shall include such other openings as are necessary to accommodate fastening devices to hold sections together, and such openings shall not permit entrance of foreign particles. Each section shall be positively indexed with respect to an adjacent section to prevent misalignment. Each housing section shall be equipped with a door with an opening and fittings for the optical unit and visor. The door shall be arranged for easy access to the optical unit components and wiring. It shall be hinged on its left side so that the door cannot be removed without the use of tools at 2 points and shall be provided with a simple, positive-acting door locking device made from stainless steel to assure tight closure. The door or housing shall be grooved to receive a neoprene

gasket to provide a resilient seal between the door and housing. The body and door of each housing section shall be of die-cast aluminum alloy and shall be clean, smooth, and free from flaw, crack, blow holes, or other imperfections. The door locking device and visor fastening screws shall be made of stainless steel. All other screws, nuts, washers, hinge pins, latch parts, clips and parts used in the assembly of the signal housing shall be made of either naval brass, everdur, phosphor bronze, stainless steel or approved equal.

4. Brackets: The signal heads, except for post-top mounting, shall be supported by mounting brackets consisting of assemblies of 1 1/2-inch (38-millimeter) standard, iron pipe and malleable iron fittings. All members shall be plumb and level, symmetrically arranged, and securely made up. Construction shall be such that all conductors are concealed within poles and assembly.

Each section of the housing shall be provided with a removable cap visor of not less than #16 B & S Gage Aluminum. The cap visor shall be painted a flat black on the inside to prevent reflection, and must also eliminate sun-phantom. The visor shall fit snugly against the door and shall not permit any perceptible filtration of light between the door and the visor.

A terminal block shall be mounted inside of the back of the housing in the top section. The terminal blocks shall have sufficient studs with separate screws to terminate all field wires and lamp wires independently to the block.

When indicated on the plans, a backplate of dimensions, as shown on the plans, constructed of 3003H 14 aluminum alloy sheet .051-inch (1.3-millimeter) minimum thickness conforming to ASTM B209 (B209M) shall be attached to the signal head housing. The backplate shall be painted a flat black on both sides.

5. Optical Unit: The optical unit shall consist of a lens, reflector, reflector frame, and socket and traffic signal lamp of the size shown on the plans. Other necessary equipment shall be designed to give clearly visible signal indications within an angle of at least 45 degrees to the traffic to be controlled and from 10 feet to 300 feet (3 meters to 91.5 meters), under all light and atmospheric conditions except dense fog; and shall be of such design as to eliminate sun-phantom effects. The optical unit shall be readily accessible for maintenance.

Lenses shall be of the color indicated, circular in shape, with a visible diameter of 8 inches (203 millimeters), unless otherwise noted on the plans, except that all arrow lenses shall have a visible diameter of 12 inches (305 millimeters). Except where indicated on the plans, the use of adapters to achieve 12-inch (305-millimeter) indications will not be allowed. Lenses shall be of such design to give an outward and downward distribution of light with a minimum above the horizontal. Arrow lenses shall conform in design to ITE standards and shall be of a green light diffusing nature, giving uniform distribution of illumination on all areas of the lens. The field for arrow lenses shall consist of a black ceramic compound, baked or fired into the glass.

Each lens shall be polycarbonate capable of withstanding continuous illumination of a standard traffic signal lamp without thermal distortion [100-Watt - 8-inch (203-millimeter) lens] [150-Watt - 12-inch (305-millimeter) lens]. The lens shall be 3/16 to 5/16 inch (4.8 millimeters to 8 millimeters) in thickness, smooth on the outside surface, annealed to relieve internal stresses and of high illumination transmission. An air-cured neoprene lens gasket shall be provided between the lens and the signal door and between the lens and the reflector ring. The two ends of the lens gasket shall be joined together by vulcanizing or other approved method. Each lens shall have the word "Top" marked on its flange to indicate proper positioning of the lens in the door, together with the trademark of the lens manufacturer and label indicating conformance with the specifications set forth in the ITE standards. The lens and its gasket shall provide water-tight and dust-tight construction. The gasket shall be molded, heat-resistant neoprene.

The reflector shall be made of specular Alzak aluminum, the thickness of the anodic coating to a minimum of 0.0001 inch (2.5 microns), or its equivalent, spun or punched from metal not less than .025 inch (0.6 millimeter) thick, equipped with a bead or flange on the outer edge to stiffen the reflector and insure its being held true to shape. The reflecting surface shall be totally free of flaws, scratches, defacements or mechanical distortion.

An opening in the back of the reflector for the lamp holder shall be so constructed that there will be no dark spots cast on the lens. The reflector shall be of the pressure type, free floating and must insure full seal against the lens gasket. The reflector frame shall be of die-cast aluminum constructed completely around the reflector, and arranged to assure maintaining proper positioning of the reflector with respect to the lens under normal operating conditions. Proper position shall be maintained after opening and closing the unit for lamp replacement and other maintenance functions. A dust-tight gasket shall be provided between the reflector and the reflector-holding ring. If this gasket is of neoprene, it shall be made continuous by vulcanizing ends together or by another process approved by the Engineer. Additional dust-tight gasketing

shall be provided between the lamp holder and the reflector.

6. Lamp Socket: The lamp socket shall be so designed that the tip or center contact shall retain its spring action and shall not twist or turn when lamps are installed. The ring or outer contact shall be securely fastened to the receptacle base so that it will not become loose, break out, or turn when replacing lamps. The lamp socket shall be mounted so that when a lamp is properly inserted and adjusted it shall retain that position. The lamp socket shall be made of heat-resistant material designed to hold a traffic signal lamp of the wattage indicated on the plans, and shall be of the vibration-proof type, weatherproof molded construction, immune to the operating temperatures of the unit and substantially supported, independent of the reflector. Each lamp socket shall be the adjustable type and shall be wired with two leads using a minimum size of #18 AWG, 600 volt, 115 degree C stranded wire not less than 3 feet (1 meter) long. This wire shall be marked in accordance with Article 310-11 of the latest edition of the NEC. The sockets shall be so wired that a white lead will be connected to the shell of the socket and a black lead to the bottom or end terminal of the socket.

All lamps shall have indelibly etched thereon the name of the manufacturer, the ratings in watts for which the lamp was designed and the operating voltage of the lamp. Each lamp shall have the beam candela specifications of the ITE.

The lamps shall operate at 67 or 69 watts as the case may be at plus or minus 4% at rated voltage. The lamps shall have a voltage rating of 125 volts and the initial lumen rating of the 67-Watt lamp shall not be less than 618 and the 69-Watt lamp not less than 630.

The bulb designations shall be AT-21 or A-21 for the 67-Watt and A-21 for the 69-Watt. The 67-Watt lamps shall have a maximum over all length of 4.625 inches (117 millimeters) and a light center of 2.44 inches (62 millimeters). The 69-Watt lamps shall have a maximum over all length of 4.44 inches (113 millimeters) and a light center of 3 inches (76 millimeters). All lamps shall have a fuse wire within their structure to prevent damage to lamp circuitry or receptacle and they shall also have an aluminum reflector disc incorporated within the bulbs to assist light control.

The base of the lamps shall be medium, made of brass, and shall have the base stamped or printed with "Scratch Out" letters and numerals which indicate 12 months of the year and at least 4 indications for years. This is for the purpose of maintaining control for re-lamping.

The burning position shall be base down or horizontal and the lamps shall have a rated life of 8,000 hours of use guaranteed by the manufacturer.

The 67-Watt lamps shall be installed in traffic signals with 8-inch (203-millimeter) lenses. The 69-Watt lamps shall be installed in the traffic signals with 12-inch (305-millimeter) lenses.

7. Mountings: All signal heads shall be equipped with positive locking devices and fittings designed to prevent the heads from turning due to external forces. Number 2 Permatex or approved equal shall be used at all points where lock nuts and washers are used in assembling heads.

8. Dual Color Fiber Optic Section: When called for on the plans, signals shall be provided which display alternate legends, consisting of either a green or amber directional arrow. The arrows shall be illuminated by the use of fiber-optics and shall be clearly legible and visible, at full intensity, anywhere within a 50-degree cone, centered about the optical axis.

Any combination of colors shall be available by changing color filters installed in the unit, i.e., a signal supplied to display both a green and amber arrow could be field modified to display red and green arrows without the necessity of removing the signal from the case.

One lamp, type ENL, shall be used for each message. These lamps shall be operated between 10.5 and 10.8 volts. Average lamp life shall be not less than 8,000 hours. Field data, laboratory data and manufacturing specifications shall be supplied to substantiate lamp life.

Non-lensed, fully randomized bundles shall be used to provide a 50-degree, total-viewing angle. 19 individual enlarged-diameter bundles shall be used to form the arrow legend. The same bundles shall be used to display either message.

In order to help balance the intensity between colors, provisions shall be made in the construction of the signal to supply approximately 50% more light to the green arrow indication than supplied to the amber arrow indication.

Transformers shall be used to reduce the incoming 120 volts AC to 10.8 volts AC. The transformer shall have Class A insulation and shall be rated at 48.5-volt amps.

Power consumption of the dual color arrow shall be less than 50 Watts.

A separate transformer and bulb shall be used for each color to allow connection with the controller wiring and conflict monitors. Identical lamp types shall be used for each message.

Fiber optics shall be glass fiber bundles assembled on flat black matrix panels with mechanical protection for the assembly. The glass fibers at the input and output ends shall be ground smooth and optically polished for maximum light transmission. Matrix panel to have flat black non-reflective finish.

To eliminate long term condensation effects of thermal cycling, individual fiber-optic bundles shall not be jacketed or encased. Lamps shall be mounted horizontally to prevent their collecting water from condensation or possible gasket leaks.

The front panel shall be rotatable to indicate the desired direction when installed. No moving parts shall be permitted. Fiber-optics shall be protected by a black ABS plastic vacuum formed sculptured cover to eliminate the possibility of damage when installing or re-lamping.

The front panel of the signal section shall be colored black to minimize legibility of the arrow when not illuminated. No color at all shall appear when not illuminated regardless of sunlight intensity.

All fiber-optic, transformers and lamps shall be mounted on the door of the signal section. All screws, washers, nuts and bolts shall be corrosion-resistant stainless steel. All components shall be readily accessible when the door is opened. The only tool required for maintenance shall be a standard screwdriver.

9. Painting: All surfaces of the signal housing, door, visors, inside and out, shall be cleaned and coated with a Primer conforming to FS MILSPEC-P-8585. The surfaces shall then be finished with three coats of infrared oven baked paint, before assembly.

First Coat: The primer shall be iron oxide backing primer and shall meet or exceed the requirements of FS TT-P-636, paragraph 4.2.3.

Second Coat: Shall be light gray exterior baking enamel and shall comply with FS TT-E-489, either #16251, #16314, or #16376 Gray.

Third Coat: Highway Yellow Enamel shall be traffic signal highway yellow exterior baking enamel and shall comply with FS TT-E-489. The color shall be No. 13538 according to Federal Standard No. 595. The inside of the visors shall be phthalic anhydride black synthetic baking enamel, with zero (0) gloss reflectance and shall meet the performance requirements of MILSPEC-E-5557 Enamel Heating Resisting Glyceryl Phthalate Type 4, Instrument black. The housing door and the outside of the visor shall be painted Flat Black unless otherwise specified.

M.16.07—Pedestrian Signal: The materials for this work shall conform to the following requirements:

A. General: The pedestrian signal shall be one section, rectangular in shape, and shall conform with the MUTCD. The over-all size of the pedestrian signal, including visor, shall be as shown on the Typical Installation details. The pedestrian signal shall be the LED type unless indicated otherwise. The display shall be the international symbols for “walk” and “don’t walk”. The symbols shall be clearly legible when illuminated. The symbols shall have the dimensions as shown on the plans. The “Walk” symbol shall be Lunar White. The “Don’t Walk” symbol shall be Portland orange.

B. Housing: The housing shall be one-piece, corrosion-resistant, aluminum alloy casting. The top and bottom of the housing shall have an opening to accommodate standard 1 1/2-inch (38-millimeter) pipe brackets. Each housing shall have a terminal block with a sufficient number of terminals to accept field wires. Two integrally-cast hinge-lugs shall be cast on one side of each housing, and two integrally-cast latch-screw pads shall be cast on the other side of the housing.

The housing door shall be a one-piece, corrosion-resistant, aluminum alloy casting. Two hinge-lugs shall be cast on the other side of each door. The door shall be attached to the housing by means of two stainless steel hinge pins. Two stainless steel hex-head, captive-latch screws shall be permanently attached to the door bosses by means of keeper washers. The door shall have a neoprene gasket which, when the door is closed, shall cause a seal against the housing, making a weatherproof and dust-tight seal.

Each signal shall be provided with an aluminum visor approximately 7 inches (178 millimeters) long, which shall encompass the top and sides of the signal face. The top of the visor shall have a downward tilt of approximately 3-1/2 degrees. The visor shall be blanked and formed, shall be not less than .05 inches (1.3 millimeters) thick, and shall meet the minimum requirements of ASTM B209 (B209M).

C. Optical Unit:

1. Incandescent: The incandescent optical unit shall consist of a lens, reflector frame, lamp socket, and traffic signal lamp.

The lens shall be of rigid type polyester resin having an especially high heat distortion point and excellent resistance to degradation at high temperatures. Lens thickness shall be a minimum of 3/16-inch (4.8 millimeters). The lens gasket shall be molded neoprene rubber channeled to cover the entire perimeter of the edge. The gasket shall press against the frame when the door is closed to form separate dust-tight optical compartments.

Reflectors shall be of one-piece parabolic construction, designed to direct light from the lamp outward with maximum efficiency. The reflector shall have a flange that will form a flush fit with the gasket when the door is closed.

Sockets shall be one-piece molded construction and shall be fastened to the reflector. The socket shall have a "lamp grip" to prevent the lamp from loosening. Color-coded leads of 18-gauge wire shall be attached to the terminal block in the signal. Lamps shall be 67-watt standard traffic signal lamps.

2. LED: The optical unit shall consist of multiple LED light sources and a regulated power supply assembled as a sealed unit. The diodes shall be arranged to display a full-hand symbol side by side with a full pedestrian symbol. The optical unit shall fit into a standard pedestrian signal housing so that it may be installed into an existing incandescent pedestrian signal. The LED optical unit shall be capable of maintaining message symbol integrity despite any partial loss of LEDs. The beam color shall match that of the incandescent message: walking symbol - lunar white, hand - Portland orange. The beam pattern and intensity shall meet ITE specifications. The intensity may not degrade by more than 10% per annum. The optical unit shall be warranted by the manufacturer for a period of five years.

Electrical Requirements:

- Input Voltage: 89 VAC to 135 VAC
- Wattage: 15 Watts
- Input Impedance at 60 Hz must satisfy all conflict monitor requirements.
- A regulated power supply shall be engineered to protect the LEDs from electrical surges and transient voltages.

D. Pedestrian Signal (Audible):

Voltage: 120VAC 50/60 Hz, $\pm 15\%$ of nominal line voltage.
Operating current: .33 amps.
Standby current: .027 amps.
Decibel at 10' (3 meters): 88dB.
Operating temperature: -31° F to 161° F (-35° C to 71.6° C).
Net weight: 1.7 pounds. (.77 kilograms).
Rated life: 400 hours at 50% duty cycle.

Housing:

Cast Aluminum.
Weatherproof with neoprene gasket.
4 7/8" (12.2 centimeters) square box.
Depth 2" (5 centimeters).
Tapped for 1/2" (3.2 centimeters) conduit.
UL listed.

Properties:

Single audible device with varying tone modules.
Internal gain control - output adjustable from 64 dB to a maximum of 88 dB at 10 ft. (3 meters).
Active to coincide with "walk" indication and pulse to coincide with "Don't Walk" indication.

Tone Module:

470 Hz continuous.
Sturdy plastic housing.
Edge connector termination's to allow rapid installation or removal of module.
Varying tones

E. Hardware: All exposed screws and fasteners shall be stainless steel. All internal screws, fasteners and metal parts shall be stainless steel, non-corrosible materials; or cadmium-plated ferrous materials.

F. Painting: All surfaces of the signal housing, door, and visors, inside and out, shall be finished with three coats of infrared-oven- baked paint before assembly. All brackets and hardware shall be painted dark green by the manufacturer. The color shall be No. 14056, Federal Standard No. 595.

First Coat—Primer: Shall be iron oxide baking primer and shall meet or exceed the requirements of FS TT-P-645.

Second Coat—Gray Enamel: Shall be light gray exterior baking enamel and shall comply with FS

TT-E-489, #16251 or #16314 or #16376 gray.

Third Coat—Dark Green Enamel: Shall be Dark Green exterior-baking enamel and shall comply with A-A2962. The color shall be No. 14056, Federal Standard No. 595. The inside of the visors shall be according to FS TT-P-527. The color shall be lusterless black Color No. 37038 to comply with Federal Standard No. 595.

M.16.08—Pedestrian Push Button: Pedestrian push buttons shall be of substantial tamper-proof construction and shall consist of a direct push type button with a single momentary contact switch in die-cast aluminum alloy housing to meet the minimum requirements of ASTM B 85, on which shall be attached the push button advisory sign as shown on the plans.

The switch shall have snap action contacts, connected by a three-bladed beryllium copper spring, and shall be rated at 10 amperes, 125 volts. Pedestrian push buttons shall not have any levers, handles, or toggle switches externally or internally, and shall operate on 12 volts AC. The pedestrian push button shall conform in size and the required force to activate the pedestrian signals as specified in the ADA, Section 14.2.6 Crossing Controls.

The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather conditions. Installations within the housing shall be so designed that they can be removed as units from the housing for the purpose of inspection and maintenance. Push-button contacts shall be entirely insulated from the housing and operating buttons. The contacts shall be normally open, and shall be closed only when the push buttons are operated by pressure, restoring immediately to the normal open position when the pressure is released. The back of the housing shall be flat type to provide a rigid installation. Cable entry shall be through the back so that all wiring may be concealed with no external conduit required, except when indicated on the plans.

Painting: All surfaces of the unit shall be finished with three coats of infrared oven baked paint, before assembly.

First Coat: Primer, shall be epon oxide baking primer and shall meet and exceed one performance specification of FS TT-P-636.

Second Coat: Gray Enamel, shall be lusterless and shall comply with FS TT-E-527.

Third Coat: Dark Green Enamel, shall be DARK GREEN exterior-baking enamel and shall comply with Federal Specifications A-A 2962. The color shall be No. 14056, Federal Standard No. 595.

M.16.09—Controllers: The materials for this work shall conform to the following requirements:

1. Pretimed Controller: It is the purpose of this section to set forth minimum design and operating requirements for the 3-dial pre-timed expansible type controller.

Constancy of Intervals: The length of any interval portion shall not change by more than 5% when the voltage of the power supply varies from 95 volts to 130 volts and the ambient temperature within the cabinet housing the controller varies from -30°F to 160°F (-34°C to 71°C). This performance shall be obtained without the use of any heater elements.

Power: The controller and all associated equipment shall be designed for use with 120-volt 60-cycle single-phase, alternating current.

Components: All components of the controller shall be designed for heavy duty. All motors, operating coils, bearings, contacts, relays, flashers, etc. shall be sufficiently large, rugged, and accessible to insure reliability and minimum maintenance. The dial contacts shall be of the leaf-spring type mounted on a molded bakelite block and equipped with terminal screws. The contact size shall be at least 1/4-inch (6.4-millimeter) diameter, 1/16-inch (1.6-millimeter) thick, and contain at least 90% pure silver. The contacts that handle any signal light load shall not require fine adjustment and readjustment for satisfactory and continuous operation. All such mechanisms shall be neatly and systematically arranged to make possible thorough inspection while the controller is operating in accordance with its normal functions.

Cabinet: Each controller assembly shall be completely wired and housed in a rigid metal cabinet with a suitable finish. The cabinet shall be of clean-cut design and appearance and shall be substantially constructed of aluminum. The pedestal mounted and pole mounted cabinets shall be approximately 15 inches x 19 1/4 inches x 35 inches (380 millimeters x 490 millimeters x 890 millimeters) in size or the equivalent in volume, and the base mounted cabinet shall be approximately 17 inches x 34 inches x 48 inches (430 millimeters x 865 millimeters x 1220 millimeters) in size or the equivalent volume. The cabinet shall have a main door which shall be equipped with a special CONN-1 lock and key and an auxiliary door which shall be equipped with a lock and a police key. Door hinge pins shall be of stainless steel material. Two keys shall be furnished for each lock. When closed, both doors shall fit tightly to neoprene gasketing material. The cabinet shall contain a suitably designed vent for the purpose of releasing any explosive gases

which may enter the cabinet. The "T" vent (1 1/2-inch (38-millimeter) diameter) shall be mounted on the top of the cabinet, with a screen vent at the bottom of the cabinet.

A panel behind the auxiliary door shall contain the following:

1. A switch to control the change from automatic control to flashing operation and vice-versa. In the flashing position, the control unit shall not be de-energized.
2. A switch to control the change from automatic control to manual operation and vice-versa. A manual cord not less than 6 feet (2 meters) long equipped with a rubber-covered hand switch, and permanently installed.
3. A "Main Switch" which will be used for signal shutdown. During signal shutdown, power to the controller shall be unaffected. The function of this switch can be incorporated into the flash switch by providing a three-position switch (NORMAL-OFF-FLASH).

The cabinet shall contain a means of mounting the controller, which will permit easy access to controller while in operation and accessibility to the components and terminals for maintenance and repair purposes. The cabinet shall be provided with necessary openings for mounting and connections and be wired to include a cable for time-clock installations with an octal 5-pin plug.

All panel wiring shall be neat and firm and the panel, which shall be mounted in the rear of the cabinet, shall mount the following:

1. Neutral Bus Bar, for neutral side of power supply line. This Bus Bar shall be rated for 30 amperes.
2. Terminals for conductors of signal light cable - one for each signal circuit and one or more terminals for the common conductors. This terminal bus shall be rated for 30 amperes. No pressure type terminal blocks will be accepted.
3. A 1-piece 120-volt convenience outlet and lamp receptacle. A heavy-duty 30-ampere screw-type fuse and socket shall be mounted on the left side of the controller cabinet. The controller equipment and terminals shall be so arranged within the cabinet that they will not prevent the entrance, training and connection of the incoming conductors. All field terminals shall be suitably identified.

The cabinet shall have a hole for cable entrance into the bottom of the cabinet of at least 3 inches (76 millimeters) in diameter. There shall be an adapter for mounting the cabinet on a 4-inch (100-millimeter) pipe, provided with each cabinet.

The outgoing traffic control signal circuits shall be of the same polarity as the line side of the power supply. The grounded side of the power supply shall be grounded to the controller cabinet.

All conductors shall be provided with lugs for attachment to binding posts. Combining of conductors to one lug will not be allowed. Non-hygroscopic materials, having good insulating qualities, shall be used for all insulating purposes. All internal wiring to lamp circuits shall be #14 AWG stranded drawn copper. Wiring shall be cabled. The cable connection from the panel board to the controller shall be made by an "MS" type positive plug. A minimum of 19 signal circuits shall be provided each rated at a minimum of 15 amperes.

Leakage resistance between electrical connections or to ground shall not be less than 1 megohm. A minimum spacing of 1/2 inch (13 millimeters) shall be maintained between any terminal connection and any other similar connection or ground. The electrical connection from the controller to the outgoing and incoming circuits shall be made in such a manner that the controller may be replaced with a similar unit without the necessity of disconnecting and reconnecting the individual wires leading therefrom. Connector plugs shall be used that will contain sufficient contacts for proper functional operation of the controller. The controller to be supplied shall be wired complete for three 3-dial operation. All relay jack panels shall be of the female type.

Timer: The timer of the controller shall consist of a signal switching unit with a combination interval and offset timing dial unit securely mounted and of such construction that the entire timer assembly can be swung out from the cabinet for inspection or maintenance without breaking any electrical connections or interrupting the normal operation of the controller. The timer shall be connected electrically to the panel of the controller by means of an electrical jack or plug disconnect that will permit quick removal of the complete timer assembly as a single unit when necessary.

Timer Housing: The timer shall be enclosed in a rigid metal housing with a transparent window so that all timing settings, interval, offset and total cycle length control shall be visible but not accessible when the control box door is open.

Color Sequence: It shall be possible by effecting a change in the shape of the cams operating the signal circuit contacts to obtain any signal color sequence desired. A minimum of 19 signal circuits and 16 signal

color intervals shall be provided on a single cam bar.

Period Timing: All signal color interval adjustments shall be quickly made, without tools, from the front of the timer on a dial clearly marked and calibrated in percent from 0% to 99%. Any signal color interval shall be adjustable to a minimum of 2% in steps of 1%. The timing dial shall give a visual indication of the relative length of each color period at all times. The duration of each signal color interval in percent of the total time cycle shall be as indicated on the percentage dial calibration. Each timing key shall be self-locking in the timing dial.

Timing Dial Units: The controller shall be furnished with three dial units each consisting of a synchronous motor-driven timing dial together with its dial contacts and other necessary parts and shall be provided with adequate mechanical mounting and electrical jacks so that it can be removed and/or replaced quickly without the use of tools in a single operation wherein both mounting and electrical connections are made simultaneously.

Motor: A drive coil shall drive the synchronous motor at the cycle length called for by the timing gear. There shall be provided a means of positively stopping the dial motor while the local controller is re-synchronizing with the master controller.

Each motor shall be of the self-starting synchronous type, such as Telechron heavy duty or disk type and shall have sufficient torque to permit its dial to operate synchronous at all outside temperatures between -30°F and 160°F (-34°C and 71°C). The transfer to an unused dial shall be possible within this same temperature range. The motor torque shall be sufficient to operate the timer at synchronous speed when used with a 30-second cycle and shall be sufficient to overcome any tendency to slow up due to shocks or vibration, thereby providing synchronous operation between the limits of 95-130 volts.

Timing Dial: The timing dial shall support the timing keys over their entire length and shall contain 100 precision die-cast slots for this purpose. All timing keys for a given function shall be identical and each key having specialized function shall be appropriately colored to provide a visual indication of such function. All contacts operated by the various timing keys shall have helical springs controlling both movement and contact pressure so that flexible arm adjustments are eliminated.

It shall be possible to keep the timing dials, not controlling the sequence at any given time, running continuously. This will allow an offset relationship to be maintained between on interconnected (hard-wire) intersections.

Cycle Change: Each controller shall be furnished with a cycle gear as specified on the plans, installed in the timing dial unit and gears for 60-70-80-90-100 seconds shall be furnished and stored in the controller cabinet. The range of possible gear change shall be from 30 to 120 seconds in 5-second steps with gears other than those normally supplied with the controller. Gears within the 30- to 120-second range shall be available from the controller manufacturer. It shall be possible to change the total cycle on the street easily and quickly without the use of tools. The action of changing gears shall automatically indicate the total cycle value in use on a scale visible from the front of the timer. The mesh between the motor pinion and any time cycle gear shall be indexed automatically so as to result in proper mesh for free-running gearing and to avoid any possibility of binding which might affect synchronous operation of the driving motor.

Manual Offset: Due to the synchronous motor drive of the timing dial, it shall be possible to obtain coordination between respective dials at adjacent but non-interconnected intersections by means of a simple motor synchronizing switch mounted on the front of the dial unit where it will be tamper-proof by virtue of the timer housing herein before specified.

Automatic Offset: The timing dial unit shall be equipped with means by which it may be automatically resynchronized by remote control when connected to a master controller. The dial unit shall be furnished complete for triple offset. The controller shall be so wired that a choice of 3 different offsets on the dial may be remotely selected over a total of not more than 3 interconnecting offset conductors.

All offset adjustments shall be made without tools on the same timing dial as the signal color period adjustment but calibrated separately in steps of 1% from 0% to 99% in the reverse direction from the color period timing. Each offset key shall be clearly identifiable. It shall only be necessary to move one offset key to change an offset setting and each key shall be self-locking in the timing dial.

Signal Switching Unit: The signal switching unit shall provide wiring for a minimum of 19 signal light circuits. Each of the signal contacts shall open and close independently of each other so that the flexibility of their operation shall not be limited. The movable signal circuit contact arms shall be of hardened steel or other suitable rigid material so that they shall be wear-resistant and shall not flex, bend or take a permanent set in operation.

All make and break contact tips, whether movable or fixed, shall give contact faces not less than 5/16 inch

(8 millimeters) in diameter, 1/8 inch (3.2 millimeter) thick and shall be made of at least 90% pure silver and 10% cadmium oxide, by weight (mass), or superior alternate material. The contacts shall be capable of breaking a current of 15 amperes, 120-volt, 60-cycle alternating current, one million (1,000,000) times without excessive pitting or burning when operated 120 times an hour. All signal contacts shall be readily accessible and easily inspected. The operation of moving or replacing movable contacts shall not change the contact pressure adjustment and shall be accomplished easily and quickly with the use of simple tools. The stationary contacts shall be replaced by the use of simple tools.

The ratchet motor shall be capable of effectively changing the position of the cams with equal efficiency up to and including the capacity of the camshaft.

Panel Board: A molded or pressed panel shall be provided on which all signal terminals (plus and common), relays, flashing mechanism and switches, flash combination terminals, terminals for field addition of manual switch accessory and terminals to allow all dial motors to run under non-interconnected operation shall be mounted.

Flasher: A Jack-mounted, unit type motor-driven or solid state flasher complete with radio interference suppressor shall be furnished to permit flashing operation of the signals when the timer is disconnected and removed from the controller. This shall be a two-circuit flasher rated at approximately 20 amperes.

Manual and Remote Switches in the Auxiliary Door: Manual switching flexibility shall be provided to permit the following operations:

Flashing Operation: The manual and remote flash switch or relays shall provide flashing indications for 4 independent circuits so that the controller may be used to control 2-phase vehicle movements and 4-phase vehicle movements (in doing so, power to dial motors shall be unaffected). In addition flash combination terminals shall allow the selection of flashing either yellow or red on the cross streets.

Manual Operation: The Auto-Hand switch shall provide means whereby manual timing of the signals may be obtained with a separate momentary contact hand switch. Operation of the timer by manual control shall provide the same color sequence as on automatic operation and no momentary undesirable indications shall show. Manual control shall be possible with the main door of the cabinet door closed.

Dial Selector Switch: The manual dial selector switch in the main cabinet shall provide for the selection of dials by:

1. Remote Control
2. Dial 1
3. Dial 2
4. Dial 3
5. Clock Position

Relay Wiring Provisions:

Jack-mounted relays shall be provided for:

1. Flashing 4-signal circuits
2. 2-dial transfer relays

Wires and Insulation: Except where soldered, all wires shall be provided with lugs or other approved terminal fittings for attachment to binding posts.

All wiring between various parts of the control box shall be a minimum of #18 AWG type TFF with 2/64—105 C. thermoplastic insulation or approved equivalent. Where cable wire must be clamped to the walls of the control box to prevent undue wear or flexing of the wires, such clamps shall be of suitable non-conducting material, such as rubber insulated metal straps.

The wiring from the timer jack connection to the terminal board shall be covered with a braided stocking or other method approved by the Engineer. The individual signal circuit wiring shall have a current carrying capacity of not less than 15 amperes.

Actuated Pedestrian Phase: The actuated pedestrian phase shall be obtained by effecting changes on the signal circuit cams and the dial drum in conjunction with auxiliary equipment which shall be external to the controller. Other than these changes, the controller shall be standard in all respects.

When an actuated pedestrian phase is called for, the pedestrian timing shall be taken out of 2 phases with no change in the cycle length.

The pedestrian clearance interval shall be flashing "DON'T WALK."

Painting: All outside surfaces of the cabinet and door shall be finished with 3 coats of infrared oven-baked paint before assembly.

First Coat—Primer: Shall be epon oxide baking primer and shall meet or exceed FS TT-P-636.

Second and Third Coats—Aluminum: The second and third coats will be aluminum paint in

conformance with the requirements of Article M.07.12.

Manuals: The contractor shall secure from the manufacturer a comprehensive service controller.

Six (6) paper prints of the cabinet wiring diagram the entire field connection chart shall be left blank.

A comprehensive parts list, detailing all replaceable components as to manufacturer part number, and commercially available part number, and manufacturer's net price each, shall be provided. This list may be referenced from the drawings supplied with the equipment.

Guarantee: The contractor shall secure from the manufacturer a guarantee for the equipment for a period of 12 months, which time shall commence from the date of delivery. If a unit is found to be defective during this 12-month period, it will be the responsibility of the contractor to assume the cost of shipping the controller to and from the factory, supplying parts and making repairs at no cost to the State of Connecticut.

M.16.10—Flasher Cabinet:

1. Cabinet: All equipment shall be housed within an aluminum or aluminum alloy weatherproof cabinet. If not cast aluminum, the seams shall be at least 0.125 inches (3.2 millimeters) in thickness and the seams shall be continuously welded. The cabinet shall be clean cut in design with a door, which shall encompass substantially the full area of the front of the cabinet. When closed, the door shall fit tightly to neoprene gasket material. The door shall be equipped with a CONN-1 lock and shall have stainless steel hinge pins. Two keys shall be provided with each cabinet. The cabinet shall have a screened "T" vent on top and a screened cut out of the bottom for ventilation. The size of the cabinet shall conform to the following dimensions:

Depth	Width	Height
12-14 inches (305-355 millimeters)	12-16 inches (305-405 millimeters)	14-25 inches (355-635 millimeters)

A panel shall be mounted in the back of the cabinet on which shall be mounted the following items:

- (a) Circuit Breaker - 15 Amp
- (b) Duplex Convenience Outlet
- (c) Lamp Receptacle
- (d) Terminal Block – Heavy-duty, screw type, to accommodate lugs for wire size #16 to #14 AWG.
- (e) Neutral Buss Bar - Rated for 30 Amps.
- (f) Radio interference filter - Rated for 30 Amps, 120 VAC, 60 HZ, and shall meet the standards of the UL and the Radio and Television Manufacturer's, Association.
- (g) Solid-State flasher mounting rack and socket.

2. Flasher: The flasher shall conform to the latest NEMA Publication, part 8, with the following additions:

The flasher output shall be from optically isolated solid-state relays.

The solid-state relay shall switch off with an input between 3 and 32 volts D.C.

The flasher shall have an L.E.D. indicator connected to each output for visual reference.

M.16.11—Vacant

M.16.12—Loop Vehicle Detector and Sawcut: The materials for this work shall conform to the following requirements:

1. Loop Vehicle Detector:

A. Functional Requirements: The loop detector shall be an electronic device, capable of detecting the presence of a moving or parked vehicle; and the detection shall be accomplished by the presence of a parked or moving vehicle over a wire loop embedded in the pavement. The detector unit shall be of the "self-tuning type." The detector shall be capable of tuning to an inductance range of 50-1000 micro Henries. It shall be possible to select a minimum of the following modes of operation, which shall function as follows.

- (1) **Mode 1 (Short Detection):** The detector sensing unit shall detect a vehicle as slow as 1/10 mile per hour (0.2 kilometer/hour) entering the loop. If a vehicle stops over a portion of the loop such as waiting for a left turn, the remaining portion of the loop shall detect additional vehicles passing over the unoccupied portion of the loop. The time for the remaining portion of the loop to become capable of detecting additional vehicles shall be no longer than the minimum time it takes for the next vehicle to pass over the loop.
- (2) **Mode 2 (Long Detection):** The detector sensing unit shall detect a vehicle as slow as 1/10 miles per hour (0.2 kilometer/hour) entering the loop. When a vehicle remains over the loop or a portion

thereof, the detector sensing unit shall cause detection to persist up to at least 10 minutes. After this period any vehicle passing over the unoccupied portion of the loop shall be detected.

- (3) **Delayed Output Detection:** The detector sensing unit shall provide digital type timing, with capabilities of 0-30 seconds delay. The sensing unit shall provide the delay except when the controller is in the green interval of the associated phase. During this green, the delay set into the detector will be omitted.

The sensing unit may also be used as a standard vehicle detector by leaving the selector switch in "off" position. A standard detector wire harness with a type "MS" plug is to be used.

B. Electrical Requirements: The detector sensing unit shall operate on 115 volts, 60 cycles A.C. and shall draw not more than 15 watts.

The unit shall contain an integral regulated power supply which will operate independent of line voltage variations between 100 and 135. The power supply shall be regulated by Zener reference and series regulation and shall be fused.

The detector shall operate properly at all temperatures between -30°F and +150°F (-34°C and 66°C). An automatic frequency control feature and automatic equalization feature shall be included in the detector to compensate for long-term drift due to environmental changes.

All transistors and integrated circuits shall be plug-in type for serviceability. The detector relay driver shall employ a silicon transistor.

C. Mechanical Requirements: The detector shall be housed in a durable finished fabricated sheet aluminum case. No special tools shall be required for removal of the cover. Removal of the cover shall provide access to the entire circuit and all components while the unit is connected and operating. The electrical connections of both the incoming and outgoing circuits shall be made by means of suitable multi-pin plug. The entire unit shall be replaced with a similar unit without the necessity of disconnecting the reconnecting individual wires leading therefrom. The plug receptacle shall be attached to one end of a connecting cable at least 48 inches (1.2 meters) long. The cable shall be color coded and each wire shall be fitted with a spade type lug for easy attachment to the controller terminal block.

A switch mounted on the front of the detector unit shall be provided for selecting the mode of operation to be in effect. Also mounted on the front of the detector will be an indicator light, which will register vehicle actuations.

When 2-channel loop amplifiers are used, each channel shall have a connecting plug with all wires in each of the harnesses connected so that it may be replaced with two single channel amplifiers.

The loop identification tag shall be 3 inches x 5 inches (80 millimeters x 130 millimeters), 10 mill (0.25 millimeters) thick plastic.

2. Sawcut:

A. #14 AWG type THWN, or THHN stranded wire rated at 600 volts shall conform to the appropriate articles of the NEC. The wire shall be encased in flexible vinyl plastic or polyethylene tubing having a 3/16-inch (4.8-millimeter) ID, a minimum of 1/32-inch (0.8-millimeter) wall and a 1/4 inch (6.4-millimeter) OD. The tubing shall be capable of resisting deterioration from oils and solvents, have a smooth bore and be highly abrasion resistant. The loop detector wire shall conform in all respects to I.M.S.A. Specification.

B. The plastic compound shall be liquid with a synthetic resin base with a specific gravity of approximately 1.7. It shall have a minimum viscosity of 3500 centipoise second (3.5 pascal·seconds) at 77°F (25°C) and a maximum viscosity of 65,000 centipoise second (65 pascal·seconds) at 25°F (-4°C). The plastic compound shall be polymerized (cured) by the addition of a specific reaction initiator (hardener). Sufficient hardener (usually a liquid organic peroxide) shall be used to cure the plastic compound in approximately 30 minutes at 70°F (21°C). It shall be possible to cure the compound at temperatures below freezing. The plastic compound, after curing shall have sufficient strength and resiliency to withstand stresses set up by vibration and expansion and contraction due to temperature changes. The compound shall also be resistant to most chemicals and solvents, including most salts, acids and hydrocarbons.

The plastic compound shall conform to the following testing requirements: ASTM D 149, ASTM D 495, ASTM D 638, ASTM D 1167, and ASTM D 192.

A one-part urethane elastomeric compound may be substituted for the plastic compound.

The elastomeric compound shall not require curing by the addition of a reaction initiator. The uncured elastomeric compound shall have a viscosity of 5,000 centipoise second to 35,000 centipoise second (5 pascal·seconds to 35 pascal·seconds). The elastomeric compound shall be viscous enough not to flow out of a sawcut in a sloped road, but still fully encapsulate all wires in the sawcut. The elastomeric compound

shall form a surface skin within 60 minutes at 75°F (24°C). The elastomeric compound shall be packaged in a standard liter caulking cartridge with the nozzle designed for insertion in a sawcut 0.25 to 0.125 inch (3 millimeters to 6.4 millimeters) in width and 1.5 to 2.5 inches (38 to 64 millimeters) in depth. The compound shall also be available in 5-gallon (19-liters) pails to be used with a pneumatic pump application system. After hardening, the elastomeric compound shall remain flexible and exhibit no visible shrinkage. The elastomeric compound shall have sufficient strength and resiliency to withstand normal stresses such as: vibration, expansion and contraction; and to resist most chemicals and vehicular fluids such as: motor oil, gasoline, brake fluids, and antifreeze solution.

The elastomeric compound shall conform to the following testing requirements: ASTM D 1875, ASTM D 2834, ASTM D 1640, ASTM D 2340, and ASTM D 412.

C. The flexible plastic conduit shall conform to the requirements of ASTM D 2737.

M.16.13—Magnetic Vehicle Detector: The materials for this work shall conform to the following requirements:

1. The magnetic elements shall be housed in a nonferrous case, and they shall be waterproofed by the vacuum impregnation process. The detector shall have an internal resistance not to exceed 3500 ohms and shall be designed for operation with a magnetic detector solid state amplifier. One end of the housing shall be threaded to accommodate a conduit. The assembled detector shall not be rendered inoperative or continuously operated by parked cars or other fixed iron objects such as road reinforcement and water or gas pipes which may be within its zone of influence.

The single lane magnetic detector shall consist of two main assemblies, the detector coil unit and the pavement box. The coil unit shall be assembled with two iron-covered coils connected in series and molded in a solid block of insulating material. The pavement box shall be a heavy duty aluminum casting with dimensions of approximately 9 inches x 8 inches x 6 inches (230 millimeters X 200 millimeters X 150 millimeters). Flanges threaded for 1 1/4-inch (32-millimeters) conduit will be provided on two sides and the bottom. The box shall have a removable cover, fastened with stainless steel bolts.

The concrete that is used in the installation of the pavement box shall be a fast-setting high-strength type. The concrete shall be hard enough in one hour to allow traffic to pass over it. It shall be a type acceptable to the Engineer.

The proper operation of the magnetic detector shall not be affected by extreme temperature or humidity.

2. The amplifier unit shall be fully transistorized utilizing open type printed wiring panels and high-grade silicon transistors. The printed circuits shall be of extra heavy (1 ounce (29 grams) or better) copper.

All circuits shall be designed to provide stable operation within an ambient temperature range of -30°F to +180°F (-34°C to 82°C).

The magnetic detector amplifier shall be designed for operation on a nominal 120-volt 60-cycle, single-phase A.C. supply. Nominal power consumption shall not exceed 2 watts.

The unit shall be housed in a durable finished fabricated sheet aluminum case. Removal of the unit from its case shall require the use of simple tools. When the unit is removed from the case, it shall be possible to gain access to the printed circuit panel and components.

Electrical connections of both the incoming and outgoing circuits shall be made by means of a suitable plug.

The unit shall be replaceable with a similar unit without the necessity of disconnecting or reconnecting individual wires leading therefrom.

The plug shall be of protected male construction and rigidly fixed to the front of the unit.

The mating plug receptacle shall be attached to one end of a connecting cable at least 24 inches (610 millimeters) long. The other end of the connecting cable shall have color-coded leads, each of which shall be fitted with a spade lug for easy attachment to terminal blocks.

The sensitivity of the unit shall be dial adjustable, and continuous over the full range. On the front of the unit adjacent to the adjustment dial and connector plug there shall be mounted two jacks for the purpose of checking the proper adjustment of the sensitivity knob.

The registration of overlapping pulses from two detector amplifier units shall be ensured by the use of normally open and normally closed contacts provided on the output relay. Any contact that opens or closes in response to vehicle actuations shall be capable of making, breaking, and carrying 3 amperes at 120 volts A.C. The front panel of the detector amplifier unit shall contain a "Detection Indicator Lamp" that will pulse as each actuation is registered.

M.16.14—Control Cable: The materials for this work shall conform to the following requirements:

1. General: All cable and wiring to be used on this project shall conform to the appropriate articles of

the NEC.

2. Conductors: Traffic control conductors shall be designed for 600 volts, AC and shall be of solid copper, having conductivity in accordance with IMSA and NEC standards.

The size of the conductors shall be as indicated on the plans.

3. Cable: Traffic control cable shall be multi-conductor and polyvinyl chloride or polyethylene sheathed. Insulation shall be polyethylene. Sheathed insulation and color coding shall conform in all respect to IMSA Specification No. 19-1 or No. 20-1, whichever is applicable. The Contractor shall furnish a manufacturer's warranty that the cable furnished is resistant to damage and deterioration by sustained contact with greases or oil.

Magnetic and loop detector lead-in cable shall be two conductor cable using stranded tinned copper conductors, color-coded polyethylene insulation, an aluminum backed mylar shield with a stranded tinned copper drain wire over the twisted pair, a black polyethylene outer jacket, and is listed under U.L. Style 2106. The loop lead-in cable shall conform to I.M.S.A. specification 50.2.

4. Number of Conductors: Sufficient signal light conductors shall be provided to perform the functional operation of the signal system. The number of conductors utilized shall be as indicated on the plans or as directed by the Engineer. Power supply cable between the sources of power and the controller shall consist of 600-volt, 2-conductor stranded wire of the size and type called for on the plans.

The number of conductors set forth in the plans is the minimum number that the Contractor shall supply. The Contractor may supply more than the specified number of conductors at his own expense.

5. Cable Closure: The cable closure shall be made of Neoprene construction. Internal brackets shall be aluminum and external parts shall be stainless steel or aluminum. The cable closure shall be provided with 4 entrances, each of which will accommodate cable with a diameter of .6 inches to 1 inch (15 millimeters to 25 millimeters). The size of the closure shall be as shown on the typical plan sheet. The cable closure shall be provided with the minimum number of terminal blocks shown on the plans. Each terminal block shall be provided with 12 brass studs, nuts, and 24 washers. The block shall be a solid injection molded ABS (acrylonitrile butadiene styrene) that has a low moisture absorption rate. The terminal blocks shall be approximately 3 1/4 inches wide x 1 1/2 inches high x 1/2 inch thick (83 millimeters wide x 38 millimeters high x 13 millimeters thick) and be provided with mounting studs.

M.16.15—Messenger and Span Wire: The materials for this work shall conform to the following requirements:

1. Messenger wire shall be made of double-galvanized 7-strand steel wire cable not less than 3/16 inch (4.8 millimeters) in diameter and 2,400-pounds (10.7-kilonewtons) breaking strength, utilities grade.

2. Span wire shall be double galvanized 7-strand steel wire cable not less than 3/8 inch (9.5 millimeters) in diameter and 11,200-pounds (50-kilonewtons) breaking strength, utilities grade.

3. All hardware accessories as shown on the plans used in span wire or messenger mounting shall be of high strength, double galvanized, first-quality materials.

M.16.16—Vacant

M.16.17—Illuminated Signs: The sign shall be a blank-out type which shall display the type of message specified, through the use of light-transmitting fiber optic bundles.

The legend displayed shall be in accordance with the plans. Shop drawings of the front panel showing the lettering, and the type of visor shall be submitted for approval. The message shall be clearly legible under any lighting condition without the need for a visor or hood and attract attention at full intensity, anywhere within a 20-degree cone centered about the optical axis. The message shall be blank when not illuminated.

The non-lensed bundles shall be fully bifurcated for burnout protection with 8 lamps. The diameter of the fiber bundles shall be as shown on the plans. There shall be a separate fiber bundle, from each of the light sources, displayed in a row along the bottom of the sign to indicate lamp outage. All fiber optics, transformers and lamps shall be mounted on the hinged door of the unit. The blank-out sign assembly shall display the message in "Lunar White." Type "ENL" quartz-halogen lamps shall be used to illuminate the message. These lamps shall operate between 10.5 and 10.8 volts via the supplied step-down transformers. Average lamp life shall be not less than 8,000 hours. The lamps shall be mounted horizontally. "Overhead Illuminated 'Stop Ahead' Signs" shall have an 8-lamp minimum.

The electrical connection shall be provided by an internal barrier-type strip for connecting the electrical service wires. There shall be a 15 amp A.C. snap switch mounted in a utility box on the inside of the sign, enabling the sign to be shut off during maintenance. Power consumption for the message shall be less than 500 Watts.

A weatherproof housing of the dimensions specified on the plans shall be provided to enclose the fiber

optic module assembly with bifurcated output fiber bundles, color filters, light sources and transformers. The sign housing frame shall be manufactured from extruded aluminum, 6061-T6, ASTM B-221. This assembly shall be provided with a hinged access door. The hinge shall be stainless steel piano type hinge mounted on the left side of the door. All external hardware shall be stainless steel, internal hardware shall be corrosion resistant. The housing shall have a minimum of four 1-inch (25-millimeter) diameter drainage holes. The entire front face of the sign shall be protected by a 1/8 inch (3.2 millimeter) thick sheet of clear polycarbonate mounted in the door frame. The housing shall be Federal Yellow according to Federal Standard 595 Color No. 13538 and the aluminum front panel shall be flat black according to Federal Standard 595 Color No. 37031 unless otherwise specified on the plans. The complete sign assembly shall not have a mass of more than 150 pounds (68 kilograms).

The legend displayed for an "Overhead Illuminated 'Stop Ahead' Sign" shall consist of letters 12 inches (305 millimeters) high and approximately 9 inches (230 millimeters) wide formed by fiber optic bundles spaced approximately 1.5 inches (38 millimeters) apart. The sign shall be supplied completely assembled and ready to be checked out.

SECTION M.17
ELASTOMERIC MATERIALS

M.17.01—Elastomeric Bearing Pads

M.17.02—Elastomeric Compression Seal

M.17.01—Elastomeric Bearing Pads: Elastomeric bearing pads shall be of the compound known as neoprene. All laminated bearings, and unlaminated bearings more than 1 inch (25 millimeters) thick, shall be individually cast in molds under pressure and heat and shall be of the size and grade indicated on the plans. Unlaminated bearings of 1 inch (25 millimeters) or less in thickness may be cut from sheet stock. All elastomeric bearing pads shall meet the requirements listed herein. Test specimens shall be in accordance with ASTM Method D 15, Part B.

1. Elastomer:

(a) Physical Properties

Grade (Durometer)	50	60	70
Original Physical Properties	50±5	60±5	70±5
Hardness ASTM D 2240			
Tensile strength, minimum psi (megapascals) ASTM D412	2,500 (17)	2,500 (17)	2,500 (17)
Elongation at break, minimum %	400	350	300
Accelerated Tests to Determine Long-Term Aging Characteristics Oven Aged-70 hrs./212°F (100°C), ASTM D 573			
Hardness, points change, maximum	+15	+15	+15
Tensile strength, % change, maximum	-15	-15	-15
Elongation at break, % change, maximum	-40	-40	-40
Ozone-1PPM in Air by Volume- 20% Strain -100± 2°F (38±1°C) ASTM D 1149* 100 Hours	No cracks	No cracks	No cracks
Compression Set-22 Hrs./212°F (100°C), ASTM D 395-Method B, % maximum ASTM D 746- Procedure B	35	35	35
Brittleness at -40°F (-40°C.)	No failure	No failure	No failure

*Samples to be solvent wiped before test to remove any traces of surface impurities.

**Effective rubber thickness.

(b) Oil Swell Test: The volume of elastomer, when submerged in ASTM Oil No. 3 for 70 hours at 212°F (100°C) shall not increase by more than 120% as tested by the procedure contained in ASTM D 471.

2. Laminae:

(a) Laminae where so noted on the plans, shall be of the thickness, material and number noted. Steel laminae shall be blast cleaned before being cast integrally with the elastomer, and shall be ASTM A 36 steel or an approved steel equivalent. Aluminum laminae shall be pickled before being cast integrally with the elastomer and shall meet the requirements of AA 6061-T6. Cut edges or perforations of the laminae shall be at least as smooth as USASI 250 finish.

(b) The length and width of the laminae shall be 3/8 inch (9.5 millimeters) (± 1/16 inch (1.6 millimeters)) less than the pad dimension. The thickness of the laminae shall be as shown on the plans

+0.012 inch (+0.3 millimeter). The vertical dimensions for the position of the laminae shall be as shown on the plans $\pm 1/16$ inch (1.6 millimeters). The vertical dimension between the bottom of the pad and any point on a particular laminae shall not vary by more than $1/16$ inch (1.6 millimeters). The laminae shall have a minimum $1/16$ -inch (1.6-millimeter) side cover after the pad is manufactured.

3. Fabricated Pads:

(a) The elastomeric bearing pads shall conform to the following requirements:

(1) The finish, flash and bond of laminated bearings shall conform to the following requirements as noted in RMA, Rubber Handbook, latest edition.

Symbol	Requirements & Reference
F3	Finish—Table V
T.063	Flash—Table VI

B2 Grade 2, Method B Rubber to Metal Bonding, Tables VII and VIII

(2) The dimensional tolerances of plain and laminated bearings shall conform to the dimensions and configurations required by the plans and these specifications with the following permissible variations.

1. Overall Vertical Dimensions	
Average Total Thickness	- 0,+1/8 inch
1 1/4 inch (32 millimeters)	(3.2 millimeters)
or less	- 0,+1/4 inch
Average Total Thickness over	(6.4 millimeters)
1 1/4 inches (32 millimeters)	
2. Overall Horizontal Dimension	
36 inches (914 millimeters)	- 0,+1/4 inch
and less	(6.4 millimeters)
Over 36 inches (914 millimeters)	- 0,+1/2 inch
	(12.5 millimeters)
3. Thickness of Individual Layers of Elastomer (Laminated Bearings Only)	
	$\pm 1/8$ inch
	(3.2 millimeters)
4. Variation from a Plane Parallel to the Theoretical Surface (as determined by measurements at the edges of the bearings)	
Top	1/8 inch
	(3.2 millimeters)
Sides	1/4 inch
	(6.4 millimeters)
Individual Non-Elastic Laminates	1/8 inch
	(3.2 millimeters)
5. Position of Exposed Connection Members	
	1/8 inch (3.2 millimeters)
6. Edge Cover of Embedded Laminates or Connection Members	
	- 0,+1/8 inch (3.2 millimeters)
7. Size of Holes, Slots or Inserts	
	$\pm 1/8$ inch (3.2 millimeters)
8. Position of Holes, Slots or Inserts	
	$\pm 1/8$ inch (3.2 millimeters)

Buffing, cutting, or any other attempt to alter the size of the pads, for the purpose of meeting the tolerances stated herein will not be permitted.

(b) The following values shall be met under laboratory testing conditions of full size bearings:

- (1) Compressive strain of any layer of an elastomeric bearing shall not exceed 7% at 800 psi (5.5 megapascals) average unit pressure, or at the design dead load plus live load pressure if so indicated on the plans.
- (2) The shear resistance of the bearing shall not exceed 50 psi (345 kilopascals) for 50 Durometer, 75 psi (517 kilopascals) for 60 Durometer or 110 psi (758 kilopascals) for 70 Durometer at 25% strain of the total effective rubber thickness after an extended 4-day ambient temperature of -20°F (-29°C).
- (c) A minimum of 30 days prior to the installation of the elastomeric bearing pads, the Contractor shall deliver to the job site the required number of pads for installation plus the required number of test pads. Pads shall be packed in containers holding not more than 10 pads. The pads in one container shall be of the same type, size and shall be for one structure only. The containers shall be plainly marked with the type and number of pads, the project number, the bridge number, the name of the manufacturer and the lot number. A lot of elastomeric bearing pads is defined as the number of pads manufactured from one batch of elastomer. A batch of elastomer is defined as the amount of elastomer prepared and compounded at one time. The Contractor shall furnish Certified Test Reports and Materials Certificates for each lot in conformance with the requirements set forth in Article 1.06.07.
- (d) For structures requiring less than 50 pads, one test pad shall be furnished. For structures requiring more than 50 pads, 1 extra test pad shall be furnished for each additional 50 pads or part thereof. If there are two or more types of pads in one structure, and only one test pad is required, the test pad will be furnished for the type of which there are the greater number. All test pads shall be furnished without charge.
- (e) All of the pads on one structure shall be manufactured by the same firm.
- (f) Pad Identification: Each pad shall have embossed on it the following: the word "Conn." the project number, the manufacturer's identification code, the pad type number, and the month and year of manufacture. The pad shall also have stenciled on it, with indelible ink the bridge number, the lot number and the pad number. The location of the identification shall be as shown on the plans.

4. Adhesive for Bonding:

- (a) The adhesive for bonding the elastomeric bearing pads to steel or to the concrete surfaces where indicated on plans shall be an approved type and shall be a controlled setting adhesive made of such materials that it is compatible with the elastomeric pads, steel and concrete.
- (b) The adhesive shall be a two-component, contact, long-lasting, high bonding strength material and shall be an air curing adhesive meeting the following requirements:

Property	Requirement	ASTM Test Procedure
Tensile Strength, min., psi (megapascals)	1800 (12.5)	D 412
Elongation before breaking, min., %	750	D 412
Brookfield Viscosity @ 77°F (25°C), #2 Spindle @ 10 rpm, pascal-seconds	2500 - 3500 (2.5-3.5)	D 1084
Average Mass per gallon, pounds (liter, kilogram)	7.60 ± (0.91)±5%	

The 90° peel-pull test is described in MIL-R-15058G (ships) shall exceed 35 psi (241 kilopascals). If the adhesive which is applied to the bonded surfaces requires a primer, the primer shall be supplied by the manufacturer of the adhesive.

- (c) The Contractor shall deliver the adhesive and primer (if primer is required) to the job site a minimum of 30 days prior to installation. Each separate container of adhesive and primer shall be clearly tagged or marked with the manufacturer's name, trade-mark and batch number. A batch is defined as that amount of adhesive that can be prepared and compounded at one time. The Contractor shall furnish Certified Test Reports and Material Certificates for each batch in conformance with the requirements set forth in the Article 1.06.07.

M.17.02—Elastomeric Compression Seal: The material shall be a polychloroprene elastomer. It shall be resistant to heat, oil, and ozone, be resilient, and shall be compatible with concrete and steel. The elastomeric compression seal shall conform to the requirements of ASTM D 3542.

The compression seal in each lot shall be plainly marked with the manufacturer's name, trademark and lot number. A lot shall be defined as that amount of compression seal extruded from one batch of elastomeric compound for each width indicated on the plans. A batch shall be defined as that amount of elastomeric compound prepared and compounded at one time. The Contractor shall furnish Certified Test Reports and Materials Certificates for each lot in conformance with the requirements set forth in Article 1.06.07.

The Contractor shall deliver the compression seal to the job site a minimum of 15 days prior to installation. The compression seal shall be in a separate length or lengths for each joint as shown on the plans and each separate length shall be clearly marked for identification with the manufacturer's name, trade mark and lot number.

Prior to delivery of the compression seal the Contractor shall notify the Engineer of the date of shipment and the expected date of delivery. Upon delivery of the compression seal to the job site, the Contractor shall immediately notify the Engineer.

The Contractor shall furnish a 2-foot (610-millimeter) extra length of compression seal, identified by lot number, in each lot for purposes of inspection and testing by the Engineer. The Engineer may also inspect each separate piece of compression seal at each end to determine the conformance to the requirements stated herein.

The Engineer may reject any lot or portion of a lot that does not conform to the requirements stated herein. A rejected lot or portion of a lot may be resubmitted provided the Contractor has removed or corrected, in a manner acceptable to the Engineer, all nonconforming material.

Lubricant-Adhesive: The lubricant-adhesive shall be a controlled setting adhesive conforming to one of the following systems.

System A: The lubricant-adhesive shall be a 1-component polychloroprene compound containing only soluble phenolic resins blended together with anti-oxidants and acid acceptors in an aromatic hydrocarbon solvent mixture and shall have the following physical properties:

Average net weight per gallon (mass per liter)	7.84 pounds (0.94 kilograms) ± 5%
Solids Content	24% min. by weight (mass)
Brookfield Viscosity (77°F (25°C), #2 spindle at 10 RPM) or approved equal	6500 - 7500 centipoise second (6.5-7.5 pascal·seconds)
The adhesive shall remain fluid from	5°F to 120°F (−15°C to 49°C)
Film Strength (ASTM D 412) 750% min. elongation before breaking	2300 psi (16 megapascals) min. tensile strength

System B: The lubricant-adhesive shall be a one-part moisture curing polyurethane and hydrocarbon solvent mixture and shall have the following physical properties:

Average net weight per gallon (mass per liter)	8.00 pounds (0.96 kilograms) ± 10%
Solids Content	72-74% by weight (mass)
Adhesive to remain fluid from	5°F to 120°F (−15°C to 49°C)
Film Strength (ASTM D 412)	1200 psi (8.5 megapascals)
Elongation	350%

Only one system shall be used in a project.

The adhesive shall be stored at a temperature of 50°F to 80°F (10°C to 27°C).

Any adhesive not used within 270 days of its manufacture shall be unacceptable.

Each batch of the lubricant-adhesive shall be delivered in containers plainly marked with the manufacturer's name or trade mark and batch number. A batch shall be defined as that amount of lubricant-adhesive compounded at one time. The Contractor shall furnish Certified Test Reports and Materials Certificates for each batch in conformance with the requirements set forth in Article 1.06.07.

**SECTION M.18
SIGNING**

- M.18.01--Overhead Sign Support**
- M.18.02--Anchor Bolts**
- M.18.03--Vacant**
- M.18.04--Vacant**
- M.18.05--Vacant**
- M.18.06--Vacant**
- M.18.07--Delineators**
- M.18.08--Paint for Sign Panel Overlay**
- M.18.09--Reflective Sheeting**
- M.18.10--Demountable Copy**
- M.18.11--Sign Panels-Extruded Aluminum**
- M.18.12--Panel Bolt Assemblies and Post Clip Assemblies**
- M.18.13--Sign Face--Sheet Aluminum**
- M.18.14--Metal Sign Posts**
- M.18.15--Sign Mounting Bolts**

M.18.01--Overhead Sign Support:

1. Pipes and Flanges

A. Overhead Truss Supports

Pipes for end support posts shall conform to the requirements of ASTM A 53, Grade B. Pipes for all overhead truss members and end support web members shall conform to the requirements of ASTM A 53, Grade B.

150 pounds and 300 pounds (68 kilograms and 136 kilograms) ASA Flanges for truss chord splices shall be lap joint type and shall conform to the requirements of ASTM A 181, Grade II. 400 pounds (182 kilograms) ASA lap joint flanges for truss chord splices shall conform to the requirements of ASTM A 105/A 105M, including the Supplementary Chemical Requirements of Table 1 and the Mechanical Properties of Table 2, of ASTM A 105.

B. Overhead Cantilever Supports

Pipes for posts, truss chords and truss web members shall conform to the requirements of ASTM A 53, Grade B.

Flanges for splices between outer and inner sections of truss chords shall be 150 pounds (68 kilograms) ASA Flanges, lap joint type, and shall conform to the requirements of ASTM A 181, Grade II. Special flanges and attached plates for truss chord to post attachment shall conform to the requirements of ASTM A 588A 588M.

2. Stainless Steel plates shall conform to the requirements of ASTM A 240, Type 304.

3. Base plates and attached stiffener plates shall conform to the requirements of ASTM A 588A 588M.

4. All other elements except bolts and nuts shall conform to the requirements of ASTM A 36A 36M.

5. After complete fabrication, each of the fabricated steel sections of all sign supports shall be hot-dip galvanized in accordance with the requirements of ASTM A 123A 123M.

6. Nuts for anchor bolts shall conform to the requirements of ASTM A 563, Grade DH, self-locking type. Washers for anchor bolts shall conform to the chemical requirements of ASTM A 325, Type 1, and shall be quenched and tempered. Nuts and washers for anchor bolts shall be hot-dip galvanized in accordance with the requirements of ASTM A 153/A 153M, Class C. Nuts for anchor bolts shall be tapped oversize, after galvanizing, in accordance with ASTM A 563, Section 5.3, and shall be provided with a lubricant in accordance with the requirements of ASTM A 325.

High-Strength bolts, nuts and washers shall conform to the requirements of ASTM A 325, and shall be hot-dip galvanized in accordance with the requirements of ASTM A 153, Class C.

All nuts for high strength bolted connections including nuts for anchor bolts shall be "prevailing torque-reusable type" locking nuts.

7. All U-Bolts shall conform to the requirements of ASTM A 36/A 36M and shall be hot-dip galvanized in accordance with the requirements of ASTM A 153.

8. Square head bolts for supporting electrical equipment shall conform to the requirements of ASTM A 307.

9. Stainless Steel bolts shall conform to the requirements of ASTM A 193, Class 1, Grade B8. Stainless steel nuts shall conform to the requirements of ASTM A 194, Grade 8. Stainless steel lock washers shall conform to the requirements of ASTM A 167, Type 302.

M.18.02--Anchor Bolts: Anchor bolts shall conform to the requirements of ASTM A 449.

Leveling nuts and nuts for anchor bolt assemblies shall conform to the requirements of ASTM A 563, Grade DH. Leveling nuts and anchor bolt assemblies shall be hot-dip galvanized in accordance with the requirements of ASTM A 153/A 153M, Class C. Leveling nuts shall be tapped oversize, after galvanizing, in accordance with ASTM A 563, Section 5.3, and shall be provided with a lubricant in accordance with the requirements of ASTM A 325/A 325M.

The Pedestal grout leveling template shall conform to the requirements of ASTM A 36A 36M and shall be a minimum of 1/2 inch (12.5 millimeters) in thickness.

M.18.03--Vacant

M.18.04--Vacant

M.18.05--Vacant

M.18.06--Vacant

M.18.07--Delineators

1. Reflectors: The reflectors used in the delineator units shall have a reflective area, herein referred to as the lens, and a heat sealable plastic coated metallic foil back fused to the lens under heat and pressure around the entire perimeter of the lens to form a unit permanently sealed against dust, water and water vapor. The back and edge of the plastic shall be enclosed in an aluminum housing with a grommeted center mounting hole. Reflectors shall be either silver-white, amber or red as required.

The reflective lens shall be methyl methacrylate conforming to the requirements of FS L-P380B, 1968.

The lens shall consist of a smooth front surface free from projections or indentations other than a central mounting hole and identification with a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

a. Testing:

Definitions:

Entrance Angle shall mean the angle at reflector between direction of light incident on it and direction of reflector axis.

Observation Angle shall mean the angle at reflector between observer's line of sight and direction of light incident on reflector.

Specific Brightness shall mean candela returned at the chosen observation angle by a reflector per square inch (millimeter) of reflecting surface for each foot-candle (lux) of illumination at the reflector.

Optical Testing Procedure--The reflector shall be tested at observation angle station 1/10° and at entrance angle degrees 0° and 20° on the Esna Reflex Photometer at the photometric distance of 10 feet (3 meters).

The specific intensity of each reflex reflector intended for use in delineators shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

OBSERVATION ANGLE DEGREE	ENTRANCE ANGLE DEGREE	SPECIFIC INTENSITY CANDELA PER FOOT-CANDLE (LUX)		
		SILVER-WHITE	AMBER	RED
1/10°	0°	119 (11)	71 (6.6)	29 (2.7)
1/10°	20°	47 (4.4)	28 (2.6)	11 (1.0)

Seal Test--Samples shall be submerged in a water bath at the room temperature. The submerged samples shall be subjected to a vacuum of 5 inches gage (127 millimeters of Hg) for 5 minutes. The submerged samples shall then be restored to atmospheric pressure and remain submerged for 5 minutes more. The samples shall then show no water intake upon examination.

2. Metal Delineator Posts:

The "Standard Metal Delineator Posts" having a weight (mass) of approximately 1.12 pounds (1.7 kilograms) per linear foot (meter) shall be made of structural steel conforming to the requirements of ASTM A 36. The posts shall conform to the dimensions shown on the plans. After delineator mounting holes have been made, the posts shall be galvanized in accordance with ASTM A 123/A 123M.

3. Bridge Rail Mounting Brackets:

The bracket shall be made of 0.125-inch (3.2-millimeter) Aluminum Alloy 6061-T6 fabricated to the dimensions shown on the plans and shall be fastened to the metal bridge rail with two 3/8-inch (10-millimeter) diameter x 5/8-inch (16-millimeter) long cadmium plated steel box head self-tapping screws. Fasteners shall conform to the requirements indicated on the plans.

M.18.08--Paint for Sign Panel Overlay: The paint to be used for the finished coat shall be an extremely durable, highest quality, semi-gloss green enamel for use on plywood and metal signs and shall be resistant to air, sun and water.

It shall consist of pigments of the required fineness and composition ground in the required vehicle by a suitable grinding machine to the required fineness. All pigments, resins, oils, thinners and driers used shall be of the best quality, free from adulterants of any kind, and shall comply with the requirements below.

	Min.	Max.
Enamel Composition		
Pigment, %	40	—
Vehicle, %	—	60
Volatile matter in vehicle, % by weight (mass)	—	55
Coarse particles and skins retained on #325 (45 microns) screen, based on pigment, %	—	0.5
Viscosity, Krebs units at 77°F (25°C)	65	75
Weight per gallon, pounds (Mass per liter, kilograms)	10.5 (1.3)	—
Fineness of grind (North Standard)	5	—
Pigment Composition		
Chrome green, %	57	—
Extender pigment, %	—	43

The chrome green shall be Imperial A 4464 Velvet Green or approved equal.

The extender pigments shall consist of any one of the following or combination thereof: magnesium silicate, barium sulfate, or diatomaceous silica. A ratio of 50% magnesium silicate and 50% diatomaceous silica has been found to produce the desired semi-gloss.

Vehicle--The vehicle shall contain not less than 45% solids by mass and shall be composed of a long oil soya modified alkyd resin solution or solutions, petroleum solvent thinners and driers. Rosin or rosin derivatives shall not be present. The alkyd resin solution or solutions shall conform to FS TT-R-266, Type I, Class A of latest issue.

Specular Gloss--The enamel shall be flowed on a tin panel and allowed to dry for 24 hours before measuring. The specular gloss at 60° angle of incident, ASTM D 523 shall be between 35 and 45.

Color--Standard color chips may be obtained from the Connecticut Department of Transportation Division of Materials Testing, 280 West Street, Rocky Hill, Connecticut.

Setting and Drying Time--This enamel shall set to touch in less than 5 hours. It shall dry hard and tough in not more than 24 hours.

Flash Point--Not below 86°F (30°C) when determined by the Pensky-Martin Closed Flash Tester.

Water Resistance--The enamel shall be flowed on a tin panel and allowed to dry for 48 hours. After being immersed for 18 hours in distilled water, it shall show no blistering or wrinkles upon removal and shall show no dulling or change in color after two hours recovery.

Skinning--This enamel shall not skin over within 48 hours in a three-quarters filled, closed container. Small amounts of anti-skinning agents, wetting agents, suspension agents, and anti-drier absorption agents may be added at the discretion of the manufacturer.

Working Properties--The enamel shall be well ground, shall not settle in the container, and shall be capable of being broken up with a paddle to a smooth uniform enamel of good brushing consistency, and shall have good flowing, covering and leveling properties.

M.18.09--Reflective Sheeting:

1. Reflective sheeting materials shall appear on the Department's Approved Product List for the application intended.

2.--Bright Wide Angle Retroreflective:

- (1) **Description:** The retroreflective sheeting shall have a smooth surface with a distinctive interlocking diamond seal pattern and datum orientation marks visible from the face. The sheeting shall be precoated with a pressure sensitive adhesive backing protected by a removable liner. Bright wide angle retroreflective sheeting material shall appear on [the Department's Approved Products List](#) for the application intended.
- (2) **General Characteristics and Packaging:** The retroreflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks and extraneous materials, and shall be furnished in either rolls or sheets.

When furnished in continuous rolls, the average number of splices shall not be more than 3 per 54.7 yards (50 meters) of material with a maximum of 4 pieces in any 54.7-yard (50-meter) length. Splices shall be butted or overlapped and shall be suitable for continuous application as furnished. When furnished as cut sheets or sign faces, the sheeting shall be packaged flat in accordance with commercially accepted standards. The sheeting shall be packed in accordance with commercially accepted standards. Each carton shall clearly stipulate the brand, quantity, size, lot or run number and color. Stored under normal conditions the retroreflective sheeting as furnished shall be suitable for use for a minimum period of 1 year.

M.18.10--Demountable Copy: The materials for this work shall conform to the following:

1. Reflex Reflector:

Demountable copy consisting of plastic reflectors mounted in embossed aluminum frames shall be used where shown on the plans. All letters, symbols, and borders shall be demountable copy of the size and design conforming to the "Manual of Signs and Pavement Marking of the National System of Interstate and Defense Highways."

Demountable copy with plastic reflex-reflectors shall consist of reflectors securely supported by individual embossed metal frames. The metal frames shall be fabricated of no thinner than 0.040-inch (1-millimeter) sheet aluminum for copy and 0.032-inch (0.8-millimeter) aluminum for border. Both shall be thoroughly cleaned after fabrication and treated for protection against corrosion. The frame shall be neatly finished in a workmanlike manner and shall have embossed edges.

Frames shall be painted with three coats of white baking enamel. Metal part of the letters, digits, symbols, and borders shall withstand 50 hours of salt spray in accordance with the requirements of ASTM B117 with no evidence of rusting or pin holing. The frames shall be fastened to the panel background with aluminum rivets. Rivets shall be of the pull through type and of the size and number designated by the demountable copy manufacturer. Wherever a directional arrow is to be installed on a sign, the arrow shall be installed in the field.

The round reflectors shall consist of a clear, transparent face, hereinafter called the lens and a plastic back of identical material fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit permanently sealed against dust, water, or water vapor. Reflector units assembled with gaskets will not be acceptable.

Seal Test--Samples shall be submerged in a water bath at room temperature. The submerged samples shall be subjected to a vacuum of 5 inches gage (127 millimeters of Hg) for 5 minutes. The submerged samples shall then be restored to atmospheric pressure and remain submerged for 5 minutes more. The samples shall then show no water intake upon examination.

The lens shall consist of a smooth front surface free from projections or indentations other than for identification and a rear surface having a configuration that will effect internal reflection of light without the aid of plating or separate reflector.

The specific brightness of reflex or reflex reflectors shall be equal to or exceed the following minimum values when measurements are made with the reflectors spinning.

Entrance Angle Degrees	Observation Angle Degrees	Specific Brightness
		Candle Power (Square Inch) Foot (Candela Power (Square Millimeter) Lux)
0°	1/10°	14.0
20°	1/10°	5.6

For the purpose of testing optical performance, as designated herein, the following definitions are established:
 Entrance Angle--Angle at the reflector between direction of light incident on it and direction of reflector axis.
 Observation Angle--Angle at the reflector between observer's line of sight and direction of light incident on reflector.

Specific Brightness-Candela returned at the chosen observation angle, per square inch (square millimeter) of reflecting surface for each foot candle (lux) of illumination, at the reflector.

Optical Testing Procedure--The reflector shall be tested at observation angle station 1/10° and at entrance angle degrees 0° and 20° on the Esna Reflex Photometer at a photometric distance of 10 feet (3 meters).

2. Type III Reflective Sheeting:

Demountable cutout letters, digits, border, corner radii and copy accessories shall consist of adhesive coated reflective sheeting permanently adhered to flat aluminum backing. The reflective sheeting shall conform to Section M.18.09.01. The design of letters and accessories shall conform to FHWA Standards for use on "National System of Interstate and Defense" highways.

Aluminum backing shall be a minimum of .032-inch (0.8-millimeter) thick aluminum sheet of 3003-H14 alloy. Aluminum sheeting shall be properly treated according to sheeting manufacturer's specifications.

The demountable copy shall be fastened to the sign panel with aluminum rivets. Rivets shall be of the pull through type and of the size and number designated by the demountable copy manufacturer.

3. Non-Reflective Plastic Sheeting:

Description: Demountable cutout letters, digits, border, corner radii and copy accessories shall consist of adhesive-coated, non-reflective plastic sheeting permanently adhered to flat aluminum backing.

The material shall consist of a flexible, pigmented, plastic film completely pre-coated with a solvent or heat-activated, tack-free adhesive. The adhesive shall be protected by a treated paper liner, which shall be removable without soaking in water or other solvents. The non-reflective plastic sheeting shall conform to the following:

Property Requirements:

- A. Thickness: The thickness of the plastic film with adhesive shall be a minimum of 0.003 inch (76 microns) and a maximum of 0.004 inch (114 microns).
- B. Film: The unapplied or applied film shall be readily processed with, and insure adequate adhesion of, process inks recommended by the manufacturer.
 - (1) Flexibility: The material shall be sufficiently flexible to permit application over and conform to moderately contoured surfaces.
 - (2) Gloss: The film shall have an initial 60-degree gloss value of 35 (minimum), when tested in accordance with ASTM D 523, measuring at least three portions of the film to obtain uniformity.
- C. Adhesive: The pre-coated adhesive shall form a durable bond to smooth, clean, corrosion and weather-resistant surfaces, shall be of uniform thickness, non-corrosive to applied surfaces and shall have no staining affect on the film.
- D. Adhesion: The material, applied according to Paragraph I "Preparation of Test Panels" shall have sufficient bond to prevent removal from the panel in one piece without the aid of a physical tool.
- E. Exterior Exposure: The material shall withstand three years' vertical, south-facing exterior exposure at a sight acceptable to the Engineer, showing no appreciable discoloration, cracking, crazing, blistering, delamination, or loss of adhesion. A slight amount of chalking is permissible.

The film shall not support fungus growth.
- F. Dimensional Stability: The material shall show no more than 0.02 inch (397 microns) shrinkage in any direction from edge of the panel when prepared in accordance with Paragraph I after being subjected to a temperature of 149°F (65°C) for 48 hours.
- G. Heat Resistance: The material, applied according to Paragraph I, shall be heat-resistant enough to retain adhesion after 1 week at 149°F (65°C).
- H. Solvent and Chemical Resistance: The material, when prepared in accordance with Paragraph I, shall withstand immersion in the following liquids at 70-90°F (21-32°C), showing no appreciable decrease in adhesion, color or general appearance.

<u>Liquids</u>	<u>Time/Hours</u>
Reference Fuel (MIL-F-8799A) (15 parts xylol - 85 parts mineral spirits by mass)	1
Distilled Water	24
SAE #20 Motor Oil	24

- I. Opacity: When applied, the material shall be sufficiently opaque to hide a contrasting black printed legend and white surface.
- J. Preparation of Test Panels: Test panels shall be prepared using a 6.5 inch x 6.5 inch (165 millimeters x 165 millimeters) piece of the plastic film, applied to a clean 6.0 inch x 6.0 inch (150 millimeters x 150

millimeters) aluminum panel, premasked or as recommended by the manufacturer, trimmed evenly at the edge of the panel, and aged for 48 hours at 70 - 90°F (21-32°C).

- K. **Shelf-Life Storage:** The material shall withstand one year's shelf life when stored in a clean area free from exposure to excessive heat, moisture and direct sunlight.
- L. **General Characteristics and Packaging:** The plastic film shall be furnished in rolls, cut sheets or characters, as may be specified. The film, as supplied, shall be free from ragged edges, streaks, blisters, foreign matter or other surface imperfections which would make it unsuitable for the intended usage, and shall be readily cut with scissors, knife, blade, shears or other production tools. Complete and detailed instructions for mounting the plastic film shall be supplied with each package of material.
- M. **Quality Assurance:** For the non-reflective plastic sheeting a Certified Test Report conforming to 1.06.07 shall be submitted.

M.18.11--Sign Panels-Extruded Aluminum: Sign panels (extruded aluminum) shall be of the butt type, alloy 6063-T6 ASTM B 221. Several extruded sections shall be joined with panel nuts, bolts, and washers to achieve the desired sign size. The extruded aluminum panels shall be of 6-inch and 12-inch (150-millimeter and 300-millimeter) heights to achieve sign panel vertical dimensions in increments of 6 inches (150 millimeters); however, no more than one 6-inch (150-millimeter) panel shall be used on any one sign. The weight (mass) and section properties of the 6-inch and 12-inch (150-millimeter and 300-millimeter) extruded panels shall be as indicated on the plans.

On the vertical axis (the 6-inch or 12-inch (150-millimeter or 300-millimeter) dimension), the panel face shall be in the same plane within 0.015 inches (0.4 millimeters) in any six inches (150-millimeters). Extruded sections shall be mounted horizontally, and the panel faces shall be flush after the erection of the sign is complete.

Cleaning: Extruded aluminum sign panels shall be thoroughly cleaned and degreased by total immersion in an alkaline solution which is controlled and titrated to the solution manufacturer's recommendations. Immersion time shall be sufficient to completely remove all grease, dirt or other contaminants. After cleaning, the panels shall be thoroughly rinsed with clear running water.

Pretreatment: Sign panels shall be treated with a light, tightly adherent chromate conversion coating, free of any powdery residue, ranging in color from a silvery iridescent to a pale yellow, conforming with ASTM B 449, Class 2, 10-35 milligram/square foot (108-377 milligram/square meter), with 25 milligram/square foot (269 milligram/square meter) as the optimum coating weight.

M.18.12--Panel Bolt Assemblies and Post Clip Assemblies:

Panel Bolt Assembly: Aluminum hex head bolt, hex nut and washer shall be as shown on the plans and shall be used to unite several panels sections to conform to the designed sign size. Nuts shall be drawn tight. Bolt holes may be drilled or blanked to finished size.

Thread fit for bolts shall conform to class 2-A fit of American Standard Association.

Post Clip Assembly: Aluminum post clips square head bolt, lock nut and washer shall be as shown on the plans.

The shank of the post clip bolts shall fit tightly against the sign support flange after nuts have been tightened. The clip bolts shall be torqued to 225 inch-pounds (25.4 newton•meter) when using dry, clean, unlubricated threads.

M.18.13--Sign Face--Sheet Aluminum: Sheet aluminum sign blanks shall be constructed of sheet aluminum, alloy 6061-T6 or alloy 5052-H38. Sheet aluminum sign blanks shall conform to ASTM B 209. They shall be degreased and etched in accordance with the recommendations of the sheeting manufacturer or treated with a light, tightly adherent chromate conversion coating, free of any powdery residue, ranging in color from silvery iridescent to a pale yellow, conforming to ASTM B 449, Class 2 (10-35 milligrams/square foot) (108-377 milligrams/square foot) with 25 milligrams/square foot (269 milligrams/square meter) as the optimum coating. The thickness shall be as specified on the plans.

M.18.14--Metal Sign Posts: Metal sign posts, square tubular supports and parapet mounted sign supports shall conform to the requirements as noted on the plans. The size, shape and mass of posts and supports shall be as specified in the plans.

After fabrication of the posts and supports, including hole punching or drilling, they shall be galvanized as noted on the plans.

M.18.15--Sign Mounting Bolts: Bolts used for sign mounting shall be of aluminum alloy 2024-T4. Self-locking nuts shall be of aluminum alloy 2011-T3, 2014-T4 or 2017-T4. Aluminum alloys shall conform to the requirements of ASTM B 211.

LIST OF STANDARD PAY ITEMS

This list has been prepared for the convenience of those using these Standard Specifications, for the sole express purpose of locating quickly the information contained herein; and no claims shall arise due to omissions, additions, deletions, etc.

<u>Section Reference</u>	<u>Pay Item</u>	<u>Pay Unit</u>
2.01	Clearing and Grubbing	l.s. (l.s.)
2.02	Rock Excavation (No Explosives)	c.y. (cu. m)
2.02	Earth Excavation	c.y. (cu. m)
2.02	Rock Excavation	c.y. (cu. m)
2.02	Channel Excavation — Earth	c.y. (cu. m)
2.02	Channel Excavation — Rock	c.y. (cu. m)
2.02	Cut Concrete Pavement	l.f. (m)
2.02; 4.06	Cut Bituminous Concrete Pavement	l.f. (m)
2.02	Removal of Concrete Pavement	s.y. (s.m)
2.02	Unsuitable Material Excavation	c.y. (cu. m)
2.03	Structure Excavation— Earth (complete)	c.y. (cu. m)
2.03	Structure Excavation— Rock (complete)	c.y. (cu. m)
2.03	Structure Excavation— Earth (excluding Cofferdam and Dewatering)	c.y. (cu. m)
2.03	Structure Excavation—Rock (excluding Cofferdam and Dewatering)	c.y. (cu. m)
2.04	Cofferdam and Dewatering	l.f. (m)
2.05	Trench Excavation () Deep	c.y. (cu. m)
2.05	Rock-in-Trench Excavation () Deep	c.y. (cu. m)
2.06	Ditch Excavation	c.y. (cu. m)
2.06	Rock in Ditch Excavation	c.y. (cu. m)
2.07	Borrow	c.y. (cu. m)
2.08	Free-Draining Material	c.y. (cu. m)
2.09	Formation of Subgrade	s.y. (s.m)
2.10	Water Pollution Control	est. (est.)
2.10	Temporary Slope Protection	s.y. (s.m)
2.12	Subbase	c.y. (cu. m)
2.13	Granular Fill	c.y. (cu. m)
2.14	Compacted Granular Fill	c.y. (cu. m)
2.16	Pervious Structure Backfill	c.y. (cu. m)
2.18	Sedimentation Control Bales	l.f. (m)

2.19	Sedimentation Control System	l.f. (m)
2.19	Sedimentation Control (Type) System	l.f. (m)
3.02	Rolled Granular Base	c.y. (cu. m)
3.03	Concrete For Base	c.y. (cu. m)
3.03; 4.01	Mat Reinforcement for Concrete Pavement	s.y. (s.m)
3.03; 4.01	Transverse Expansion Joints	l.f. (m)
3.03; 4.01	Transverse Contraction Joints	l.f. (m)
3.03; 4.01	Longitudinal Joint Support	ea. (ea.)
3.03; 4.01	Type and Thickness Expansion Joint Filler	l.f. (m)
3.04	Processed Aggregate Base	ton (t)
3.05	Processed Aggregate	ton (t)
4.01	Concrete for Pavement	c.y. (cu. m)
4.03	Cold Reclaimed Asphalt Pavement	s.y. (s.m.)
4.03	Additional Aggregate	ton (t)
4.06	Bituminous Concrete, Class ()	ton (t)
4.06	Sawing and Sealing Joints	l.f. (m)
4.06	Cleaning and Sealing Joints and Cracks	lb. (kg)
4.06	Material for Tack Coat	gal. (L)
4.06	Cutting and Sealing Joint in the Bituminous Concrete Shoulder	l.f. (m)
4.06	Kerf Cut in Bituminous Concrete Pavement	l.f. (m)
4.14	Bituminous Material for Surface Treatment	gal. (L)
4.14	Sand Cover for Bituminous Surface Treatment	s.y. (s.m)
4.15	Pressure Relief Joint	s.y. (s.m)
5.03	Removal of Superstructure	l.s. (l.s.)
5.03	Maintaining Existing Bridge	l.s. (l.s.)
5.04	Railroad Protection	hr. (hr.)
5.06	Concrete for Steps and Copings	c.y. (cu. m)
5.07	(Type) Catch Basin	ea. (ea.)
5.07	(Type) Catch Basin Over () Deep	ea. (ea.)
5.07	(Type) Drop Inlet	ea. (ea.)
5.07	Manhole (Type)	ea. (ea.)
5.07	Manhole (Type) Over () Deep	ea. (ea.)
5.07	Reset Catch Basin (Type), Drop Inlet (Type), Reset Manhole	ea. (ea.)

5.07	Manhole Frame and Cover	ea. (ea.)
5.07	Convert Catch Basin to (Type) Catch Basin	ea. (ea.)
5.07	Convert Catch Basin to Manhole	ea. (ea.)
5.07	Convert Manhole to Catch Basin	ea. (ea.)
5.07	(Type) Catch Basin Top	ea. (ea.)
5.07	(Type) Junction Box	ea. (ea.)
5.07	(Type) Junction Box — Over () Deep	ea. (ea.)
5.08	Shear Connectors	l.s. (l.s.)
5.09	Welded Studs	ea. (ea.)
5.13	(Size) Polyvinyl Chloride Plastic Pipe	l.f. (m)
5.14	Prestressed Beams — Pretensioned, Type ()	l.f. (m)
5.14	Prestressed Deck Units (size)	l.f. (m)
5.21	Elastomeric Bearing Pads	c.i. (cu. dm)
5.22	(Size) Elastomeric Compression Seal	l.f. (m)
6.01	Concrete (Class _)	c.y. (cu. m)
6.01	Underwater Concrete	c.y. (cu. m)
6.01	Ornament Moulds	l.s. (l.s.)
6.01	(Type and Thickness) Joint Filler for Bridges	s.f. (s.m)
6.01	Metal Flashing	lb. (kg)
6.02	Deformed Steel Bars	lb. (kg)
6.02	Deformed Steel Bars - Epoxy Coated	lb. (kg)
6.02	Deformed Steel Bars - Galvanized	lb. (kg)
6.02	Deformed Steel Bars - Weldable	lb. (kg)
6.02	Welded Wire Fabric	lb. (kg)
6.02	Dowel Bar Splicer System	ea. (ea.)
6.02	Dowel Bar Splicer System - Epoxy Coated	ea. (ea.)
6.02	Dowel Bar Splicer System - Galvanized	ea. (ea.)
6.03	Structural Steel (Site No.)	l.s. (l.s.)
6.03	Structural Steel	cwt. (kg)
6.03	Structural Steel (Low Alloy)	cwt. (kg)
6.03	Wrought Iron	lb. (kg)
6.03	Structural Steel Sign Support	cwt. (kg)
6.05	Dimension Stone Masonry	s.y. (s.m)

6.05	Ashlar Stone Masonry	s.y. (s.m)
6.05	Pointing (Kind)	s.y. (s.m)
6.06	Cement Rubble Masonry	c.y. (cu. m)
6.07	Dry Rubble Masonry	c.y. (cu. m)
6.09	Repointed Masonry	s.y. (s.m)
6.11	Shotcrete	bag (bag)
6.12	Concrete Cylinder Curing Box	ea. (ea.)
6.51	(Size and Type) Pipe (Thickness)	l.f. (m)
6.51	(Size) C.C.M. Pipe-Arch (Thickness)	l.f. (m)
6.51	(Size and Type) Corrugated Metal Pipe Elbow	l.f. (m)
6.51	(Size) Corrugated Structural Plate Pipe (Thickness)	l.f. (m)
6.51	(Size) Corrugated Structural Plate Arch	l.s. (l.s.)
6.51	(Size) Corrugated Structural Pipe-Arch	l.s. (l.s.)
6.51	Re-laid Pipe (Type and Size)	l.f. (m)
6.51	Re-laid Pipe-Arch (Type and Size)	l.f. (m)
6.51	Bedding Material	c.y. (cu. m)
6.51	(Size) Slotted Drain Pipe	l.f. (m)
6.51	(Size) Temporary Slotted Drain Pipe	l.f. (m)
6.52	(Size-Type) Reinforced Concrete Culvert Ends	ea. (ea.)
6.52	(Size-Type) Metal Culvert Ends	ea. (ea.)
6.53	Clean Existing Catch Basin	ea. (ea.)
6.53	Clean Existing Manhole	ea. (ea.)
6.53	Clean Existing Drop Inlet	ea. (ea.)
6.53	Clean Existing Culvert — () to () Diameter	l.f. (m)
6.53	Clean Existing Culvert — Greater than () Diameter	l.f. (m)
7.02	Furnishing (Type) Piles (Lengths)	lb. (kg)
7.02	Driving (Type) Piles	l.f. (m)
7.02	Test Pile (Type-Length)	ea. (ea.)
7.02	Splicing (Type) Piles	ea. (ea.)
7.02	Point Reinforcement for (Type) Piles	ea. (ea.)
7.02	Pile Loading Test	ea. (ea.)
7.03	(Type) Riprap	c.y. (cu. m)
7.04	Gabions	c.y. (cu. m)

7.04	Polyvinyl Chloride Coated Gabions	c.y. (cu. m)
7.05	Slope Paving	s.y. (s.m)
7.07	Membrane Waterproofing (Woven Glass Fabric)	s.y. (s.m)
7.08	Damp-proofing	s.y. (s.m)
7.13	Permanent Steel Sheet Piling	s.f. (s.m)
7.14	Temporary Sheet Piling	s.f. (s.m)
7.15	Sheet Piling Material Left in Place	s.f. (s.m)
7.25	Bagged Stone	c.f. (bag)
7.28	Crushed Stone for Slope Protection	ton (t)
7.32	Concrete Block Slope Protection	s.y. (s.m)
7.51	(Size) Underdrain	l.f. (m)
7.51	(Size) Foundation Underdrain	l.f. (m)
7.51	(Size) Slope Underdrain	l.f. (m)
7.51	(Size) Structure Underdrain	l.f. (m)
7.51	(Size) Outlets for Underdrain	l.f. (m)
7.51	(Size-Type) Underdrain	l.f. (m)
7.51	(Size-Type) Foundation Underdrain	l.f. (m)
7.51	(Size-Type) Slope Underdrain	l.f. (m)
7.51	(Size-Type) Structure Underdrain	l.f. (m)
7.51	(Size-Type) Outlets for Underdrain	l.f. (m)
7.55	Geotextile	s.y. (s.m)
7.55	Geotextile (Type)	s.y. (s.m)
8.03	Paved Ditch	s.y. (s.m)
8.03	Paved Channel	s.y. (s.m)
8.11	Concrete Curbing (Type)	l.f. (m)
8.13	Stone Curbing (Type-Size)	l.f. (m)
8.13	Curved Stone Curbing	l.f. (m)
8.14	Reset Curbing (Type-Size)	l.f. (m)
8.15	Bituminous Concrete (Type) Curbing	l.f. (m)
8.16	Granite Slope Curbing (Size)	l.f. (m)
8.16	Curved Granite Slope Curbing (Size)	l.f. (m)
8.18	Protective Compound for Bridges	s.y. (s.m)
8.21	Precast Concrete Barrier Curb (Size)	l.f. (m)

8.22	Temporary Precast Concrete Barrier Curb	l.f. (m)
8.22	Relocated Temporary Precast Concrete Barrier Curb	l.f. (m)
9.04	Metal Bridge Rail (Type)	l.f. (m)
9.05	Stone Wall Fence	l.f. (m)
9.06	Wire Fence with Wood Posts	l.f. (m)
9.06	Wire Fence with Metal Posts	l.f. (m)
9.07	Barway	ea. (ea.)
9.08	Farm Wall Fence	l.f. (m)
9.10	Metal Beam Rail (Type)	l.f. (m)
9.10	Metal Beam Rail R-B 350 (Type I, II or III) Section	ea. (ea.)
9.10	(Type) Attachment	ea. (ea.)
9.10	Convert Metal Beam Rail (Type) to Metal Beam Rail (Type)	l.f. (m)
9.10	(Type) Curved Guide Rail Treatment	ea. (ea.)
9.11	(Type) End Anchorage Type I	ea. (ea.)
9.11	(Type) End Anchorage Type II	ea. (ea.)
9.11	Anchor in (Type) Slope	ea. (ea.)
9.12	Reset (Type) Cable Guide Rail (Type Post)	l.f. (m)
9.12	Reset Metal Beam Rail (Type) (System)	l.f. (m)
9.12	Reset Single Post	ea. (ea.)
9.12	Reset Rail Anchorage	ea. (ea.)
9.12	Remove Single Post	ea. (ea.)
9.12	Remove Cable Guide Rail (Type)	l.f. (m)
9.12	Remove Metal Beam Rail (Type)	l.f. (m)
9.13	(Height) Chain Link Fence	l.f. (m)
9.13	(Height) Polyvinyl Chloride Chain Link Fence	l.f. (m)
9.13	(Type) (Size) Chain Link Gate	ea. (ea.)
9.13	(Type) (Size) Polyvinyl Chloride Chain Link Gate	ea. (ea.)
9.14	Metal Handrail	l.f. (m)
9.15	Tree Root Protection	c.y. (cu. m)
9.16	Noise Barrier Wall (Type and Designation)	s.f. (s.m)
9.18	Three-Cable Guide Railing (I-Beam Posts)	l.f. (m)
9.18	End Anchorage (Type)	ea. (ea.)
9.21	Concrete Sidewalk	s.f. (s.m)

9.22	Bituminous Concrete Sidewalk	s.y. (s.m)
9.22	Bituminous Concrete Driveway	s.y. (s.m)
9.23	Bituminous Concrete for Patching	ton (t)
9.24	Concrete Driveway Ramp	c.y. (cu. m)
9.25	Pavement for Railing	s.y. (s.m)
9.30	Object Marker (Type)	ea. (ea.)
9.39	Sweeping for Dust Control	hr. (hr.)
9.41	Service Bridge	ea. (ea.)
9.42	Calcium Chloride for Dust Control	ton (t)
9.43	Water for Dust Control	m. gal. (kL)
9.44	Furnishing and Placing Topsoil	s.y. (s.m)
9.45	(Wildflower Name)	lb. (kg)
9.46	Liming	ton (t)
9.47	Bus Passenger Shelter	ea. (ea.)
9.49	(Caliper) (Deciduous Tree Name)	ea. (ea.)
9.49	(Height) (Evergreen Tree Name)	ea. (ea.)
9.49	(Size) (Shrub Name)	ea. (ea.)
9.49	(Size) (Broad-leaved Evergreen Name)	ea. (ea.)
9.49	Vines (Name)	ea. (ea.)
9.49	Groundcover (Name)	ea. (ea.)
9.49	Wood Chip Mulch	s.y. (s.m)
9.49	Gravel Mulch	s.y. (s.m)
9.49	Spraying Glyphosate	s.y. (s.m)
9.50	Turf Establishment	s.y. (s.m)
9.50	Erosion Control Matting	s.y. (s.m)
9.51	Rock Excavation for Planting	c.y. (cu. m)
9.52	Selective Clearing and Thinning	l.s. (l.s.)
9.53	Sodding	s.y. (s.m)
9.70	Trafficperson	est. (est.)
9.71	Maintenance and Protection of Traffic	l.s. (l.s.)
9.73	Safety Patrol Service	hr. (hr.)
9.74	Removal of Existing Masonry	c.y. (cu. m)
9.75	Mobilization	l.s. (l.s.)

9.76	Barricade Warning Lights (Type)	day (day)
9.77	Traffic Cone	ea. (ea.)
9.78	Traffic Drum	ea. (ea.)
9.79	Construction Barricade (Type)	ea. (ea.)
9.80	Construction Staking	l.s. (l.s.)
9.81	42 – Inch (1m) Traffic Cone	ea. (ea.)
9.99	Disposal of Buildings	l.s. (l.s.)
10.01	Trenching and Backfilling	l.f. (m)
10.01	Rock in Trench – () Deep	c.y. (cu. m)
10.02	Light Standard Foundation (Type)	ea. (ea.)
10.02	Traffic Control Foundation (Type)	ea. (ea.)
10.02	Rock in Foundation Excavation	v.f. (v.m.)
10.03	Light Standard (Type-Size-Kind)	ea. (ea.)
10.04	Roadway Luminaire (Type-Size)	ea. (ea.)
10.06	Underbridge Luminaire (Kind-Type-Size)	ea.. (ea.)
10.08	(Size) (Kind) Conduit (Type)	l.f. (m)
10.09	Cast Iron Junction Box (Size)	ea. (ea.)
10.10	Concrete Handhole	ea. (ea.)
10.10	Concrete Handhole Type II	ea. (ea.)
10.10	Concrete Handhole Type II Bank Adapter	ea. (ea.)
10.10	Cast Iron Handhole Cover	ea. (ea.)
10.10	Concrete Handhole (Type)	ea. (ea.)
10.11	4 Inch (102 mm) Drain Pipe	l.f. (m)
10.12	Single Conductor (Size)	l.f. (m)
10.14	Cable in Duct (No.— Size)	l.f. (m)
10.15	Bare Copper Grounding Conductor (Size)	l.f. (m)
10.17	Service Entrance and Cabinet (Type)	ea. (ea.)
10.18	Navigation Light	ea. (ea.)
11.01	Pole Anchor	ea. (ea.)
11.02	Pedestal (Type and Size)	ea. (ea.)
11.03	(Type) Steel Span Pole	ea. (ea.)
11.03	(Type) Steel Combination Span Pole (Bracket Type)	ea. (ea.)
11.03	Wood Span Pole	ea. (ea.)

11.05	Traffic Signal (Type)	ea. (ea.)
11.06	Pedestrian Signal (Type)	ea. (ea.)
11.07	Pedestrian Push Button and Sign (Type)	ea. (ea.)
11.08	Pre-timed Controller (Type)	ea. (ea.)
11.08	Actuated Controller (Type)	ea. (ea.)
11.11	Loop Vehicle Detector (Type)	ea. (ea.)
11.11	Loop Detector Saw Cut	l.f. (m)
11.12	Magnetic Vehicle Detector (Type)	ea. (ea.)
11.13	(No.) Conductor # () (Type)	l.f. (m)
11.13	Cable Closure	ea. (ea.)
11.14	Messenger Wire	l.f. (m)
11.14	Span Wire	l.f. (m)
11.16	Overhead Illuminated "Stop Ahead" sign	ea. (ea.)
11.16	Internally Illuminated sign	ea. (ea.)
11.17	Alternate Flashing Signals for Warning Signs	ea. (ea.)
11.18	Removal and/or Relocation of Traffic Signal Equipment	l.s. (l.s.)
11.30	High Mounted Internally Illuminated Flashing Arrow	day (day)
11.31	Changeable Message Sign	day (day)
11.31	Remote Controlled Changeable Message Sign	day (day)
12.01	Overhead Truss Sign Support Type ()	ea. (ea.)
12.01	Overhead Cantilever Sign Support (Type)	ea. (ea.)
12.02	Overhead Truss Sign Support Foundation (Type)	ea. (ea.)
12.02	Overhead Cantilever Sign Support Foundation (Type)	ea. (ea.)
12.03	Side Mounted Sign Foundation	ea. (ea.)
12.04	Sign Panel Overlay—Plain	s.f. (s.m)
12.04	Sign Panel Overlay—with Copy	s.f. (s.m)
12.05	Type DE-() Delineator	ea. (ea.)
12.06	Removal of Existing Signing	l.s. (l.s.)
12.06	Removal of Existing Overhead Signing	l.s. (l.s.)
12.07	Sign Face—Extruded Aluminum (Type III Reflective Sheeting)	s.f. (s.m)
12.08	Sign Face—Sheet Aluminum (Type)	s.f. (s.m)
12.09	Painted Legend, Arrows and Markings	s.f. (s.m)
12.09	Painted Pavement Markings (Width) (Color)	l.f. (m)

12.09	Hot-Applied Painted Pavement Markings (Width) (Color)	l.f. (m)
12.10	(Width) (Color) Epoxy Resin Pavement Markings	l.f. (m)
12.10	Epoxy Resin Pavement Markings, Symbols and Legends	s.f. (s.m)
12.11	Removal of Pavement Markings (Type)	s.f. (s.m)
12.12	Temporary Plastic Pavement Marking Tape (Width) (Color)	l.f. (m)
12.14	(Width) Preformed Black Line Mask Pavement Marking Tape	l.f. (m)
12.16	(Width) Black Epoxy Resin Pavement Markings	l.f. (m)
12.16	Black Epoxy Resin Symbols and Legends	s.f. (s.m)
12.20	Construction Signs—Type III Reflective Sheeting	s.f. (s.m)
18.02	Type A Impact Attenuation Module (Weight(Mass))	ea. (ea.)
18.04	Type NC Impact Attenuation System	ea. (ea.)
18.06	Type D Portable Impact-Attenuation System	hr. (hr.)
18.07	Temporary Impact Attenuation System Type A Module (Weight (Mass))	ea. (ea.)
18.07	Temporary Impact Attenuation System (Type)	ea. (ea.)
18.07	Relocation of Temporary Type A Impact Attenuation Module	ea. (ea.)
18.07	Relocation of Temporary Impact Attenuation System (Type)	ea. (ea.)
18.07	Repair of Temporary Impact Attenuation System	est. (est.)

METRIC TO ENGLISH
APPROXIMATE CONVERSION FACTORS

<u>SYMBOL</u>	<u>WHEN YOU KNOW</u>	<u>MULTIPLY BY</u>	<u>TO FIND</u>	<u>SYMBOL</u>
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LENGTH

mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi

AREA

mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
km ²	square kilometers	0.386	square miles	mi ²
ha	hectares (10,000 m ²)	2.47	acres	ac

MASS

g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams (1000 kg)	1.103	short tons	T
(t)	(metric ton)		(2000 lb)	

VOLUME

mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F
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ILLUMINATION

lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl

FORCE and PRESSURE or STRESS

N	newtons	0.225	pound force	lbf
kPa	kilopascals	0.145	pound force per square inch	lbf/in ²

ENGLISH TO METRIC
APPROXIMATE CONVERSION FACTORS

<u>SYMBOL</u>	<u>WHEN YOU KNOW</u>	<u>MULTIPLY BY</u>	<u>TO FIND</u>	<u>SYMBOL</u>
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LENGTH

in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km

AREA

in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yards	0.836	square meters	m ²
mi ²	square miles	2.59	square kilometers	km ²
ac	acres	0.405	hectares	ha

MASS

oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb.)	0.907	megagrams (metric ton)	Mg (t)

VOLUME

fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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ILLUMINATION

fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²

FORCE and PRESSURE or STRESS

lbf	pound force	4.45	newtons	N
lbf/in ²	pound force per square inch	6.8	kilopascals	kPa